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## REVIEW

# Toward optimal prosthetic strategies: the biomechanical impact of design and material in posterior implant-supported fixed partial denture

Karina Mutiara Kasih Suwarno,<sup>1</sup> Ricca Chairunnisa,<sup>1,2</sup> Syafrinani<sup>1,2\*</sup>

### ABSTRACT

**Keywords:** Finite element analysis, High-performance polymers, Implant-supported fixed partial denture, Stress distribution, Zirconia

Implant-supported fixed partial dentures (iFPDs) are used for posterior rehabilitation. Biomechanical problems arise in the posterior due to complicated occlusal stresses and insufficient bone support. Prosthetic design and material stiffness affect stress distribution on peri-implant bone and components, affecting iFPD success. This systematic review examined the biomechanical performance of zirconia, PEKK, and PEEK two- and three-unit iFPDs with fixed-fixed and cantilever designs. FEA was used to evaluate stress distribution and clinical implications. PICO criteria and Boolean operators were used to search PubMed, Scopus, ScienceDirect, and MyEBSCO for 2020–2025 studies. Five of 158.353 documents met PRISMA 2020 criteria. Von Mises stress, prosthesis configurations, material stiffness, and stress concentration zones were extracted. Cantilever designs had the highest stress values, especially at the connector and prosthesis-abutment interface. Due to its stiffness, zirconia shielded the periimplant bone, while PEKK and PEEK reduced prosthesis stress but transferred more stress to the bone. Connectors were the most biomechanically susceptible in all designs and materials. The synergistic interplay between prosthetic design, material mechanical properties, and loading direction determines the stress distribution pattern and long-term stability of implant-supported prosthetic structures. (IJP 2025;7(1):1-7)

### Introduction

Implant-supported Fixed Partial Dentures (iFPDs) have become a common rehabilitative option for patients with posterior tooth loss. Rehabilitation in the posterior region presents complex biomechanical challenges due to high occlusal loads and uneven masticatory force distribution compared to the anterior region.<sup>1-3</sup> Two principal designs are typically employed in iFPDs: the fixed-fixed and cantilever configurations. Although the cantilever design is often selected for economic reasons or limited prosthetic space, it carries a higher biomechanical risk, as it can induce excessive stress concentration on peri-implant bone and prosthetic components—particularly when applied in the posterior area.<sup>4,7</sup> In contrast, the fixed-fixed design provides greater stability by allowing a more uniform load distribution between two or more supporting implants.<sup>8</sup>

With the advancement of prosthetic materials, zirconia has gained wide application due to its superior strength and esthetic properties. However, its high rigidity may increase stress at the implant–bone interface.<sup>9,10</sup> Conversely, high-performance polymers such as polyetheretherketone (PEEK) and polyetherketoneketone (PEKK) have been introduced as alternatives, offering a lower elastic modulus that enables better masticatory force absorption and reduces stress transmission to the bone.<sup>11-14</sup> Therefore, both material selection and prosthetic design must be carefully determined with respect to the biological and biomechanical conditions of patients.

According to Callister (2010), conventional testing methods for

allceramic fixed partial dentures have been extensively used in *in vitro* studies to evaluate fracture resistance. Although considered a standard approach, these methods possess inherent limitations, including time-consuming procedures, high costs, operator-dependent variability, and limited ability to reveal detailed internal stress distributions. Moreover, physical test outcomes are often influenced by microscopic flaws within the specimens, which are difficult to control and may lead to data inconsistencies.<sup>15</sup>

To overcome these limitations, Finite Element Analysis (FEA) has emerged as a preferred approach for biomechanical simulation in prosthodontics. By enabling numerical interpretation of complex structures, FEA provides a comprehensive visualization of stress distribution that cannot be achieved through conventional experimental methods. It allows for predicting of stress patterns in peri-implant bone, abutments, and prosthetic components under various loading and geometrical conditions.<sup>16-19</sup> Despite the extensive clinical application of implant-supported Fixed Partial Dentures (iFPDs), there remains a significant gap in understanding how the interplay between prosthetic design and material properties affects biomechanical stress distribution. Hence, a systematic review of contemporary evidence is essential to clarify the influence of design and material on biomechanical stress distribution. This review represents the first attempt to integrate design parameters, material

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

\*Corresponding author: [syafrinani@usu.ac.id](mailto:syafrinani@usu.ac.id)

**Table 1. Compilation of keywords and corresponding related terms.**

Component	Keywords	Related Terms
P (Population)	Zirconia, PEEK, or PEKK Implantsupported Fixed Partial Dentures	"Implant-supported Bridge" "Implant-Borne Prosthesis" "Posterior Implant Prosthesis" "Posterior Implant Bridge" "Implant-supported 2-abutment FPD" "3-unit Posterior Implant Prosthesis"
I (Intervention)	Fixed-Fixed design	"Fixed-Fixed Prosthesis" "Rigid Connector Design" "Fixed-Fixed Bridge" "Fixed-Fixed Configurations"
C (Comparison)	Cantilever design	"Cantilever Bridge" "Cantilever Prosthesis" "Cantilever Extension" "Cantilever-type Prosthesis" "Cantilever Framework" "Cantilever Configurations"
O (Outcome)	Biomechanical	"Finite Element Analysis" "Stress Distribution" "Fracture Resistance" "Mechanical Behavior" "Mechanical Properties" "Load-bearing Performance"

**Table 2. Summary database.**

Data Base	First screening based on keywords	Custom Range (2020-2025)	Subject Area	Document type, Source type, Language, Open access	Exclude screening	Title screening	Abstract screening	Fulltext screening
Scopus Data Base	53	25	14	12	11	9	4	1
PubMed	1164	300	291	87	85	64	6	1
MyEBSCO	1240	635	323	31	30	18	5	1
Science Direct	155.896	61.641	2.652	552	551	26	4	2
TOTAL	158.353	62.601	3.280	682	677	117	19	5

**Table 3. Assessment of the risk of bias in the included studies.**

Author (Year)	GM	MQ	MP	ETS	BC	LC	CD	A	MV	SA	OV	CR	Total (Max 24)
Aboelfadl et al. (2023)	2	2	2	2	2	2	2	2	0	0	2	2	20
Sadek et al. (2025)	2	2	2	2	2	2	2	2	0	1	2	2	21
Ahmed et al. (2022)	2	2	2	2	2	2	2	2	0	1	2	2	21
Alberto et al. (2022)	2	2	2	2	2	2	2	2	1	2	2	2	23
Botsali et al. (2025)	2	2	2	2	2	2	2	2	1	1	2	2	22

**Table 4. Biomechanical characteristics of restorative materials based on elastic modulus and poisson's ratio.**

Structure	Modulus Elastisitas (GPa)	Poisson's Ratio
Cortical Bone(15,22-25)	13.70	0.30
Cancellous Bone(22,24)	1.37	0.30
Prosthesis Monolithic Zirconia(22,23,25)	200	0.26
Prosthesis Polyetherketoneketone	3.5(25)	0.36(25)
	510(22)	0.36(22)
Titanium(24)	110	0.30
Implant Complex(22,23,25)	110	0.34
Implants Screws(15)	110	0.35
Framework Zirconia(15)	210	0.30
Framework PEEK(23)	3.5	0.36
Enamel(24)	841	0.33
Dentin(24)	18.6	0.32
Periodontal Ligament(24)	0.05	0.45
VITA Ambria(24)	100	0.20

characteristics, and stress locations within a unified biomechanical framework for posterior implant-supported Fixed Partial Dentures (iFPDs) using finite element analysis.

## Methods

### Protocol Registration and Research Question

The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA 2020) guidelines were followed in the preparation of this review, as shown in Figure 1. This review investigates the biomechanical performance of iFPDs with two distinct prosthetic designs, i.e. fixed-fixed and, cantilever fabricated from different prosthetic materials, including zirconia, PEEK, and PEKK was focused research question used in this study, using the PICO framework where (P) the population is iFPDs fabricated using zirconia, PEEK or PEKK materials, intervention (I) is fixed-fixed design, comparison (C) is cantilever design, and outcome (O) is biomechanical performance of stress distribution on peri-implant bone, implant components, and iFPDs materials.

### Eligibility Criteria

Inclusion Criteria; Inclusion criteria for this systematic literature review involved the following: (a) articles published in English, (b) articles published in the last 5 years between May 2020 and May 2025 (searches completed on 30 May 2025), (c) full-text research articles published in academic journals, (d) studies related to finite element analysis measurement method, and (e) evaluating the biomechanics of 3-unit implant supported prosthetic material using zirconia, PEEK or PEKK with fixed-fixed bridge design or cantilever bridge design; Exclusion Criteria; Exclusion criteria for this systematic literature review involved the following: (a) articles published more than 5 years ago or before May 2020, (b) articles published were not written in English, (c) autobiography, bibliography, biography, books and documents, interview, lecture, legal case, legislation, letter, meta-analysis, news, newspaper, study design randomized control trial, in vitro studies, case report, preprint, review, scientific integrity review or systematic review, (d) studies that are multi-unit prostheses, overdenture, tooth-implant supported prostheses, (e) full text not available/accessible, and (f) articles not published in academic journals.

Data Sources and Search Strategy; During the period from May 2020 to May 2025, the initial searches for this study were systematically conducted using four electronic databases, which are PubMed, ScienceDirect, Scopus, and MyEBSCO. We used these databases as they are recognized for the high-quality, peer-reviewed literature related to medicine and dentistry. Only English publications published during this period were selected. The literature search was conducted using a combination of keywords aligned with the research question, applying Boolean operators (AND, OR, NOT), quotation marks ("...") as part of the search strategy in each database MeSH terms (if applicable in PubMed) and TITLE-ABS-KEY (if applicable in Scopus/ScienceDirect/MyEBSCO) were utilized to integrate the terminology from each component. The list of keywords and their potential related terms is presented in table 1.

**Table 5. Data extraction results.**

TITLE, AUTHOR, YEAR & PUBLISHER	METHOD, MAGNITUDE AND DIRECTION OF LOADING	DESIGN AND MATERIAL FIXED PARTIAL DENTURE	VALUE OF VON MISES STRESS	MAIN CONCLUSION
Biomechanical behavior of implant retained prostheses in the posterior maxilla using different materials: a finite element study. Aboelfadl, et al. 2024 BMC Oral Health	In silico by using Finite Element Analysis with a total axial load of 300 N was statically applied in the axial direction on each experimental model, where each central fossa was subjected to a 100 N load.	DESIGN 3-unit implant-supported prostheses a. Fixed-fixed (MF-ZR, MF-PEKK) b. Mesial cantilever (MM-ZR, MM-PEKK) c. Distal cantilever (MD-ZR, MDPEKK) MATERIAL a. Monolithic zirconia b. Polyetherketone ketone (PEKK)	MAXIMUM FPD MD-Zr 105 MPa IMPLANT MD-PEKK 111,6 MPa PERI-IMPLANT BONE MD-PEKK 100,0 MPa MINIMUM FPD MF-PEKK 35,4 MPa IMPLANT MF-ZR 48,9 MPa PERI-IMPLANT BONE MF-ZR 19,6 MPa	Stress Distribution: -Monolithic zirconia as a rigid prosthetic material transmits less stress than PEKK to the implant and bone interfaces in implant-supported fixed prostheses. -Mesial cantilever design together with zirconia as a rigid prosthetic material is suggested as a second alternative with acceptable biomechanical behavior in clinically demanding conditions.
Biomechanical Evaluation of Cantilevered 2-Unit Implant Supported Prostheses: A 3D Finite Element Study Sadek, et al. 2025 International Dental Journal 75	In silico by using Finite Element Analysis: The first scenario involved applying a 100 N vertical load, the second used a 50 N oblique load at a 30° angle, and the third involved a 50 N oblique load at a 45° angle.	DESIGN 2-unit implantsupported prostheses: a. First premolar implant supporting a second premolar (M1) b. Second premolar implant supporting a first premolar (M2) c. Second premolar implant supporting a first molar (M3) d. First molar implant supporting a second premolar (M4) MATERIAL a. Monolithic Zirconia b. Polyetherketone ketone (PEKK)	MAXIMUM 100 N VERTICAL LOAD MODEL M3 PEKK 117 MPa CORTICAL BONE) 50 N OBLIQUE LOADING 30° MODEL M3 PEKK 95 MPa & Zr 90 MPa (IMPLANT) 50 N OBLIQUE LOADING 45° •MODEL M4 Zr 95 MPa (IMPLANT) •MODEL M1 Zr 82 MPa (PROSTHESIS) MINIMUM 100 N VERTICAL LOAD MODEL M2 Zr 37 MPa and PEKK 35 MPa (IMPLANT) 50 N OBLIQUE LOADING 30° MODEL M2 Zr and PEKK 35 MPa (PROSTHESIS) 50 N OBLIQUE LOADING 45° MODEL M2 Zr and PEKK 45 MPa (CORTICAL BONE)	Stress Distribution: -In the vertical loading scenario, the highest von Mises stress values were concentrated at the connectors of the cantilevered crowns. -The monolithic zirconia models showed slightly higher stress values in the prosthetic body. -Zirconia better resists bending forces and reduces implant stress compared to PEKK. PEKK models exhibited greater implant and cortical bone stress. -Oblique loading caused higher stress in implants and prostheses.
Effect of prosthetic design and restorative material on the stress distribution of implant-supported 3-unit fixed partial dentures: 3D-FEA Ahmed, et al. 2022 Brazilian Dental Science	In silico by using Finite Element Analysis. 6 different screwretained implant restorations were designed and fabricated using a CAD/CAM system. Each subgroup was subjected to a vertical load of 100 N, and their biomechanical behaviour was evaluated using a strain gauge (Kyowa, Japan)	DESIGN These implants were divided into three main groups according to each design: a. Group FB (fixed bridge) b. Group CB (cantilever bridge) c. Group SC (separate crowns) MATERIAL a. Ultratranslucent multi-layered zirconia b. Combination of PEEK framework and zirconia crowns.	MAXIMUM CANTILEVER ZIRCONIA 1098 MPa (RESTORATIONS) CANTILEVER ZIRCONIA 272053 MPa (IMPLANTS) MINIMUM FIXED-FIXED PEEK & ZIRCONIA 182,97 MPa (RESTORATIONS) FIXED-FIXED PEEK & ZIRCONIA 250.34 MPa (IMPLANTS)	Stress Distribution: -Among all prosthetic designs, the cantilever configuration consistently exhibited the highest von Mises stress values, irrespective of the type of restorative material applied -The fixed bridge showed the lowest von Mises stress values. -The lowest von Mises stress value was recorded in the fixed bridge with combined PEEK and zirconia. -The highest von Mises stress value was recorded in the cantilever bridge with the zirconia.
Three-Dimensional Finite Element Analysis of Different Connector Designs for All-Ceramic ImplantSupported Fixed Dental Prostheses. LHJ Alberto, et al. 2022 Multidisciplinary Digital Publishing Institute (MDPI)	In silico by using Finite Element Analysis. Evaluate the influence of the different radii of curvature of the gingival embrasure on the stress distribution of a three-unit allceramic implant-supported under a 100 N applied load at the central fossa of the pontic.	DESIGN The gingival embrasure radius of the distal 3-unit fixed-fixed implantsupported prostheses connector was adjusted: a. 0,25 mm b. 0,50 mm c. 0,75 mm MATERIAL Zirconia	MAXIMUM 0,25 mm 194 MPa MINIMUM 0,50 mm 56 MPa	Stress Distribution: •The radius of curvature of gingival embrasure had a significant influence on the stress distribution at the assessed components. •The tensile peak stresses at all structures were highest in the 0.25 mm model, while the 0.50 mm and 0.75 mm models presented similar values and more uniform stress distribution.
Mechanical Evaluation of Two Different ZirconiaReinforced Lithium Silicate Ceramics: a Finite Element Analysis Merve Botsali,et al. 2025 Ataturk University Publications	In Silico by using Finite Element Analysis. 500 N under vertical and oblique 45° loading to evaluate the von Mises and minimum principal stresses.	DESIGN Six different models were analyzed. -Tooth-supported anterior crown (TA) -Tooth-supported posterior crown (TP) -Tooth-supported 3-unit bridge (TB) -Implant-supported anterior crown (IA) -Implant-supported posterior crown (IP) - Implant-supported 3-unit bridge (IB) MATERIAL Zirconia-reinforced lithium silicate	MAXIMUM OBLIQUE 45° LOADING: •IMPLANTSUPPORTED BRIDGE (IBS) 179,95 MPa •IMPLANTSUPPORTED CROWN (IBA) 176,17 MPa MINIMUM TOOTH-SUPPORTED POSTERIOR CROWN (TP)	Stress Distribution: -Connector regions exhibited increased stress levels irrespective of the type of support, whether in tooth-supported or implant-supported bridge configurations -Tooth-supported restorations showed lower stress values than implantsupported forms of the same restoration. -Stresses were higher and distributed over a larger surface under oblique loading compared to vertical loading. Implant-supported bridge model under oblique loading -shows the highest stress. However, both milling and pressable forms of zirconiareinforced lithium silicate didn't make a difference on the stress concentration and distribution areas.

The search string used in Scopus/ScienceDirect/MyEBSCO: TITLE-ABSKEY ("Zirconia Implant-supported Fixed Partial Dentures" OR "Zirconia Implant-supported Bridge" OR "Zirconia Posterior Implant Prosthesis") AND TITLE-ABS-KEY ("Fixed-Fixed design" OR "Fixed-Fixed Prosthesis" OR "Rigid Connector Design") AND TITLE-ABS-KEY ("Biomechanical" OR "Finite Element Analysis" OR "Stress Distribution" OR "Fracture Resistance"). The search string used in PubMed: (("Zirconia Implant-supported

Fixed Partial Dentures"[All Fields] OR "Zirconia Implant-supported Bridge"[All Fields] OR "Zirconia Posterior Implant Prosthesis"[All Fields]) AND ("Fixed-Fixed design"[MeSH Terms] OR "Fixed-Fixed Prosthesis"[MeSH Terms] OR "Rigid Connector Design"[MeSH Terms]) AND ("Biomechanical"[MeSH Terms] OR "Finite Element Analysis"[MeSH Terms] OR "Stress Distribution"[MeSH Terms]) OR "Fracture Resistance"[MeSH Terms]]).

Choosing the Sources of Evidence; Following the comprehensive search across the designated databases, all identified records were subjected to a multistage screening process in accordance with the predefined eligibility criteria. The retrieved citations were initially exported to the Mendeley Reference Manager, where duplicate records were automatically identified and removed. Subsequently, the literature screening was performed using the Mendeley Reference Manager, which enabled independent and blinded assessment by all authors. During the first phase of screening, titles and abstracts were carefully examined to identify potentially eligible studies, and any records not meeting the inclusion criteria were excluded. In the second phase, full-text articles of the shortlisted studies were thoroughly reviewed to determine their final eligibility for inclusion in the analysis.

## Results

### Study Selection and Data Charting

The literature search process for this systematic review was concluded on July 4, 2025. The initial search, conducted using a keyword strategy formulated according to the PICO framework, yielded a total of 158,353 articles. Following subsequent filtering based on publication period (2020–2025), document type, English language, and open-access availability, the number of eligible articles was reduced to 682 for further assessment. The first stage of screening, performed by evaluating article titles, identified 117 potentially relevant publications. Thereafter, a comprehensive abstract screening was conducted, resulting in 19 articles deemed relevant and suitable for full-text review.

After the final evaluation for compliance with the predefined inclusion and exclusion criteria, five studies met all eligibility requirements and were ultimately included in the final analysis, as detailed in table 2. To ensure transparency and methodological rigor in the selection process, the PRISMA 2020 flow diagram was employed to illustrate the identification, screening, eligibility assessment, and final inclusion stages. The screening process adhered strictly to the predetermined inclusion and exclusion criteria, while also considering methodological appropriateness and topical relevance to the review's objectives.

### Quality Assessment

The methodological quality assessment of finite element modeling was performed on the five studies included in this systematic review using a 12-item appraisal tool specifically designed for *in silico* studies based on Finite Element Analysis (FEA) (21). Each item was scored on a scale of 0 (not reported), 1 (partially reported), and 2 (fully reported), with a maximum total score of 24, as presented in table 3. The five evaluated studies demonstrated good methodological quality, with total scores ranging from 20 to 23. The study by Alberto et al. (2022) achieved the highest score (23/24) due to comprehensive model validation and robust sensitivity analysis, whereas the study by Aboelfadl et al. (2023) obtained the lowest score (20/24) owing to insufficient reporting of model validation and sensitivity analysis. Figure 2 illustrates the distribution of total quality assessment scores across the included studies. Score Description: 2 = Fully addressed; 1 = Partially addressed or unclear; 0 = Not addressed.

Description of Evaluation Criteria; GM: Geometry Model; CD: Contact Definition; MQ: Mesh Quality; A: Assumptions; MP: Material Properties; MV: Model Validation; ETS: Element Type & Size; SA: Sensitivity Analysis; BC: Boundary Conditions; OV: Output Variables; LC: Loading Conditions; CR: Clinical Relevance.

### Synthesis of Results

One of the primary biomechanical param-

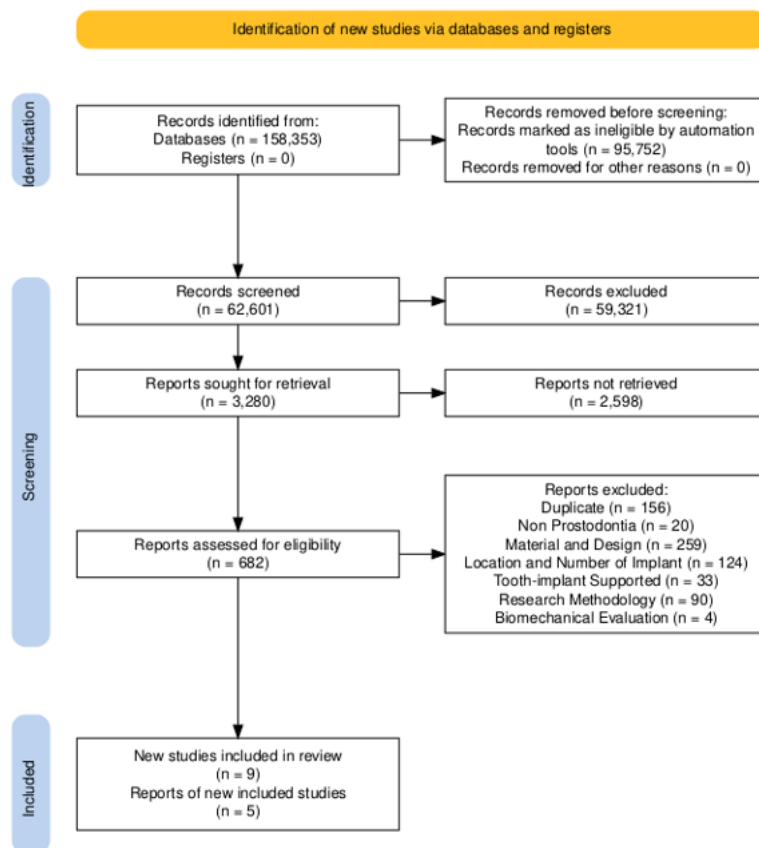
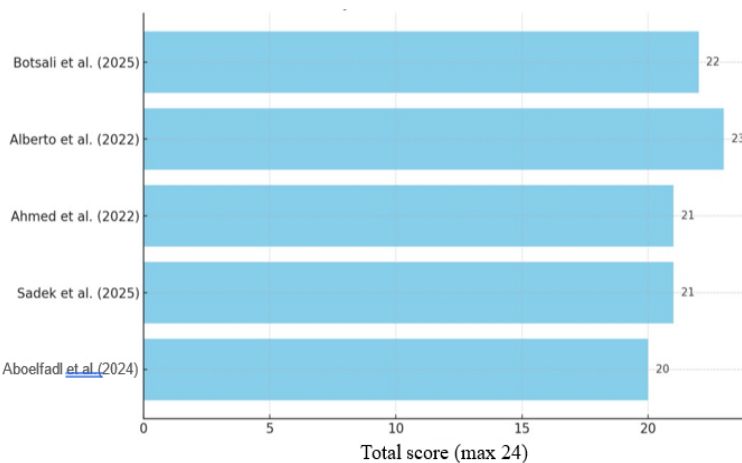
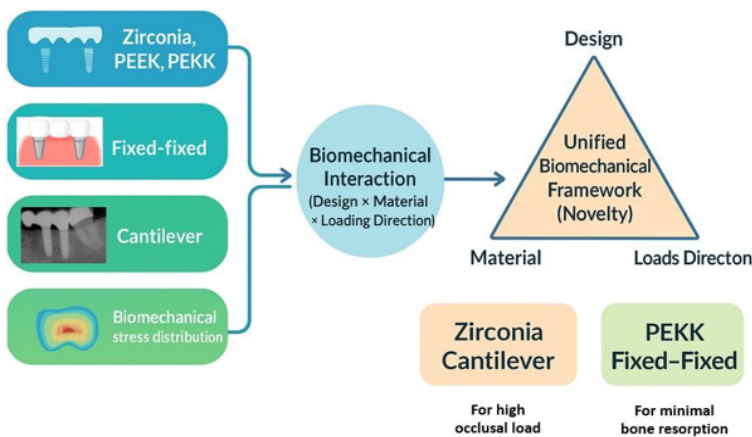


Figure 1. Flowchart of study selection process.

ters is the elastic modulus, which characterizes the stiffness of a material and influences the stress distribution within the prosthesis. Table 4 summarizes the elastic modulus and Poisson's ratio values of commonly used and analyzed structures in implant-related prosthodontics. Biomechanical data indicate that materials with a high elastic modulus, such as zirconia frameworks (210 GPa) and monolithic zirconia (200 GPa), exhibit substantially greater stiffness compared with cortical bone (13.7 GPa) and titanium implants (110 GPa). This suggests that zirconia tends to absorb stress within the prosthetic body, thereby providing a clinically beneficial stress-shielding effect on peri-implant bone. Conversely, materials such as PEEK and PEKK demonstrate considerably lower elastic moduli (~3.5–5.1 GPa), values that are closer to those of trabecular bone, implying higher elasticity and potentially greater load transmission to the supporting osseous structures, particularly when used in cantilever designs.



**Figure 2.** Bar chart of FEA quality assessment results based on total scores (Maximum 24).



**Figure 3.** Integrative biomechanical framework linking PICO structure to novelty in posterior implant-supported fixed partial dentures.

VITA Ambria (100 GPa) and enamel (84.1 GPa) exhibit intermediate stiffness, whereas the periodontal ligament, with an elastic modulus of 0.05 GPa, represents the most flexible component which is emphasizing the importance of accurate soft-tissue modeling in FEA simulations. The mismatch in elastic properties among these components directly contributes to the concentration of peak stresses, particularly at the connector regions and abutment interfaces, as illustrated in table 5.

### Discussion

In the modern biomechanical approach to implant-supported Fixed Partial Dentures (iFPDs), the focus extends beyond the inherent strength of restorative materials to encompass the stress distribution behavior within the entire bone-implant-prosthesis system. Recent comparative studies evaluating prosthetic designs made of monolithic zirconia and PEKK for implant restorations have demonstrated consistent biomechanical patterns. According to Sadek et al. (2025), monolithic zirconia prostheses exhibited slightly higher stress concentrations within the prosthetic body compared to PEKK, accompanied, however, by a significant reduction in stress values at the implant and cortical bone levels.<sup>22</sup> This trend aligns with the findings of Aboelfadl et al. (2024), in which the MF-Zr model recorded the lowest von Mises stress value of 19.6 MPa in cortical bone under vertical loading conditions.<sup>25</sup>

Conversely, Aboelfadl et al. (2024) reported that the MD-PEKK design demonstrated the highest bone stress value (up to 111.6 MPa), with localized stress concentrations near the distal offset extension an area clinically susceptible to biomechanical overloading. Furthermore, the MD-Zr model showed the highest von Mises stress within the prosthetic body (105 MPa), particularly at the interface between the prosthesis and the abutment adjacent to the offset extension.<sup>25</sup> Although stress concentration was higher within the prosthetic structure itself, this pattern indicates a superior stress-shielding effect for the supporting bone when zirconia is used. In contrast, PEKK, which exhibits lower internal prosthetic stress, tends to transmit a greater portion of the load to the surrounding bone structures, potentially increasing the long-term risk of alveolar bone resorption.

While several studies have emphasized the dominant role of material characteristics in influencing biomechanical stress behavior, emerging evidence suggests that prosthetic design may serve as a more critical determinant of stress distribution patterns, regardless of the material employed. In this context, comparisons among fixed-fixed, separate-crown, and cantilever designs have yielded inconsistent findings, forming a significant research gap that remains insufficiently addressed. Ahmed et al. (2022) reported that

prosthetic design exerts a greater impact on stress distribution than the choice of restorative material, with cantilever and separate-crown configurations generating the highest von Mises stress values. Moreover, as the length or complexity of the iFPD (e.g., 3-unit bridge) increases, stress magnitudes also rise, particularly in implant-supported iFPDs subjected to oblique loading.<sup>23</sup> These findings highlight the need for comprehensive biomechanical design considerations in prosthetic planning and encourage a reevaluation of design preferences for posterior regions subjected to high masticatory loads.

Alberto et al. (2022) and Botsali et al. (2025) further contributed valuable insights into the interplay between prosthetic design and material composition on stress distribution within iFPDs. Their studies revealed that both factors exert a significant influence on the biomechanical behavior of three-unit iFPDs. The regions of highest stress concentration were consistently located at the abutment–prosthesis interface and the occlusal surface zones of direct occlusal contact. Correspondingly, maximum stress values were also observed at the connector areas, regardless of the supporting configuration, identifying this region as a biomechanical weak point in the iFPD structure.<sup>24</sup> Other studies similarly reported that zirconia abutments exhibited high peak stress values, particularly at the cervical region on the buccal surface of the mesial abutment and the lingual surface of the distal abutment with stress magnitudes ranging from 56 to 194 MPa, depending on the model configuration.<sup>15</sup> These data collectively underscore that abutment geometry and material composition play pivotal roles in load redistribution, ultimately influencing the long-term durability of both the prosthetic structure and its supporting tissues, as shown in [figure 3](#). Accordingly, this systematic review identifies the biomechanical risk prediction based on the integrative combination of design–material–location parameters, an area that has not been comprehensively explored previously.

#### Clinical Relevance And Future Direction

These findings underscore the importance of adopting a personalized prosthetic approach. The combination of a fixed–fixed design with PEKK material may be recommended for patients with good bone quality, whereas zirconia is more suitable for highload conditions due to its superior resistance to deformation, tailored to specific clinical conditions such as the need for distal extension, limited supporting bone availability, and patient-specific occlusal conditions (e.g., high lateral loading).

#### Conclusion

Through Finite Element Analysis (FEA), five studies published between 2020 and 2025 demonstrated that stress distribution is predominantly governed by the

interplay among prosthetic design, restorative material, and loading direction. Cantilever designs consistently exhibited the highest von Mises stresses at the connector and prosthesis–abutment interface, while fixed–fixed designs reduced stress concentration, particularly when combined with flexible materials such as PEKK. In contrast, the high stiffness of zirconia provided a stress-shielding effect by retaining loads within the prosthesis.

The novelty of this review lies in its integrative analysis of design, material, and stress location—variables rarely examined together. Clinically, zirconia is recommended for posterior cantilever prostheses under high occlusal load, whereas PEKK suits fixed–fixed configurations with minimal bone resorption. This review highlights connector optimization as a critical factor in mitigating stress concentration, positioning it as a central focus in digital prosthodontic design research through FEA.

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## REVIEW

### Occlusal scheme in complete denture for knife-edge ridge: What works best?

Deasy Faradita Putri,<sup>1</sup> Ismet Danial Nasution,<sup>2\*</sup> Putri Welda Utami Ritonga<sup>2</sup>

#### ABSTRACT

**Keywords:** Atrophic ridge, Complete denture, Knife-edge ridge, Occlusal scheme, Stress distribution

Fabrication of complete dentures for atrophic and knife-edge mandibular ridges poses challenges due to uneven stress distribution, which affects support, stability, and comfort. The selection of an occlusal scheme plays an important role in optimizing load transmission to the denture-supporting tissues. This systematic review aims to evaluate stress and strain distribution as well as denture displacement across various occlusal schemes in patients with atrophic or knife-edge ridges. A structured literature search was conducted through PubMed, Scopus, ScienceDirect, SpringerLink, and Google Scholar for studies published between 2015 and 2025. Seven studies met the inclusion criteria, encompassing in vitro experiments, finite element analysis (FEA), photoelastic models, and clinical evaluations. From 407 screened articles, seven studies were analyzed. Lingualized occlusion (LO) demonstrated the most even stress distribution centered along the ridge crest, while bilateral balanced occlusion (BBO) improved stability under functional loading. Monoplane occlusion (MO) reduced vertical strain but exhibited higher localized stress under specific conditions. No single occlusal scheme was universally superior. LO and MO provided favorable biomechanical outcomes in specific conditions, whereas occlusal scheme selection should be adapted to ridge morphology and patient functional needs. (IJP 2025;7(1):8-13)

#### Introduction

Complete tooth loss is recognized as a key indicator of the overall burden of oral diseases, and it remains a major oral health concern worldwide. This condition is often the final consequence of chronic oral diseases, particularly advanced dental caries and severe periodontal disease, although trauma and other contributing factors may also lead to complete tooth loss.<sup>1,2</sup> According to the World Health Organization, the global average prevalence of complete tooth loss in 2025 is approximately 7% among individuals aged 20 years and older, with this figure increasing sharply to 23% in those aged 60 years and above.<sup>2</sup>

Edentulism leads to significant alveolar bone remodeling, affecting both the vertical and horizontal dimensions of the residual ridge.<sup>3</sup> This process is known as residual ridge resorption and occurs up to four times more frequently in the mandible than in the maxilla.<sup>4</sup> It is primarily caused by functional stresses transmitted by removable complete dentures, which have limited contact areas and suboptimal design features that contribute to uneven load distribution and further alter the morphology of the mandibular residual ridge.<sup>4,5</sup> Residual ridge resorption over time results in a severe form of ridge atrophy known as knife-edge ridge in the mandible, which compromises denture support and long-term comfort.<sup>6</sup>

Despite advances in implant-supported prostheses, conventional complete denture (CD) therapy remains a widely utilized and realistic treatment option for many edentulous patients worldwide, particularly among the elderly or those with systemic or financial limitations.<sup>7,8</sup> CD are

designed to restore essential oral functions, yet their effectiveness can be challenged in patients with advanced ridge resorption. This knife-edge shaped ridge may act as a fulcrum during mastication, leading to denture instability, pressure point pain, and compromised treatment outcomes with complete dentures.<sup>9</sup>

The occlusal scheme defines the arrangement of occlusal contacts during mandibular movements and directly influences how occlusal forces are transmitted to the denture-bearing tissues.<sup>10</sup> Proper occlusal contact helps distribute masticatory forces uniformly across the residual ridge, potentially minimizing tissue overload and preventing further bone resorption.<sup>11,12</sup> These complications can be further minimized by ensuring optimal distribution of occlusal forces through careful selection of the occlusal scheme. The transmission of masticatory forces is strongly influenced by the size, shape, and occlusal design of posterior denture teeth.<sup>13</sup> Studies have shown that modifying cusp inclination and choosing appropriate occlusal schemes, such as monoplane or lingualized occlusion, can reduce pressure on the supporting tissues, enhance patient comfort, and decrease the risk of soft tissue trauma.<sup>13,14</sup>

Despite the variety of occlusal schemes proposed for atrophic ridges, including bilateral balanced occlusion (BBO), monoplane occlusion (MO), and lingualized occlusion (LO), no clear consensus has been established regarding which occlusal scheme offers the most favorable biomechanical outcomes, particularly in

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

\*Corresponding author: ismetdaniel@yahoo.com

cases involving knife-edge residual ridges. This uncertainty highlights the need for a systematic evaluation of the existing literature to better understand the biomechanical implications of occlusal scheme selection in complete denture rehabilitation.

Therefore, this systematic review aims to synthesize current biomechanical evidence on the influence of occlusal schemes in complete dentures for knife-edge residual ridges, with particular focus on stress distribution, load transmission, and overall denture performance.

## Methods

### Search Strategy

This systematic review was conducted in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. A protocol outlining the research objectives, eligibility criteria, search strategy, and data extraction method was developed a priori; however, it was not registered in any public registry.

A comprehensive literature search was performed in PubMed, Scopus, ScienceDirect, SpringerLink, and Google Scholar for studies published between January 2015 and June 2025. The search was designed to identify studies evaluating the biomechanical impact of different occlusal schemes in complete dentures, particularly in cases involving atrophic or knife-edge mandibular ridges. Search terms included both Medical Subject Headings (MeSH) and free-text keywords combined with Boolean operators (AND, OR). Typical search strings included combinations such as: ("complete denture" OR "full denture") AND ("occlusal scheme" OR "occlusal pattern") AND ("atrophic ridge" OR "knife-edge ridge" OR "resorbed ridge") AND ("stress distribution" OR "strain" OR "biomechanical"). Search queries were customized for each database. Duplicates were removed before screening.

### Eligibility Criteria

This review followed the PICO framework: Population (P): Edentulous patients or models with atrophic or knife-edge mandibular ridges; Intervention (I): Complete dentures fabricated with various occlusal schemes; Comparison (C): Bilateral balanced occlusion (BBO), monoplane occlusion (MO), and lingualized occlusion (LO); Outcomes (O): Biomechanical parameters such as stress/strain distribution, load transmission, and indicators of denture stability.

Inclusion criteria: In vitro or simulation-based biomechanical studies; In vivo clinical studies evaluating complete dentures with different occlusal schemes in patients with atrophic or knife-edge ridges; Studies reporting relevant biomechanical outcomes directly (e.g., stress, strain) or indirectly (e.g., retention, tissue pressure, patient-reported stability). Articles published between 2015–2025 in English, in peer-reviewed journals.

Exclusion criteria: Case reports, review

articles, expert opinions, animal studies; Studies not involving atrophic or knife-edge ridges; Studies evaluating implant-supported or implant-retained prostheses; Non-English or non-peer-reviewed publications; Studies lacking methodological transparency or sufficient data; Grey literature (conference abstracts, theses, dissertations).

### Selection Process

Titles and abstracts were initially screened by a single reviewer according to predefined criteria. Full-text articles were subsequently assessed for eligibility. Final inclusion decisions were discussed and confirmed with co-authors to ensure reliability. The PRISMA 2020' flow diagram [figure 1](#) illustrates the number of studies identified, screened, excluded, and included.

### Data Extraction and Synthesis Method

Data extraction was carried out using a standardized Microsoft Excel form [table 1](#). Extracted data included author(s), year, study design, occlusal scheme, ridge condition (atrophic or knife-edge), biomechanical testing method, main outcomes, and key findings. No automation tools were used. Extracted data were reviewed for accuracy and completeness before synthesis.

### Data Synthesis

Due to heterogeneity in study design, ridge condition, and biomechanical evaluation methods, a narrative synthesis was conducted. Key biomechanical outcomes, including stress or strain distribution, load transmission, and occlusal force balance, were analyzed in relation to occlusal scheme and ridge resorption level. Most studies reported that LO distributed stress more evenly and reduced mucosal loading compared to MO, particularly in atrophic ridges. BBO contributed to denture stability under oblique forces. MO showed mixed results, enhancing stability in certain occlusal plane configurations but often associated with increased ridge stress. The variety of measurement techniques (T-scan, strain gauges, finite element analysis [FEA], photoelastic analysis) led to differences in reported units and data formats, which limited quantitative synthesis. Therefore, trends and clinical implications were interpreted descriptively.

### Risk of Bias Assessment

Risk of bias was assessed using the Joanna Briggs Institute (JBI) checklist, adapted for in vitro and simulation-based biomechanical studies. Key criteria included clarity of objectives, study design, sample preparation, measurement validity, consistency of reporting, and methodological transparency.

Most of the seven included studies demonstrated low to moderate risk of bias. Common limitations involved the absence of sample size justification, lack of calibration details, and unreported blinding procedures. The single in vivo clinical study (El-Agamy et al., 2023) used an appropriate design but lacked details on participant allocation and assessor blinding. Risk of bias

**Table 1. Data extraction results.**

Author(s)	Title	Study Design	Occlusal Scheme	Ridge Condition	Biomechanical Method	Outcome Measured	Key Findings
Hafezeqoran A, et al. (2018)	Evaluation of strain in mandibular denture-supporting area in three different occlusal schemes during jaw movements	In Vitro with Strain Gauge	BBO, LO, MO	Atrophic Mandibular Ridge	Strain Gauge	Strain in specific mandibular areas	MO occlusal scheme produced lower strain on the denture-supporting area, with the buccal shelf bearing the highest pressure. Across all occlusal schemes, the working side experienced more strain than the non-working side during eccentric movements.
Fatola, et al. (2024)	Pain-related analysis on a resorbed ridge with various denture occlusal schemes using finite element method	Finite Element Analysis	BBO, LO, MO	Atrophic Mandibular Ridge (Class III)	3D Finite Element Method	von Mises Stress	MO showed the lowest overall stress, while LO exceeded the pressure pain threshold in only one small area. The researchers concluded that the LO is the ideal occlusal scheme for fabricating denture with resorbed alveolar ridge conditions.
Fatiallah & Faraj (2016)	Comparing Maximum Stresses and Displacements in A Lower Complete Denture with Different Occlusal Plane Levels and Schemes: A Three Dimensional Finite Element Stress Analysis Study	Finite Element Analysis	BBO, LO, MO	Mandibular edentulous ridge	3D Finite Element Analysis	Stress and Displacement	LO showed the lowest stress on supporting tissues. MO improved denture stability and reduced rotational movement across all occlusal plane levels.
Chandratara, et al. (2020)	Analysis of the Stress Distribution Pattern of Anatomic and Non-Anatomic Tooth Forms on Maxillary and Mandibular Edentulous Ridges—A Photoelastic Study	Photoel-astic In Vitro Study	Anatomic, Non Anatomic	Medium Ridge Height	Polariscope	Stress Distribution	Stress of greater magnitude was observed with cuspal teeth whereas non-anatomic (0°) showed slightly less magnitude of stress.
Chaturvedi, et al. (2021)	Clinical analysis of CAD-CAM milled and printed complete dentures using computerized occlusal force analyser	Clinical In Vivo Study	BBO, LO, MO	General Edentulous	T-Scan III Occlusal Force Analysis	Force Distribution, Centralization	LO scheme and subtractive method yielded optimal force distribution
El-Agamy, et al. (2023)	The Effect of Different Occlusal Schemes on Masticatory Performance for Conventional and Digital Complete Dentures	Clinical In Vivo Study	BBO, LO	General Edentulous	Masticatory Performance Testing	Chewing Time and Swallowing	BBO and LO similarly effective; 3D BBO slightly superior
Madalli P, et al. (2015)	Effect of Occlusal Scheme on the Pressure Distribution of Complete Denture Supporting Tissues: An In Vitro Study	In Vitro with Strain Gauge	BBO, LO, MO	General Edentulous	Strain Gauge Measurement	Pressure on supporting tissues	Overall monoplane occlusion had lesser pressure values compared to completely balanced and lingualized occlusal scheme. Lingualized occlusal scheme was found to transfer stresses from working side to non-working side to stabilize the mandibular denture.

**Table 2. Risk of Bias Assessment for Included Study (Based on JBI Checklist).**

Author(s)	Study Design	Tool Used	Risk of Bias	Notes
Hafezeqoran et al. (2018)	In Vitro	JBI In Vitro	Low	Clear objectives and valid; minor sample size concern
Chaturvedi et al. (2021)	Clinical (RCT)	JBI Clinical Trials	Moderate	No randomization/blinding, unclear allocation
El-Agamy et al. (2023)	Clinical (Crossover)	JBI Clinical Trials	Moderate	Limited washout info; small sample size
Fatiallah & Faraj, (2022)	FEA Simulation	JBI In Vitro	Low	Defined load and ridge levels; methodologically sound
Chandratara, et al. (2020)	In Vitro (Photoelastic)	JBI In Vitro	Low	Clear objectives and valid; minor sample size concern
Madalli P, et al. (2015)	In Vitro	JBI In Vitro	Low	Clear objectives and valid; minor sample size concern
Fatola et al. (2025)	FEA Simulation	JBI In Vitro	Low	Accurate ridge modeling, appropriate FEA

assessment informed interpretation but was not used as an exclusion criterion. A summary of the assessment is presented in [table 2](#).

### Results

Out of 407 records initially identified, 7 studies met the inclusion criteria and were included in the final synthesis. These comprised three in vitro experiments, two

finite element FEA simulations, and two clinical in vivo studies, all investigating the biomechanical effects of different occlusal schemes in complete dentures for atrophic or severely resorbed mandibular ridges. The included studies compared at least two of the following occlusal schemes: bilateral BBO, LO, and MO. Outcomes of interest included stress or strain distribution, tissue pressure, and occlusal force balance, measured using techniques such as strain gauges, T-scan digital analysis, pressure sensors, photoelastic models, and finite element analysis (FEA).

Thematic findings are summarized as follows: Lingualized Occlusion (LO); LO consistently demonstrated a more uniform stress distribution across the residual ridge compared with other schemes. Stress concentration was primarily centralized along the ridge crest, with reduced loading on the mucosal slopes. This scheme also enhanced masticatory efficiency and load transmission balance, particularly in patients with atrophic ridges. Bilateral Balanced Occlusion (BBO); BBO showed advantages in maintaining denture stability under oblique and eccentric loading. It effectively minimized denture tipping during functional movements but was associated with slightly higher localized stresses on posterior ridges in some in vitro and FEA studies.

Monoplane Occlusion (MO): MO yielded variable results. While several studies reported reduced vertical strain and simplified occlusal adjustments, others noted increased localized stress on residual ridges and less effective load distribution compared to LO. The absence of cusp interdigitation contributed to decreased shear forces but compromised overall stability in knife-edge ridges.

Across all studies, the variety of biomechanical assessment methods and ridge morphologies limited direct comparison and meta-analysis. However, the general trend suggests that LO offers superior stress distribution, BBO provides functional stability, and MO serves as a simplified option for severely resorbed ridges where minimal lateral stress is desired. Detailed study characteristics are presented in table 1, while risk of bias assessment using the Joanna Briggs Institute (JBI) tools is summarized in table 2.

dentures becomes narrower and less favorable for stress distribution, compromising denture retention, stability, and patient comfort.<sup>15,16</sup> Therefore, selecting an occlusal scheme that can optimize load transmission while minimizing strain on the compromised mucosa is critical in edentulous prosthodontic rehabilitation.

This review synthesized findings from seven studies, including in vitro experiments, FEA, photoelastic simulations, and clinical assessments. These studies compared three main occlusal schemes: BBO, LO, and monoplane occlusion MO. The primary outcomes measured were stress or strain on the mucosa, pressure on denture-bearing areas, occlusal force distribution, and denture stability.

Several studies reported consistent biomechanical advantages of the LO scheme in atrophic ridges. Fatola et al. and Fatiallah & Faraj found that LO resulted in lower von Mises stress values compared to BBO and MO, particularly under oblique loading conditions.<sup>17,18</sup> These findings suggest that LO can concentrate occlusal forces more centrally and reduce lateral interferences, thus lowering the risk of mucosal trauma.

Interestingly, Hafezeqoran et al. reported a different outcome. Using strain gauge analysis, they found that MO produced the lowest strain on the denture-supporting tissues, especially in the buccal shelf region.<sup>12</sup> This apparent contradiction may be due to differences in biomechanical models and loading directions. While LO may be superior under dynamic or oblique forces, MO could be more advantageous under controlled vertical loads or in specific anatomical contexts.

Further insights were provided by clinical studies using occlusal force measurement systems. Chaturvedi et al. and El-Agamy et al. observed that LO and BBO produced better occlusal force balance and more symmetrical left-right distribution compared to MO.<sup>19,20</sup> These findings reinforce the clinical relevance of occlusal scheme selection in optimizing masticatory efficiency and patient satisfaction.

Studies using photoelastic and pressure sensor methods also supported the superiority of LO and BBO over MO in terms of stress distribution. These schemes spread occlusal forces across a wider area, minimizing localized pressure points, especially in the posterior regions.<sup>13,21</sup> However, MO showed improved stability when the occlusal plane was leveled with the ridge crest or aligned with the middle third of the retromolar pad, as reported by Fatiallah & Faraj.<sup>18</sup>

In the context of knife-edge mandibular ridges, the biomechanical implications of these occlusal schemes become particularly relevant. The sharp and narrow crest provides a limited denture-bearing area and tends to concentrate functional loads along the ridge peak, predisposing to mucosal soreness and accelerated resorption. In such cases, LO appears most

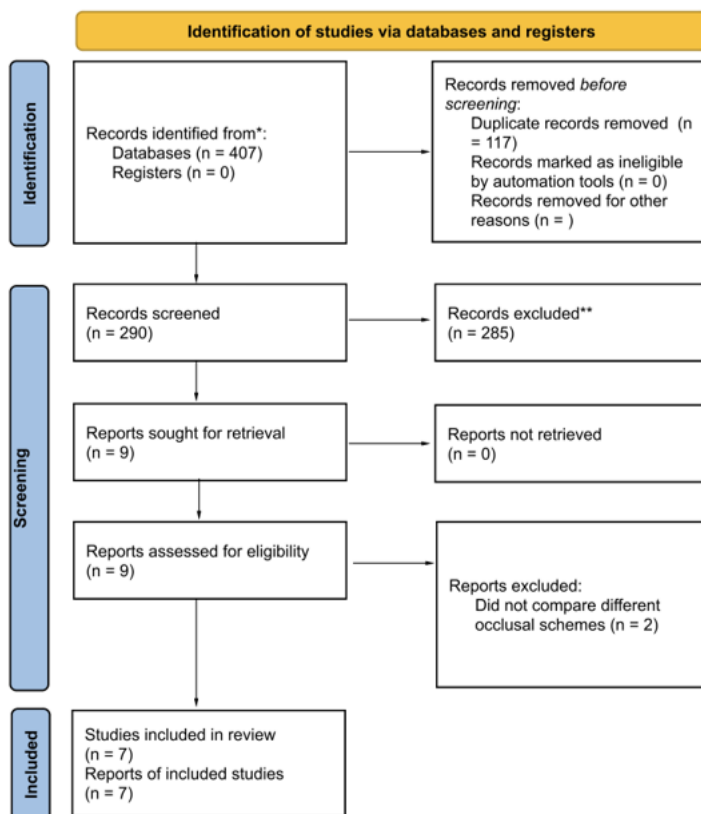


Figure 1. PRISMA flow diagram of study selection.

## Discussion

This systematic review aimed to critically evaluate biomechanical evidence on the influence of occlusal schemes in complete denture prostheses for patients with atrophic or knife-edge residual ridges. As residual ridge resorption progresses, the supporting area for

beneficial because it directs occlusal contacts more centrally and transfers forces toward the middle of the ridge, minimizing shear stress on the crest. BBO may further enhance stability during lateral or oblique movements, which helps prevent tipping of the denture on the knife-edge ridge. Conversely, MO can reduce vertical load but may still generate localized pressure on the sharp ridge crest if the occlusal plane is not carefully aligned. Therefore, these findings underscore the importance of adapting the occlusal scheme to ridge morphology to achieve optimal comfort, stability, and long-term tissue preservation in patients with knife-edge mandibular ridges.

Overall, while the findings across studies were not entirely uniform, several consistent patterns emerged. LO generally reduced stress on the mucosa and provided more centralized occlusal force distribution. MO, while effective in reducing vertical strain in some controlled scenarios, often resulted in higher stress concentrations under non-ideal occlusal plane configurations or lateral loading. These findings suggest that no single occlusal scheme is universally superior in all biomechanical contexts. Instead, the selection of an appropriate occlusal scheme should be guided by individual patient factors, including residual ridge morphology, occlusal plane orientation, and anticipated functional load. Furthermore, the heterogeneity in study design, ridge modeling, and loading protocols likely contributed to variations in outcomes and should be taken into account when interpreting the evidence.

## Conclusion

This systematic review evaluated the biomechanical effects of different occlusal schemes in complete dentures for patients with atrophic or knife-edge mandibular ridges. Across seven included studies—comprising *in vitro*, finite element analysis, and clinical evaluations—consistent trends emerged regarding stress distribution and denture stability.

LO generally demonstrated more uniform stress distribution on the denture-bearing mucosa and better balance of occlusal forces, contributing to enhanced comfort and load control. BBO improved denture stability, particularly under functional and oblique loading conditions. MO tended to reduce vertical strain in some configurations but often produced higher localized stresses, especially during lateral or uneven loading.

No single occlusal scheme exhibited universal superiority under all biomechanical conditions. Therefore, occlusal scheme selection should be individualized, taking into account the patient's ridge morphology, occlusal plane orientation, and functional requirements.

Variations in study design, ridge modeling, and biomechanical testing methods among existing research emphasize the need for standardized,

high-quality experimental and clinical studies. Future investigations integrating *in vivo* load measurements with digital simulation models are recommended to strengthen the evidence base and refine clinical decision-making for edentulous patients with resorbed ridges.

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## REVIEW

### The relationship between salivary flow rate and masticatory performance in hypertensive and nonhypertensive complete denture wearers

Anggun Hutauruk,\* Ismet Nasution, Ariyani, Silvia Pridana

#### ABSTRACT

**Keywords:** Complete denture, Hypertensive, Masticatory performance, Salivary flow rate

Edentulism is the complete loss of natural teeth, leading patients to rely on complete dentures to restore masticatory function. The success of denture use is influenced by salivary flow rate, which affects retention and stability. Salivary flow may be altered by systemic conditions such as hypertension, potentially reducing masticatory performance. This study aimed to determine the mean salivary flow rate and masticatory performance, and to analyze their relationship in hypertensive and nonhypertensive complete denture wearers at the Dental and Oral Hospital of Universitas Sumatera Utara. This analytic cross-sectional study involved 20 subjects (10 hypertensive and 10 non-hypertensive). Salivary flow rate was measured using the spitting method with sugar-free chewing gum, while masticatory performance was assessed using color-changeable chewing gum and the Visual Analog Scale (VAS). Data were analyzed using Spearman's correlation test ( $p < 0.05$ ). The mean salivary flow rate was  $0.36 \pm 0.11$  ml/min in hypertensive patients and  $0.86 \pm 0.15$  ml/min in nonhypertensive patients. The mean masticatory performance scores were  $2.8 \pm 0.78$  and  $3.9 \pm 0.99$ , respectively. A significant correlation was found between salivary flow rate and masticatory performance in both hypertensive ( $p = 0.0001$ ) and nonhypertensive groups ( $p = 0.001$ ). (IJP 2025;7(1):14-19)

#### Introduction

Edentulism is defined as the loss of one or more teeth from their sockets, while the complete loss of all natural teeth is referred to as complete edentulism. This condition may result from various factors, including dental caries, periodontal disease, trauma, and tooth extraction. According to the Indonesian Health Survey (2023), the prevalence of tooth loss in Indonesia is 21%. Tooth loss, particularly complete edentulism, can significantly affect masticatory function, esthetics, phonetics, and overall quality of life.<sup>1,2</sup>

Mastication is the mechanical process of breaking down food into a bolus to facilitate digestion and nutrient absorption.<sup>3</sup> This function involves the coordination of teeth, the temporomandibular joint, masticatory muscles, and the central nervous system, and can be objectively assessed through masticatory performance as an indicator of chewing efficiency.<sup>4</sup> Masticatory performance is influenced by several factors, one of which is saliva. Saliva plays a crucial role in lubrication, bolus formation, and in supporting the retention and stability of complete dentures. Salivary flow rate is an important parameter, as its reduction may impair masticatory efficiency.<sup>5</sup>

Systemic conditions such as hypertension are known to affect salivary gland function. Hypertension not only impacts the cardiovascular system but also causes alterations in saliva, including decreased pH, increased viscosity, and reduced salivary flow rate, either due to the disease itself or the use of antihypertensive medications. These changes may lead to xerostomia and affect oral function.<sup>6</sup>

Complete dentures are used to restore masticatory function in edentulous patients; however, their success largely depends on retention and stability, which are influenced by saliva. A decreased salivary flow rate, as observed in hypertensive patients, may compromise denture stability and reduce masticatory performance.<sup>6</sup>

Studies investigating the relationship between salivary flow rate and masticatory performance in hypertensive complete denture wearers remain limited. Therefore, this study aims to analyze this relationship in both hypertensive and nonhypertensive patients.

#### Methods

In this study, a total of 20 subjects were included and divided into two groups: 10 hypertensive patients and 10 nonhypertensive patients.

The first stage involved blood pressure measurement. This was performed by instructing the subjects to sit in a resting position, with their feet flat on the floor, back supported, and arm positioned at heart level. Subjects were instructed to avoid caffeine intake, smoking, and physical exercise for at least 30 minutes prior to the measurement, which was preferably conducted in the morning. The cuff was placed on the upper arm approximately 2 cm above the antecubital fossa, with the tubing positioned along the midline of the arm, and tightened to allow the insertion of two fingers. The measurement was initiated by pressing the "start" button while ensuring the subject

**Table 1A. Salivary flow rate values of hypertensive patients using complete denture.**

Age (Years)	Sex	Salivary Flow Rate (ml/min)
57	Male	0,5**
70	Male	0,4
75	Female	0,33
72	Female	0,4
80	Female	0,23*
77	Female	0,33
69	Female	0,5**
80	Female	0,23*
64	Female	0,5**
80	Female	0,23*
x±SD		0,36±0,11

Notes: \*Lowest value \*\*Highest value

**Table 1B. Salivary flow rate values of nonhypertensive patients using complete denture.**

Age (Years)	Sex	Salivary Flow Rate (ml/min)
72	Male	0,83
72	Male	1
67	Male	0,83
65	Male	1
69	Female	0,7
68	Female	0,67*
64	Female	0,83
52	Female	1,1**
60	Female	1
74	Female	0,7
x±SD		0,86±0,15

Notes: \*Lowest value \*\*Highest value

**Table 2A. Masticatory performance scores of hypertensive patients using complete denture.**

Age (Years)	Sex	Salivary Flow Rate (ml/min)
57	Male	4**
70	Male	3
75	Female	2*
72	Female	3
80	Female	2*
77	Female	3
69	Female	3
80	Female	2*
64	Female	4**
80	Female	2*
x±SD		2,8±0,78

Notes: \*Lowest value \*\*Highest value

**Table 2B. Masticatory performance scores of hypertensive patients using complete denture.**

Age (Years)	Sex	Salivary Flow Rate (ml/min)
72	Male	3
72	Male	5**
67	Male	4
65	Male	5**
69	Female	3
68	Female	2*
64	Female	4
52	Female	5**
60	Female	4
74	Female	4
x±SD		3,9±0,99'

Notes: \*Lowest value \*\*Highest value

**Table 3. The relationship between salivary flow rate and masticatory performance in hypertensive and nonhypertensive patients using complete denture.**

Group	x±SD		P
	Salivary Flow Rate (ml/min)	Masticatory Performance	
Hypertensive	0,36± 0,11	2,8±0,7 8	0,0001*
Nonhypertensive	0,86± 0,15	3,9±0,9 9	0,001*

\*Significant (p<0,05)

remained still until the cuff deflated and the blood pressure reading appeared on the monitor, after which the result was recorded.

The second stage was the salivary flow rate measurement, measured using a measuring cup. The procedure was carried out by instructing the subjects to sit in a relaxed position for five minutes, followed by rinsing their mouth and swallowing any residual saliva. Subsequently, the subjects were asked to chew sugar-free chewing gum for three minutes using a timer. Saliva was allowed to accumulate in the floor of the mouth and was expectorated into the measuring cup every 60 seconds or whenever the subject felt the urge to swallow. The collected saliva volume was then measured without including foam, and the result was expressed in milliliters per minute (mL/min).

The third stage was the assessment of masticatory performance using color-changeable chewing gum. Subjects were instructed to sit and rinse their mouth prior to the procedure, then chew the colorchangeable chewing gum for 120 seconds. After chewing, the gum was removed from the mouth, placed into a plastic zip-lock bag, and flattened using a glass plate to a thickness of approximately 1.5 cm to evaluate the uniformity of color change. The degree of color change was subsequently assessed using the color scale provided on the product packaging.



**Figure 1. A. Blood pressure measurement, B One of the blood pressure readings, C. Salivary flow rate measurement, D. Salivary flow rate value, E. The assessment of masticatory performance, F. One of the color result of the color-changeable chewing gum.**

## Results

This study involved 20 complete denture wearers who were divided into two groups: 10 hypertensive patients and 10 nonhypertensive patients. The results showed that the mean salivary flow rate in hypertensive patients was  $0.36 \pm 0.11$  ml/min, whereas in nonhypertensive patients it was  $0.86 \pm 0.15$  ml/min. These findings indicate that the salivary flow rate in hypertensive patients was lower than that in nonhypertensive patients.

Furthermore, the mean masticatory performance score in hypertensive patients was  $2.8 \pm 0.78$ , while in nonhypertensive patients it was  $3.9 \pm 0.99$ . This result indicates that masticatory performance in the nonhypertensive group was better than that in the hypertensive group.

Statistical analysis using Spearman's correlation test revealed a significant relationship between salivary flow rate and masticatory performance in both groups. In hypertensive patients, the pvalue was 0.0001, while in nonhypertensive patients it was 0.001 ( $p < 0.05$ ), indicating a statistically significant correlation.

## Discussion

This study demonstrated that the mean salivary flow rate in hypertensive patients was lower than that in nonhypertensive patients, with the hypertensive group categorized as having hyposalivation. This condition can be explained physiologically, as hypertension induces changes in the vascular system, including thickening of blood vessel walls and reduced elasticity, which consequently decreases blood flow to the salivary glands.<sup>7</sup> In addition, the use of antihypertensive medications may contribute to reduced salivary secretion through autonomic nervous system mechanisms and alterations in body fluid balance.<sup>8</sup>

Furthermore, variations in salivary flow rate are also influenced by other factors such as age and sex. The aging process leads to degeneration of the salivary glands, resulting in decreased saliva production, while differences in gland size between males and females may contribute to variations in salivary secretion. In complete denture wearers, saliva plays a crucial role in maintaining denture retention and stability; therefore, a reduction in salivary flow rate can directly affect oral comfort and function.<sup>9,10</sup>

Masticatory performance in hypertensive patients was also found to be lower compared to the nonhypertensive group. This reduction is closely associated with decreased salivary flow, which functions as a lubricant, facilitates bolus formation, and enhances adhesion and cohesion between the denture base and the oral mucosa. When saliva production is reduced, denture retention and stability become suboptimal, leading to less efficient mastication.<sup>11</sup>

Correlation analysis revealed a significant

relationship between salivary flow rate and masticatory performance in both groups. Physiologically, saliva acts as a lubricant, aids in bolus formation, and improves adhesion and cohesion between the denture base and the mucosa. Therefore, higher salivary flow rates are associated with better masticatory performance, whereas reduced salivary flow impairs denture retention and masticatory efficiency.<sup>12</sup>

## Conclusion

Based on the results of this study, it can be concluded that: The mean salivary flow rate in hypertensive and nonhypertensive complete denture wearers was as follows: Hypertensive patients:  $0.36 \pm 0.11$  ml/min; Nonhypertensive patients:  $0.86 \pm 0.15$  ml/min; The mean masticatory performance in hypertensive and nonhypertensive complete denture wearers was as follows: Hypertensive patients:  $2.8 \pm 0.78$ ; Nonhypertensive patients:  $3.9 \pm 0.99$ . There was a statistically significant relationship between salivary flow rate and masticatory performance in hypertensive patients ( $p = 0.0001$ ;  $p < 0.05$ ) and nonhypertensive patients ( $p = 0.001$ ;  $p < 0.05$ ) among.

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## REVIEW

### Optimizing occlusal schemes to reduce masticatory stress in resorbed class III jaw relations edentulous ridges: A systematic literature review

Sonia Nduma Nola Padang,<sup>1</sup> Ismet Danial Nasution,<sup>2\*</sup> Ricca Chairunnisa<sup>2</sup>

#### ABSTRACT

**Keywords:** Alveolar ridges, Class III, Occlusal schemes, Stress distribution

An unfavorable jaw relationship, such as Class III, contributes to uneven masticatory stress distribution, accelerating alveolar bone resorption and potentially resulting in a flattened ridge morphology. This condition directly impacts denture stability and retention. Therefore, selecting an appropriate occlusal scheme is essential to guide and balance masticatory forces, enabling more even and physiological stress distribution. However, there is currently no clear consensus on the most effective occlusal scheme for Class III jaw relationships with flat ridges. This systematic review aims to evaluate and synthesize current scientific evidence regarding the influence of different occlusal schemes on stress distribution in patients with Class III jaw relationships accompanied by flat alveolar ridges. Following the PRISMA guidelines. A comprehensive electronic search was conducted through PubMed, Cochrane, and ScienceDirect databases to identify relevant studies published between 2015 and 2025. The search strategy included keywords such as: ("alveolar ridge" AND "occlusal schemes") AND ("stress distribution"), as well as ("alveolar ridge" OR "occlusal schemes") AND ("stress distribution"). Out of 1061 articles screened, five studies met the inclusion criteria. Lingualized and balanced occlusion demonstrated a more uniform stress distribution compared to monoplane occlusion, particularly in patients with Class III jaw relationships and flat ridges. Occlusal schemes play a crucial role in reducing masticatory stress, especially in patients with Class III jaw relationships and flattened alveolar ridges. Further research is recommended, particularly in vitro biomechanical studies using masticatory simulation models that better represent the clinical conditions of Class III patients with flat ridges. (IJP 2025;7(1):20-24)

#### Introduction

Complete edentulism refers to the condition of losing all teeth in one or both dental arches and remains a significant clinical challenge, particularly among the elderly population. Total tooth loss affects speech, mastication, esthetics, and overall quality of life.<sup>1</sup>

Complete dentures (CDs) continue to be the primary treatment option for edentulous patients, especially when implant therapy is not feasible due to anatomical, economic, or medical limitations.<sup>2</sup>

The success of complete dentures largely depends on the support from the remaining anatomical structures, particularly the alveolar ridge. Following tooth loss, the ridge undergoes progressive bone resorption. A flat or knife-edge ridge morphology can reduce the prosthetic support area, negatively affect retention and stability, and increase the risk of uneven stress distribution.<sup>3</sup>

In addition to ridge morphology, the type of jaw relationship and occlusal scheme play crucial roles in determining how masticatory forces are distributed to the supporting tissues. Patients with skeletal Class III malocclusion characterized by mandibular prognathism experience complex alterations in occlusal force distribution. When combined with a resorbed ridge, this creates a significant biomechanical challenge in

complete denture treatment.<sup>4</sup>

Occlusal schemes for complete dentures can be categorized into several types, including monoplane occlusion, lingualized occlusion, and bilateral balanced occlusion. A study by Madalli et al.<sup>5</sup> demonstrated that different occlusal schemes affect the pressure transmitted to the supporting mucosa. Lingualized occlusion is widely recommended because it directs occlusal forces vertically along the ridge, thereby minimizing lateral forces that could damage the supporting tissues.<sup>6</sup>

The development of biomechanical analysis technologies, such as finite element analysis (FEA), has enabled simulation of stress distribution and prosthetic pressure analysis on supporting tissues. FEA studies by Lü et al. and Ohguri et al.<sup>7</sup> revealed that ridges of varying shapes demonstrate markedly different stress distribution patterns depending on the occlusal scheme applied.

This systematic review aims to evaluate the influence of occlusal schemes and alveolar ridge morphology on stress distribution in complete dentures, using evidence-based findings from recent FEA and experimental studies. This knowledge is expected to provide a scientific foundation for selecting the most appropriate occlusal

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

\*Corresponding author: ismetdanial@yahoo.com

scheme in patients with complex ridge conditions.

**Table 1. Search strategy according to PICO criteria.**

Focused Question (PICO)	How does the variation in occlusal schemes influence stress distribution in complete dentures, particularly in cases with flat ridges and/or skeletal Class III malocclusion?
P (Population/Patient)	Completely edentulous patients with flat or severely resorbed alveolar ridges, including skeletal Class III malocclusion
I (Intervention)	Application of different occlusal schemes in complete dentures (monoplane, lingualized, bilateral balanced occlusion)
C (Comparison)	Comparison between occlusal schemes (e.g, monoplane vs. lingualized; balanced vs. nonbalanced)
O (Outcome)	Stress distribution on supporting tissues, prosthetic stability, risk of pathological pressure, and patient comfort

**Table 2. List of primary keywords and related terms.**

Keywords	Related Terms
"Occlusal Scheme"	"Bilateral Balanced Occlusion","Lingualized Occlusion", "Monoplane Occlusion"
"Stress Distribution"	"Jaw Relationship" "Alveolar Ridge", "Jaw Relation"

**Table 3. Summary database.**

Data Base	First screening based on keywords	Duplicate	Subject Area	Free Full Text	Title screening	Inclusion criteria screening
PubMed	563	362	201	135	12	3
Cochrane	103	60	42	25	3	0
Science Direct	498	348	149	72	6	2
Total	1164	770	291	232	21	5

**Table 4. Summary of reviewed studies.**

Author (Year)	Study Design	Occlusal Schemes Investigated	Evaluation Method	Ridge Characteristics	Main Findings
Choi et al. (2018)	FEA Simulation	Monoplane, Balanced, Lingualized	FEA + CBCT	Flat ridge	Lingualized occlusion produced the most uniform stress distribution and lowest mucosal pressure.
Lü et al. (2010)	FEA Simulation	Balanced vs Lingualized	3D FEA	Moderate to severe resorption	Balanced and lingualized schemes showed better stability than conventional occlusion.
Madalli et al. (2015)	In vivo Experimental	Monoplane vs Balanced	Mucosal pressure sensors	Flat ridge	Balanced occlusion resulted in lower posterior pressure and improved comfort.
Paulina et al. (2023)	FEA + CBCT Reconstruct ion	Monoplane, Lingualized	CBCT- based FEA	Ridge knife-edge	Lingualized occlusion with soft liner reduced pressure by up to 38%.
Garcia & Johnson (2004)	Clinical Experimental	Monoplane vs Lingualized	Pressure sensors	Flat ridge	Monoplane occlusion showed the highest posterior ridge pressure.

**Methods  
Search Strategy**

The inclusion criteria were limited to peer-reviewed journal articles published between January 2015 and June 2025, written in English. This review was structured using the PICO framework to guide the selection process, ensuring methodological consistency and clinical relevance.

**Inclusion and Exclusion Criteria**  
Inclusion Criteria: Original research articles published in English; Published between 2015 and 2025; Studies evaluating stress distribution, mucosal pressure, or complete denture stability; Comparative studies assessing

different occlusal schemes (monoplane, lingualized, or balanced occlusion); Focused on completely edentulous patients with flat alveolar ridges.

Exclusion Criteria: Systematic reviews, narrative reviews, or case reports; Articles without accessible full-text versions; Studies involving patients with Skeletal Class I or Skeletal Class II jaw relationships.

**Data Extraction**

To ensure a comprehensive and systematic literature search, the authors employed a keyword-based approach combining primary search terms and relevant synonyms associated with the topic focus. This strategy was designed to maximize search sensitivity without compromising the specificity of the scientific context. The main keywords used reflected the biomechanical and occlusal design aspects of complete dentures in varying ridge conditions.

The selection of keywords was based on commonly used terminology in scientific databases such as PubMed and ScienceDirect, referencing MeSH (Medical Subject Headings) terms and clinically relevant prosthodontic terminology. Terminological variations across studies such as differences in the usage of "lingualized occlusion" and "balanced occlusion" within the context of denture occlusion were also considered.

The selection process was conducted in two hierarchical stages. The first stage involved screening titles and abstracts, while the second stage consisted of a full-text evaluation of potentially relevant articles. Assessment was carried out independently, and after confirmation of the selected studies, data were systematically extracted, including general information such as publication title, author names, journal source, and year of publication.

**Study Selection**

This systematic review followed the PRISMA guidelines. A comprehensive electronic search was conducted using the PubMed and ScienceDirect databases to identify relevant studies. The search strategy included the following keyword combinations: ("alveolar ridge" AND "occlusal schemes") AND ("stress distribution"), as well as ("alveolar ridge" OR "occlusal schemes") AND ("stress distribution").

A total of 1,061 initial articles were identified. After removing 770 duplicates, 291 unique studies remained. Screening for free full-text availability reduced the number to 232 articles. Further evaluation targeting studies specifically discussing occlusal schemes narrowed the selection to 21 articles. Detailed examination of alveolar ridge morphology characteristics resulted in 5 studies meeting all inclusion criteria. After the final eligibility assessment based on the predetermined inclusion and exclusion criteria, five articles qualified and were included in the final analysis, as summarized in table 3.

The analysis of these five studies formed the basis for drawing conclusions about the effects of

**Table 5. Risk of bias and quality assessment.**

Article Title	Study Type	Assessment Tool	Evaluation Summary	Quality Level
Choi JH et al. (2018). Stress distribution in mandibular complete denture with various occlusal schemes: a FEA study.	In-vitro (FEA)	JBIChecklist for Quasi-Experimental Studies	Clear objectives and design; standardized load parameters; quantitative results; valid model though simulation-based.	High
Lü P et al. (2010). Threedimensional finite element analysis of lingualized occlusion in complete denture wearers.	In-vitro (FEA)	JBIChecklist for Quasi-Experimental Studies	Systematic analysis and valid results but lacked clinical data validation.	Moderate
Madalli P et al. (2015). Evaluation of masticatory efficiency in different occlusal schemes for complete dentures.	Eksperimental in-vivo	JBIChecklist for Quasi-Experimental Studies	Clear purpose and groups; objective measurement tools; no operator blinding.	High
Paulina D et al. (2023). Effect of occlusal scheme on alveolar bone stress using CBCT reconstruction and finite element simulation.	In-vitro (FEA) berbasis CBCT)	JBIChecklist for Quasi-Experimental Studies	Strong model validation using real CBCT data; clear masticatory parameters; objective and replicable results.	High
Garcia LT & Johnson GH. (2004). Effect of occlusal scheme on the pressure under complete dentures.	Eksperimental klinis	JBIChecklist for Quasi-Experimental Studies	Good experimental design; small sample size and limited ridge control.	Moderate

occlusal schemes and ridge morphology. To ensure a transparent and systematic presentation of the selection process, the PRISMA 2020 flowchart was used in this study. The diagram illustrates each stage of identification, screening, eligibility assessment, and final inclusion of studies meeting the criteria. Screening was conducted according to the predefined inclusion and exclusion criteria while ensuring methodological appropriateness and topic relevance to the study focus.

#### Data Synthesis

Data synthesis was carried out qualitatively using a narrative approach, due to heterogeneity in study design, ridge morphology variations, and reporting methods that prevented a quantitative meta-analysis. Each study was analyzed based on clinical context, type of occlusal scheme, biomechanical evaluation method, and ridge morphology.

Most studies used finite element analysis (FEA) simulations to evaluate mucosal pressure, bone stress concentration, and load distribution during mastication. The collected data were grouped according to: The occlusal scheme used (monoplane, lingualized, balanced); Ridge characteristics (flat, knife-edge, or severely resorbed); Additional interventions (soft liners, broad denture bases, flexible prostheses)

Studies by Choi et al. and Lü et al.<sup>6</sup> found that lingualized occlusion produced the most even stress distribution with well-controlled vertical forces. Madalli et al.<sup>5</sup> emphasized the role of balanced occlusion in maintaining prosthetic stability during lateral movements. In contrast, monoplane occlusion showed less efficient load distribution.

All data were compared and summarized to identify common patterns supporting evidence-based clinical recommendations for occlusal scheme selection based on ridge morphology in edentulous patients.

## Results

A total of five studies met the inclusion criteria and were analyzed to evaluate the influence of different occlusal schemes on stress distribution and denture stability in edentulous patients with flat or resorbed ridges. The included studies employed various methodologies, such as finite element analysis (FEA), CBCT-based reconstruction, and in vivo experimental evaluations using mucosal pressure sensors.

An FEA and CBCT-based simulation, compared monoplane, balanced, and lingualized occlusion in flat-ridge conditions. Their findings indicated that the lingualized occlusal scheme produced the most uniform stress distribution and the lowest mucosal pressure among the tested designs. Demonstrated through 3D FEA that both balanced and lingualized occlusal schemes offered greater denture stability compared to conventional occlusion, particularly in cases with moderate to severe ridge resorption.

In an in vivo study, Madalli et al.<sup>5</sup> assessed monoplane and balanced occlusion using mucosal pressure sensors and reported that the balanced occlusal scheme resulted in lower posterior ridge pressure and improved patient comfort. Employed CBCTbased FEA on knife-edge ridges and found that lingualized occlusion combined with a soft liner significantly reduced mucosal pressure by up to 38%, enhancing prosthetic adaptation. Conversely observed that monoplane occlusion generated the highest posterior ridge pressure, suggesting less favorable stress distribution patterns in flat-ridge patients.

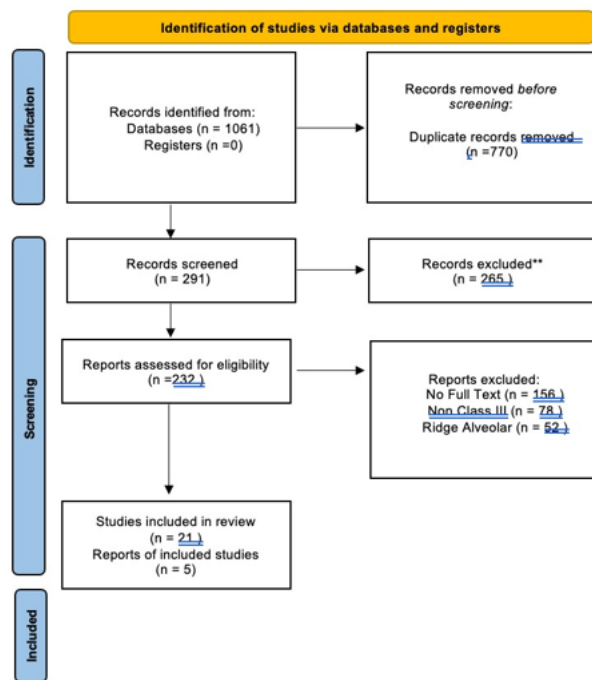
Collectively, these findings demonstrate a consistent trend: lingualized and balanced occlusal schemes provide superior biomechanical outcomes in terms of stress distribution and prosthetic stability compared to monoplane occlusion, especially in patients with flat or resorbed alveolar ridges.

**Occlusal Scheme Distribution:** The reviewed studies compared various occlusal schemes in flat ridge conditions: Lingualized occlusion demonstrated the most uniform stress distribution, directing vertical forces more effectively while minimizing destructive lateral forces; Balanced occlusion also performed well, particularly in maintaining prosthetic stability during eccentric movements; Monoplane occlusion resulted in higher posterior ridge pressure and was less efficient in distributing loads evenly.

**Effect of Ridge Morphology:** In flat ridges, higher stress concentration was observed in posterior and lingual ridge areas. That flat ridges have poorer load distribution capacity compared to normal ridges, particularly in cases with advanced resorption.

These findings suggest that selecting an appropriate occlusal scheme—combined with an understanding of ridge morphology and supplementary prosthetic interventions—significantly influences stress distribution and patient comfort in complete denture

therapy.



**Figure 1. PRISMA Flowchart of Study Selection Process.**

## Discussion

The results of this systematic review demonstrate that stress distribution in complete dentures is strongly influenced by the combination of alveolar ridge morphology and the occlusal scheme applied. In patients with flat ridges, stress tends to concentrate in the posterior and lingual ridge areas, which, if not properly managed, may increase the risk of mucosal irritation and accelerate bone resorption.<sup>7-10</sup>

Studies employing finite element analysis (FEA) provided a comprehensive understanding of stress behavior in dentures based on different anatomical ridge models. The effectiveness of lingualized occlusion in evenly distributing masticatory loads, especially in cases with ridge resorption. The dominance of vertical forces and the minimal presence of lateral components make this scheme biomechanically advantageous. Conversely, monoplane occlusion was found to generate high stress concentrations, particularly in the posterior ridge area, potentially leading to soft tissue trauma and patient discomfort.<sup>10-13</sup>

In addition to occlusal schemes, ridge morphology plays a crucial role in determining the functional success of dentures. Flat or severely resorbed ridges reduce the surface area available for load distribution, thus requiring individualized rehabilitative approaches. Several studies have indicated that additional interventions—such as the use of soft denture liners and extended denture bases—can help stabilize

functional loads and enhance patient comfort.<sup>14</sup>

From the risk of bias assessment using the JBI Checklist for Quasi-Experimental Studies, the five articles included in this review generally exhibited low to moderate levels of bias. The in vitro FEA-based rated as high-quality, given their standardized simulation designs, well-defined model validation, and quantitatively objective outcomes. They showed good reliability, although operator blinding was not reported. In contrast, earlier studies exhibited moderate bias, mainly due to limited biological validation and lack of control over ridge morphology variables.<sup>15</sup>

Overall, the risk of bias findings reinforce the reliability of this systematic review's conclusion that lingualized occlusion and balanced occlusion provide a more physiological stress distribution than monoplane occlusion, although clinical generalization should be approached cautiously since most evidence originates from FEA simulations.

The heterogeneity of study designs and the limited number of primary studies restrict the ability to generalize the findings broadly. Nevertheless, the consistent patterns across studies highlight the importance of a multidisciplinary approach in the planning and design of complete dentures, particularly in patients with flat or non-ideal ridge morphology. The integration of CBCT imaging for ridge evaluation and FEA simulation for biomechanical assessment is highly recommended as part of a more precise prosthetic treatment planning process.

## Conclusion

Based on the synthesis of the five studies analyzed in this review, it can be concluded that the occlusal scheme and alveolar ridge morphology significantly influence stress distribution in complete dentures. Lingualized occlusion has been proven to be the most effective in evenly distributing masticatory loads, particularly in patients with flat or severely resorbed ridges. This occlusal design directs masticatory forces vertically and minimizes lateral components that could potentially damage the supporting tissues.

Flat or non-ideal ridge morphology demonstrates a poorer biomechanical response to masticatory loads, thereby requiring adjustments in prosthetic design, including the use of soft lining materials or extended denture bases. Studies also show that the utilization of FEA (Finite Element Analysis) and CBCT (Cone-Beam Computed Tomography) technologies can provide more accurate clinical insights for the planning and evaluation of load distribution in complete dentures.

Therefore, the management of completely edentulous patients should include a comprehensive evaluation of ridge morphology and the selection of an occlusal scheme that is biomechanically appropriate. The integration of anatomical understanding, occlusal

principles, and digital technology will lead to prosthetic outcomes that are more stable, comfortable, and predictable in the long term.

Future research is recommended to conduct in vitro biomechanical studies using masticatory simulation models that more accurately represent clinical conditions particularly in patients with Class III skeletal malocclusion and flat alveolar ridges.

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## CASE REPORT

### Preventing black triangles around posterior maxillary implants using customized peek healing abutments: A case report

Raisa Oktaviani Yanto Putri,\* Vinni Nichianishi,  
Vita Mulya Passa Novianti, Setyawan Bonifacius

#### ABSTRACT

**Keywords:** Black triangle, Customized healing abutment, Dental implant, PEEK (polyetheretherketone)

Posterior maxillary implant placement is often challenging due to low bone density, limited soft tissue support, and a higher risk of black triangle formation. Prefabricated healing abutments are manufactured in standard shapes and often fail to guide soft tissue maturation according to individual anatomy. In contrast, custom healing abutments allow precise shaping of the emergence profile and supporting better periimplant tissue healing. A 31-year-old female presented with a missing upper left second premolar and masticatory discomfort. Clinical and radiographic examinations confirmed adequate bone volume for implant placement. An implant (Dentis Implant s-Clean SQ, 4.0 × 10 mm) was placed using a digitally designed and 3Dprinted surgical guide. A custom Polyetheretherketone (PEEK) healing abutment was fabricated and adjusted using flowable composite to mimic the natural gingival contour. This approach minimized repeated abutment disconnection and facilitated soft tissue maturation. After three months, an open-tray impression was made, and a screw-retained zirconia crown was delivered. Custom PEEK healing abutments demonstrate superior adaptation to peri-implant soft tissues, preserve gingival architecture, and effectively prevent black triangle formation compared to prefabricated abutments. Their use is recommended in posterior maxillary implant restorations to enhance functional and biological outcomes. (IJP 2025;7(1):25-31)

#### Introduction

The primary goal of modern dentistry is to restore patient's oral health in a predictable, functional, and esthetic manner.<sup>1</sup> Conventional removable dentures, although widely used, significantly compromise masticatory efficiency compared to natural dentition. In contrast, implant-supported prostheses are capable of restoring function to near-natural levels.<sup>2</sup>

The utilization of dental implants has grown substantially worldwide, reflecting their clinical relevance and acceptance. In 2023, approximately 12–15 million dental implants were placed globally. Furthermore, the global dental implant and prosthetic market is projected to reach USD 16 billion by 2029, with an annual growth rate of about 7.5%. This significant increase highlights the shift of implant therapy from a specialized option to a mainstream component of contemporary prosthodontics.<sup>2</sup>

Implant dentistry has evolved beyond its initial objective of merely restoring function.<sup>1</sup> Today, long-term success requires achieving both function and esthetics while respecting hard and soft tissue biology and preserving peri-implant bone architecture over decades. This places greater emphasis on proper soft tissue management during the healing phase.<sup>1-4</sup>

Healing abutments are essential components in this process. They connect to the implant and extend through the soft tissue barrier, either during second-stage surgery or at the time of implant placement to avoid an additional procedure. Also known as healing collars, perimucosal extensions, or healing cuffs, these components are traditionally fabricated as stock

cylindrical abutments but can also be customized to match individual anatomical contours.<sup>5</sup>

Prefabricated healing abutments, which usually come in round and cylinder shapes, have been widely used due to their convenience and time-saving nature.<sup>4</sup> However, their morphology often leads to an unnatural soft tissue profile, resulting in unfavorable esthetic outcomes that may require additional surgery and recontouring procedures. Customized healing abutments (CHAs) aim to develop a custom emergence profile of peri-implant supporting tissue immediately after implant placement.<sup>6</sup>

CHAs is modified in its dimensions and transmucosal area to guide peri-implant tissue into the proper shape. Moreover, it can also be used to protect or seal underlying bone-grafting materials in the immediate placement socket without the need for sutures and to avoid disconnection of the abutment, which may interfere with the osseointegration process.<sup>6</sup> They can be fabricated from materials commonly used in dentistry, such as polyetheretherketone (PEEK), polymethyl methacrylate (PMMA), zirconia, titanium, and resin composite. CHAs can be fabricated directly at the chair side or the indirect method can be used.<sup>4</sup>

This case report aims to highlight the urgency and clinical success of using a customized healing abutment for a maxillary premolar implant to achieve optimal soft tissue contour and prevent the formation of black triangles.



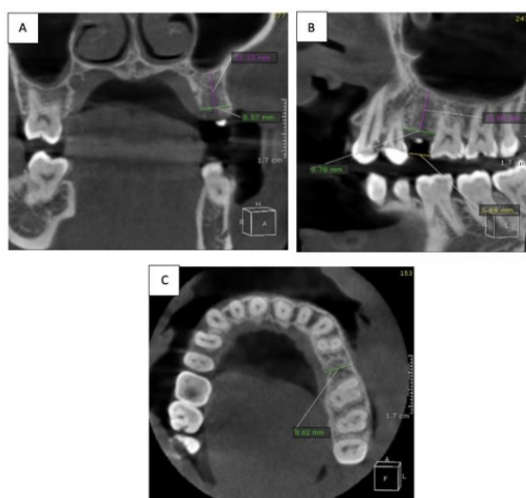
**Figure 1.** Patient's facial profile in lateral and frontal view.



**Figure 2.** Intraoral photographs of the patient.



**Figure 3.** Panoramic radiograph.



**Figure 4.** CBCT image showing the planned implant site in region 25 with composite fiducial markers for radiographic reference, displayed in three views : A. Coronal view, B. Sagittal view, C. Axial view.

## Case Report

A 31-year-old female patient presented to the Prosthodontics Department of RSGM Unpad with complaints of impaired esthetics and difficulty chewing due to the loss of the upper left premolar approximately one year earlier. The tooth had previously undergone root canal treatment; however, recurrent infection and pain occurred, leading to extraction. The patient reported that post-extraction healing was uneventful.

The patient expressed psychological discomfort and embarrassment while smiling due to the missing tooth. She had never worn any type of dental prosthesis and requested a fixed, non-removable replacement. Her medical history was non-contributory, with no systemic diseases, no known allergies, and no current medication use.

### Clinical Examination

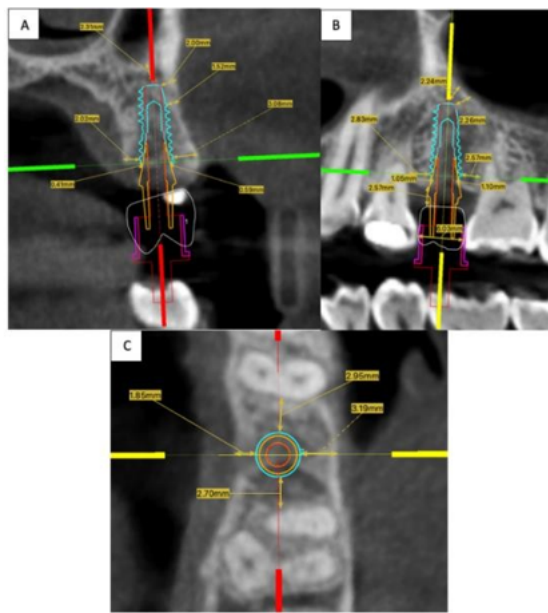
**Extraoral findings:** The patient exhibited an ovoid and symmetrical facial form, a convex facial profile, and a temporomandibular joint within normal functional limits, with no signs of abnormality.

**Intraoral findings:** Superficial carious lesions were observed on teeth 17, 16, 26, 27, 28, 38, 37, 36, 45, and 46. Tooth 24 presented with an amalgam restoration. Tooth 25 was missing.

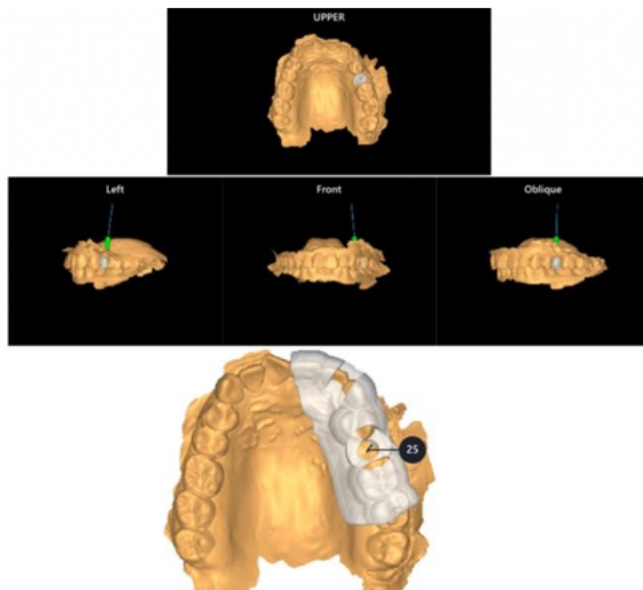
During the first visit, comprehensive data collection was performed, including anamnesis, extraoral and intraoral photographs, panoramic radiograph, Cone Beam Computed Tomography (CBCT), and maxillary-mandibular impressions for study models using irreversible hydrocolloid (Aroma Alginate, GC). Prior to CBCT acquisition, fiducial markers made of flowable composite resin were placed to serve as radiographic reference points for accurate transfer of anatomical landmarks and implant planning. CBCT analysis revealed that the bone density at the site of tooth 25 corresponded to Misch's classification of D3 bone quality, characterized by a thin, porous cortical layer and relatively dense trabecular bone, with a density range of 350–850 HU. The vertical height of the alveolar bone, measured from the alveolar crest to the floor of the maxillary sinus, was approximately 12.06 mm [figure 3](#).

A scan of the working model was performed using an intraoral scanner (IOS) to fabricate the surgical guide. Implant position and dimensions were planned using the Implant Planning Software (ImplanStation). The mesiodistal width of the edentulous area in region 25 to the proximal surfaces of adjacent teeth measured 6.52 mm. The narrowest buccolingual dimension, located at the mid-crestal area, was 8.78 mm. The alveolar ridge exhibited lingual resorption, resulting in a narrower crest compared to the middle and vestibular regions.

Based on these anatomical considerations, a Dentist Implant s-Clean SQ with a length of 9.0 mm and a diameter of 4.0 mm was selected. This implant size



**Figure 5. Digital planning of implant position and prosthetic design using ImplantStation software displayed in: A. Coronal view, B. Sagittal view, C. Axial view.**



**Figure 6. Digitally surgical guide design.**



**Figure 7. Try in surgical guide .**

and design were chosen to optimize buccal bone thickness by placing the implant in a subcrestal position of approximately 2.57 mm. Implant angulation and position were also aligned with the opposing occlusal contacts. The planned implant position is shown in figure 5.

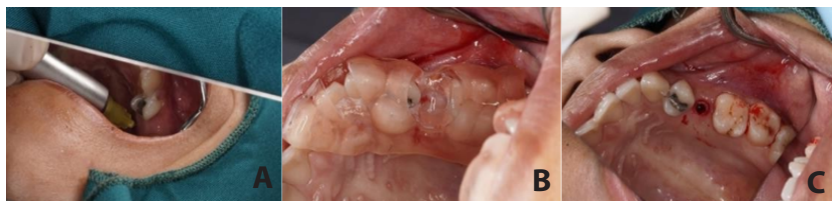
The surgical guide was designed according to the digital plan and 3D printed as a resin try-in prototype figure 6. It was evaluated intraorally to assess adaptation, retention, and stability. The patient was then instructed to prepare for the first-stage surgery and prescribed prophylactic antibiotics and analgesics to be taken one hour prior to the procedure. Once the try-in guide was confirmed to fit properly, instructions were given to fabricate the final surgical guide for use at the next appointment.

At the subsequent visit, the first-stage surgery was performed for implant fixture placement. The procedure began with preparation of sterilized instruments and materials, followed by disinfection of the surgical field. Local anesthesia was administered via infiltrative injection at the mucobuccal fold in the region of tooth 25. Sequential osteotomy was performed using an initial drill, followed by step drills with diameters of 2.2 mm and 3.5 mm, and finalized at 4.0 mm to a depth of 9 mm at 800–1200 rpm, with intermittent drilling and continuous saline irrigation. A Dentis implant fixture (4.0 mm diameter, 9.0 mm length) was inserted at 40 rpm; irrigation was discontinued during fixture insertion. The implant was placed in a subcrestal position approximately 2 mm below the alveolar crest, as planned. Primary stability was assessed using a manual torque wrench, showing a final insertion torque of 45 Ncm. figure 8.

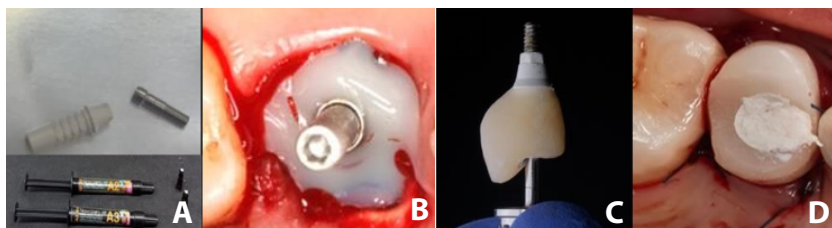
A temporary PEEK healing abutment (N-Hex PEEK, 4.5 mm diameter, Dentis) was connected to the implant. Flowable composite resin (Palfique LX5, Tokuyama Dental) was applied to the rigid cap to gradually shape the emergence profile, using the diagnostic wax-up and putty index as guidance. The composite was light-cured for 20 seconds. Additional composite was layered incrementally to mimic the anatomy of tooth 25. The customized healing abutment was removed, polished extraorally, and reinserted figure 9.

Sutures were placed at the mesial and distal interdental areas using 4-0 blue nylon sutures with a 21 mm reverse-cutting needle to minimize tissue trauma. Occlusion was evaluated to ensure there was no contact with the opposing dentition and the abutment surfaces were smooth. The patient received postoperative instructions and was scheduled for suture removal one week later.

At the fifth visit, three months after implant placement, successful osseointegration between the implant and the surrounding bone was clinically confirmed. The procedure proceeded with impression making using the open tray technique due to the



**Figure 8. Implant placement procedure: A. Infiltration anesthesia at region 25; B. Placement of the surgical guide; C. Insertion of the dental implant.**



**Figure 9. Placement of the Customized Healing Abutment: A. PEEK abutment and composite resin, B. Intraoral fabrication of the customized healing abutment, C. Customized healing abutment refined extraorally, D. Occlusal view of the customized healing abutment.**



**Figure 10. One-week follow-up after placement of the customized healing abutment.**



**Figure 11. Removal of the customized healing abutment showing the formed emergence profile.**

patient's adequate mouth opening. The session began with sterilization of the operative field followed by removal of the customized healing abutment from the implant fixture [figure 11](#). An impression coping was then attached and secured using a long central screw to ensure stability. A perforated custom tray was tried intraorally to verify proper positioning.

The impression was made using a one-step technique with polyvinyl siloxane (PVS) material in putty and light body consistency [figure 12](#). Light body material was applied around the impression coping and the

occlusal surfaces of adjacent teeth, followed by insertion of the putty and light body mixture into the tray, which was then positioned in the patient's mouth until polymerization was complete. After the material set, the long central screw was loosened, allowing the impression coping to be removed along with the impression when the tray was detached. Bite registration was performed using elastomeric material, and tooth shade selection was carried out using a shade guide. The customized healing abutment was subsequently reattached to the implant.

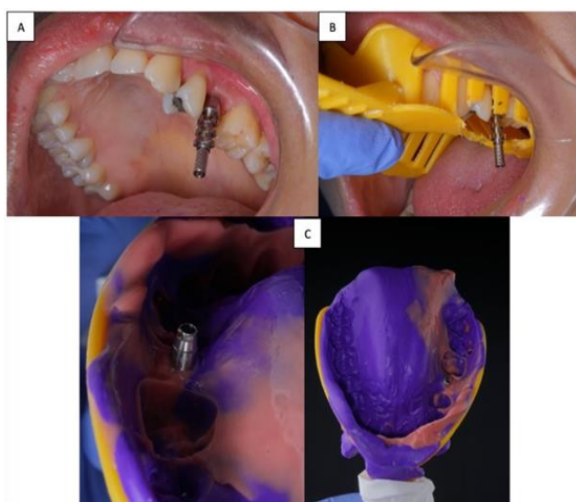
In the laboratory phase, an implant analog was connected to the impression coping within the impression, and the master cast was poured. The implant crown was digitally designed [figure 13](#), and after verification, it was fabricated using zirconia material shade A2 with a screw-cement-retained design. This workflow ensured accurate transfer of the implant position from the oral cavity to the working model and facilitated the fabrication of an anatomically precise, functional, and esthetically satisfactory restoration.

At the sixth visit, one week after the impression procedure, the zirconia crown was inserted and tightened using a screwdriver. Prior to crown placement, the periimplant soft tissues were evaluated to ensure they were free of inflammation and infection. Following insertion, proximal contact was assessed using dental floss, ensuring the floss could pass through the contact areas smoothly without obstruction. The crown was then tightened using a torque wrench to a final torque of 25 Ncm. Occlusal contacts were evaluated using articulating paper and adjusted as necessary. The screw access hole was sealed using Teflon tape and composite resin, followed by a postoperative radiograph. The patient was instructed to maintain optimal oral hygiene by brushing twice daily, using dental floss or mouthwash, and to return for follow-up after one week.

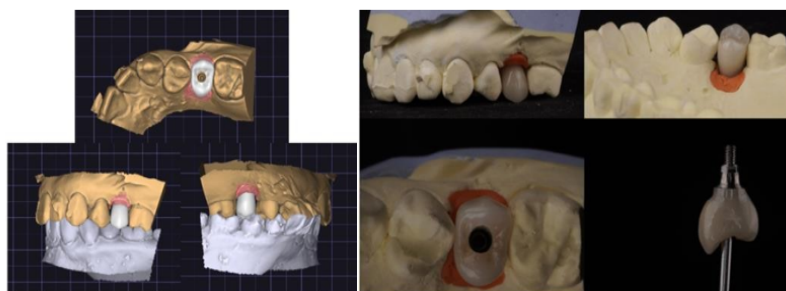
At the seventh visit, one week after crown insertion [figure 15](#), a follow-up evaluation was performed. The patient reported no discomfort during function or at rest. Occlusion and proximal contacts were reassessed, and the peri-implant tissues were confirmed to be free of inflammation or infection. The patient was advised to maintain meticulous oral hygiene and attend regular follow-up appointments every six months.

## Discussion

Implant planning and placement require a high degree of accuracy to avoid anatomical complications and ensure optimal prosthetic outcomes.<sup>1,7,8</sup> Fiducial markers are reference objects placed on or in the patient's anatomy (or in a radiographic template) that appear clearly on volumetric imaging such as CBCT, enabling accurate registration of datasets for guided implant placement.<sup>9</sup> For prosthodontic implant restorations, precise registration enhances the fit and position



**Figure 12.** Open-tray impression procedure: **A.** Impression coping connected to the implant in region 25, **B.** Perforated impression tray positioned intraorally, **C.** Completed open-tray impression with the impression coping incorporated in the impression.



**Figure 13.** Digital design of the definitive implant crown; Definitive implant crown fabricated from zirconia.



**Figure 14.** Insertion of the definitive implant crown.



**Figure 15.** One-week post-insertion follow-up of the implant prosthesis.

of the final prosthesis, reduces misalignment, and supports long-term success of the implant-prosthetic complex.<sup>7,9</sup>

Implant placement in the posterior maxillary region often presents complex biological and biomechanical challenges. This area typically exhibits low bone density, limited keratinized mucosa, and variable ridge morphology, all of which affect primary stability and peri-implant soft tissue response.<sup>2,5,6</sup> In addition to osseointegration, the long-term success of implant therapy now strongly depends on proper soft tissue management, particularly in developing a natural emergence profile and maintaining interdental papillae.<sup>5,6,10</sup>

Conventional prefabricated healing abutments are widely used due to their convenience and efficiency. However, their cylindrical, uniform shape fails to reproduce the natural tooth neck anatomy, resulting in an unnatural gingival contour and inadequate guidance of soft tissue healing. Consequently, this may lead to a flattened gingival architecture, poor papilla regeneration, and the development of open gingival embrasures or “black triangles,” which compromise esthetics and hygiene.<sup>4,6,7,11</sup>

Customized healing abutments (CHAs) provide a more biologically oriented and individualized approach. By adapting the transmucosal contour to the patient’s gingival morphology and tooth anatomy, CHAs guide peri-implant mucosal maturation in a controlled manner, promote a natural emergence profile, and support the preservation or regeneration of the interdental papilla.<sup>3,10,11</sup> In addition, CHAs help establish a continuous mucosal seal around the implant neck, which is essential to prevent bacterial penetration and maintain marginal bone stability.<sup>6,12</sup>

An important advantage of CHAs over prefabricated abutments is their ability to reduce repeated abutment disconnection and reconnection during the healing phase, which is known to disrupt epithelial attachment and trigger inflammatory responses in the peri-implant mucosa.<sup>12,13</sup> Maintaining a single abutment from implant placement to the final restoration—known as the “one abutment, one time” concept—helps preserve the integrity of the mucosal seal and prevents micro-movements at the implant–abutment interface.<sup>6,11</sup>

Material selection for CHA fabrication plays a critical role in its biological and esthetic performance. In recent years, polyetheretherketone (PEEK) has gained popularity as a material for temporary and healing abutments, replacing conventional metals such as titanium. PEEK exhibits an elastic modulus (3–4 GPa) similar to cortical bone, providing a more favorable stress distribution at the implant platform.<sup>14</sup> Furthermore, PEEK demonstrates excellent biocompatibility, chemical stability, and low plaque affinity, making it highly suitable for mucosal healing.<sup>15,16</sup>

Biologically, soft tissues surrounding PEEK abutments show less inflammation and more stable epithelial attachment compared with titanium. Milinkovic et al. reported significantly lower inflammatory cell infiltration around PEEK abutments, while Shomurodov and Mirkhusanova found more favorable mucosal tissue health in PEEK compared with titanium groups. Similarly, Suphangul et al. demonstrated that PEEK surfaces inhibit bacterial adhesion and biofilm accumulation, leading to reduced plaque retention.<sup>13,15,16</sup>

From an esthetic standpoint, the light ivory color of PEEK closely resembles the surrounding gingival tissues, preventing the “gray shine-through” effect commonly observed with metallic abutments, particularly in patients with thin gingival biotypes.<sup>6,14</sup> This advantage enhances the visual harmony of peri-implant soft tissues and improves patient satisfaction.

In the context of one-stage implant surgery, where the healing abutment is immediately placed during implant insertion and remains transgingivally exposed, PEEK has demonstrated distinct biological advantages over metal. PEEK promotes faster and more stable mucosal sealing, lower plaque accumulation and peri-implant inflammation. When combined with a customized design, PEEK CHAs support the one abutment, one time protocol, reducing tissue trauma and preserving the epithelial seal from the earliest stages.<sup>11,12</sup> Although titanium provides superior mechanical strength, this limitation is clinically insignificant during the healing phase, where occlusal load is minimal. Therefore, PEEK is considered the material of choice for customized healing abutments in one-stage implant protocols, as it enhances biological stability, peri-implant hygiene, and esthetic outcomes.<sup>6,12,14</sup>

Overall, the clinical results of this case report align with current literature demonstrating that customized PEEK healing abutments significantly improve soft tissue adaptation, maintain papilla height, and prevent black triangle formation. The use of PEEK also supports superior peri-implant mucosal health and esthetic integration. Thus, the application of customized PEEK healing abutments represents a biologically driven and contemporary approach in implant dentistry—one that prioritizes soft tissue stability, esthetic integrity, and the long-term success of implant restorations.

## Conclusion

The combination of a customized healing abutment (CHA) and the use of polyetheretherketone (PEEK) material provides a synergistic advantage in achieving biologically stable peri-implant soft tissue outcomes, besides its esthetic advantage. CHA enables precise control of the transmucosal contour, supports papilla formation, and maintains a natural emergence profile, while PEEK enhances these effects through its excellent biocompatibility, low plaque affinity, and

gingiva-like color that improves esthetic integration. In one-stage implant surgery, where mucosal healing and osseointegration occur simultaneously, the use of a customized PEEK healing abutment promotes faster soft tissue maturation, stable mucosal sealing, and reduced inflammatory response compared with metallic abutments. Within the limitations of this case, the clinical outcomes suggest that customized PEEK healing abutments represent an optimal approach for peri-implant soft tissue management, combining biological stability, functional success, and improved esthetic results in implant rehabilitation.

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## CASE REPORT

### Management of disc displacement with reduction with intermittent locking, myofascial pain, and TMD-Related headache

Andita Nurseptiani Lukman,<sup>1\*</sup> Rasmi Rikmasari<sup>2</sup>

#### ABSTRACT

**Keywords:** Disc displacement with reduction, Headache attributed to TMD, Myofascial pain, Stabilization splint, Temporomandibular disorders

Temporomandibular disorders (TMD) refer to a group of problems involving the temporomandibular joint (TMJ) and the masticatory muscles. The most common intra-articular diagnosis is disc displacement with reduction; however, cases with intermittent locking are relatively rare and can be characterized by fluctuating symptoms. This case report describes the conservative management of disc displacement with reduction with intermittent locking accompanied by myofascial pain with referral and headache attributed to TMD in a 23-year-old male patient. The patient came in with a one year history of left TMJ clicking, recurrent locking episodes, jaw pain, and sharp temporal headache. A clinical examination showed corrected deviation while opening the mouth, limited pain-free mouth opening, joint sounds, myofascial pain with referral, and headache reproduction when the muscles were palpated. The final diagnosis was disc displacement with reduction with intermittent locking complicated with myofascial pain with referral and headache attributed to TMD. Management was a combination of mandibular stabilization splint therapy, muscle conditioning exercises, and physical self regulation. Subsequent visits showed improvement in muscle pain, headaches, joint sounds and locking episodes. Conservative management with stabilization splint therapy supported by behavioral and muscle conditioning interventions can lead to successful symptom relief and functional improvement. (IJP 2025;7(1):32-36)

#### Introduction

The temporomandibular joint (TMJ) is an essential component of the stomatognathic system, and the disorders affecting it along with masticatory muscles are generally considered as temporomandibular disorders (TMD). The most common symptoms of TMD are joint noises, restricted mandibular movement, and orofacial pain.<sup>1,2</sup>

The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) offer an evidence-based, dual-axis diagnostic system that enables standardized clinical assessment and identification of both physical and psychosocial factors of TMD. Accurate diagnosis using DC/TMD is essential for establishing an appropriate and effective treatment plan.<sup>3</sup>

Within the DC/TMD framework, disc displacement with reduction is the most frequently encountered intra-articular diagnosis; however, cases accompanied by intermittent locking are relatively rare and the patients may report variable symptoms such as episodic limitation of mouth opening.<sup>4</sup> Disc displacement with reduction with intermittent locking and headache attributed to TMD are infrequently reported disorders, especially when the diagnoses are combined with myofascial pain with referral such as in the present case.<sup>1,3</sup>

Management of disc displacement with reduction with intermittent locking is primarily conservative and might include the use of a stabilization appliance therapy along with adjunctive methods such as muscle

conditioning and physical self regulation. A comprehensive and individualized treatment strategy is especially important in patients presenting with co-existing myofascial pain and headache attributed to TMD.<sup>5,6</sup>

This case report describes the conservative management of disc displacement with reduction with intermittent locking accompanied by myofascial pain with referral and headache attributed to TMD in a 23-year-old male patient.

#### Case Report

A 23-year-old male came to the Prosthodontics Clinic of Oral and Dental Hospital (RSGM) Unpad with a complaint of clicking noises from the left temporomandibular joint for one year when opening and closing the mouth. During the last week before the consultation, the patient experienced left jaw pain, especially when opening the mouth, which was aggravated by mainly chewing on the right side due to an ulcer in the left side of the mouth. In addition, he was experiencing recurrent sharp stabbing pain in the left temporal region which was consistent with the headache. The patient reported previous episodes of jaw locking with inability to open the mouth, first occurring one year earlier and most recently one month prior to examination.

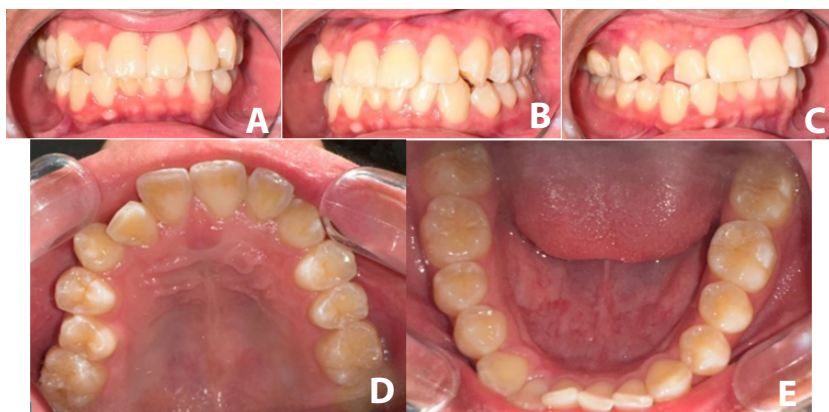
The patient admitted to habitual cheek and tooth biting

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

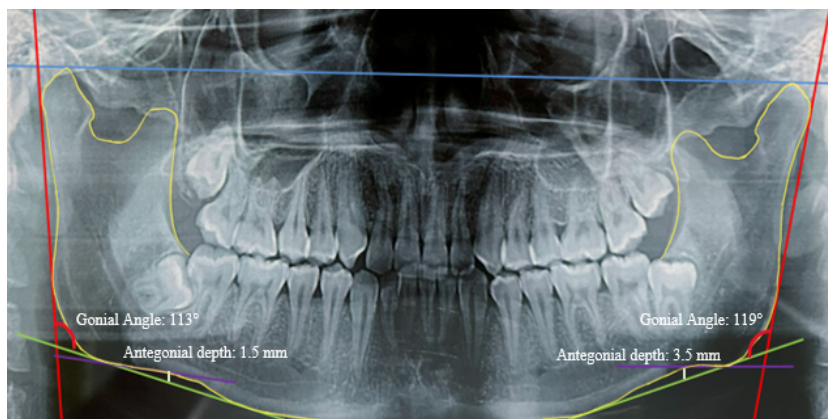
\*Corresponding author: andita12001@mail.unpad.ac.id



**Figure 1.** Extraoral profile of the patient: A. Left lateral view, B. Frontal view, C. Right lateral view.



**Figure 2.** Intraoral findings of the patient: A. Left lateral view, B. Frontal view, C. Right lateral view, D. Maxillary occlusal view, E. Mandibular occlusal view.



**Figure 3.** Panoramic radiograph of the patient



**Figure 4.** Insertion of mandibular stabilization splint

during rest but denied sleep bruxism. Other factors which might have contributed were unilateral sleeping posture, prolonged forward head posture during computer work, and recently started weightlifting exercises.

On the extraoral examination, there was mild facial asymmetry with a flat profile and postural imbalance characterized by right shoulder elevation figure 1A - figure 1C. Intraoral examination figure 2A - figure 2E showed anterior open bite, a crossbite involving tooth 12, dental rotations, palatally and buccally positioned posterior teeth, and wear facets on the mandibular anterior teeth. Bony exostoses were present in both the maxilla and mandible.

Panoramic radiography demonstrated asymmetry of the mandibular condyles, with the right condyle positioned more superiorly and posteriorly than the left, while both condyles remained within the glenoid fossae figure 3.

DC/TMD Axis I examination revealed pain in the left temporalis and masseter muscles, corrected deviation during mouth opening, limited pain-free opening (30 mm), joint sounds in the left TMJ during opening and closing, and a history of intermittent closed locking. Palpation elicited myofascial pain with referral from the left lateral pterygoid muscle to the left masseter, as well as headache reproduction upon palpation of the left temporalis muscle. DC/TMD Axis II assessment indicated severe pain distribution on pain drawing, with low pain-related disability (Graded Chronic Pain Scale Grade I).

Based on the DC/TMD diagnostic algorithm, the final diagnosis was disc displacement with reduction with intermittent locking accompanied by myofascial pain with referral and headache attributed to temporomandibular disorder.

At the initial visit, the patient underwent comprehensive subjective and objective examinations based on the DC/TMD protocol, supported by panoramic radiographic evaluation. Maxillary and mandibular impressions were taken using stock trays and alginate to obtain diagnostic study models. The patient was educated on eliminating parafunctional habits that could trigger or exacerbate symptoms. Physical self-regulation (PSR) was introduced, including bilateral chewing, correction of sleeping position, posture improvement, and muscle relaxation techniques. In addition, the patient was instructed to perform muscle conditioning in the form of jaw exercises.

At the second visit, a wax pattern was fabricated for a maxillary stabilization splint. Centric relation was recorded with the condyles positioned in an anterosuperior position and a posterior disocclusion of approximately 1.5–2.0 mm, corresponding to the intended splint thickness. The patient was thoroughly instructed on the bite registration procedure and allowed to practice prior to recording. The wax rim was

adapted to cover the occlusal surfaces, incisal edges, and palatal areas of the maxillary teeth.

At the third visit, the mandibular stabilization splint was inserted [figure 4](#). Occlusal adjustment was performed using articulating paper to ensure even and balanced contacts across the splint surface. The patient was instructed to wear the splint continuously, except during meals and cleaning, and to clean the appliance twice daily. A follow-up visit was scheduled 14 days after insertion.

At the first follow-up visit (14 days after splint insertion), joint clicking was still present in both the left and right TMJs. The patient reported that locking had occurred two days before the appointment. On the other hand, muscle pain had gone down from baseline to this visit. The patient added that he had experienced fewer temporal headaches. Although physical self regulation (PSR) was attempted, it was not done regularly because of the residual discomfort. The occlusal surface of the splint was adjusted, and PSR instruction as well as habit elimination were carried out.

At the second follow-up visit, two weeks later, the patient reported complete resolution of muscle pain. Joint sounds were still present bilaterally, but the intensity had decreased compared to previous visits. The patient had been performing PSR regularly; initially, a sensation of warmth was felt in the left jaw, which subsequently subsided and became comfortable. During this visit, the patient disclosed that he had asked family members about his habits at night and was told that they had witnessed sleep bruxism. The splint was further occlusally adjusted.

At the third follow-up visit, the patient reported no muscle or joint pain and no recurrence of headache. The right TMJ no longer produced joint sounds, while a clicking sound was still detectable in the left TMJ. Occlusal adjustment was performed.

At the fourth follow-up visit, the patient remained free of muscle and joint pain, with no recurrence of headache or locking episodes. The right TMJ continued to be asymptomatic without joint sounds, while the left TMJ produced only a faint residual clicking sound. Occlusal adjustment was again performed.

At the fifth follow-up visit, the patient reported sustained absence of muscle and joint pain, headache, and locking episodes. There were no joint sounds from either TMJ, except for a barely audible click of the left TMJ upon maximal mouth opening. The occlusal adjustment was done, and the patient was advised to start reducing the use of the splint by wearing it every other day in the first week and then stopping it altogether in the second week. The patient was given an appointment for a one month follow up. During the one month follow up, the patient had no complaints and was clinically considered to be resolved.

## Discussion

The patient in this case was a 23-year-old young adult male diagnosed with disc displacement with reduction with intermittent locking accompanied by myofascial pain with referral and headache attributed to temporomandibular disorder (TMD). This finding is consistent with previous literature reporting a global TMD prevalence of approximately 34%, with the highest incidence occurring in individuals aged 18–50 years.<sup>7</sup>

The patient reported joint sounds and a previous episode of closed lock, during which he was unable to open his mouth. Disc displacement with reduction is the most frequently encountered TMD diagnosis, however, cases involving intermittent locking are relatively uncommon.<sup>4</sup> In a case series on disc displacement with reduction with intermittent locking, three out of five patients were younger than 30 years.<sup>6</sup> supporting the age profile observed in the present case. Clinical examination revealed myofascial pain upon palpation of the temporalis, masseter, and lateral pterygoid muscles. The patient experienced referred pain in the left masseter area when the left lateral pterygoid muscle was palpated. Myofascial pain is a common TMD diagnosis, affecting approximately 30%–85% of patients with musculoskeletal pain, and is most frequently observed in individuals aged 27–50 years.<sup>8,9</sup>

The patient also complained of sharp, stabbing pain localized to the left temporal region. Among headache disorders associated with TMD, primary headaches such as migraine and tension-type headache are the most commonly reported comorbidities; particularly in their chronic forms. Patients afflicted with TMD have double the chance of developing chronic daily headache patterns, with scenarios including or excluding migrainous features. A linear relationship between TMD symptom severity and migraine intensity has been proposed.<sup>10</sup> Furthermore, headaches influenced by or secondary to TMD are recognized as headache attributed to TMD according to the DC/TMD classification.<sup>3</sup>

TMD can be influenced by various factors such as psychological stress and anxiety, postural alterations, excessive occlusal loading, and occlusal interference. Although the patient denied nocturnal bruxism, intraoral examination revealed wear facets on the mandibular anterior teeth and exostoses on both jaws, which are considered clinical signs suggestive of bruxism.<sup>10</sup> This finding is further supported by the gonial angle assessment, which showed a right gonial angle of 113° and a left gonial angle of 119°, both below the normal range of 120–135°. A reduced gonial angle has also been reported as one of the morphological indicators associated with bruxism.<sup>11</sup> Bruxism is an involuntary oral parafunctional habit where clenching (centric bruxism) and/or grinding (eccentric bruxism) actions are carried

out unconsciously. This habit can happen during sleep (sleep bruxism) or at the time when the individual is awake (awake bruxism).<sup>10</sup>

Bruxism and clenching habits may have contributed to the etiology of TMD in this case. Kalaykova et al.<sup>12</sup> reported that daytime clenching may be a risk factor for the development of disc displacement with reduction with intermittent locking. Similarly, Lee et al.<sup>13</sup> provided evidence suggesting that sleep bruxism may contribute to the progression of this condition. Additionally, Kalaykova et al.<sup>12</sup> suggested that increased masticatory forces may play a role in the occurrence of intermittent locking.

Management in this case consisted of mandibular stabilization splint therapy, muscle conditioning, and physical self-regulation. Both surgical and non-surgical approaches have been proposed for the management of disc displacement with reduction with intermittent locking; however, occlusal splints remain the most commonly used non-surgical modality. Two main types of occlusal splints are typically employed in patients with functional jaw limitations: stabilization splints and repositioning splints. In patients with bruxism, occlusal splints may also function as night guards.<sup>14</sup>

Several treatment strategies for disc displacement with reduction with intermittent locking have been described. According to Yamaguchi et al.<sup>15</sup> one of the simplest and most cost-effective approaches involves instructing patients to guide disc reduction by following the path of least resistance, particularly during lateral mandibular movements. Patients with parafunctional habits should be encouraged to discontinue these behaviors. Although bruxism may complicate the condition, patients with disc displacement with reduction with intermittent locking who exhibit bruxism may benefit from occlusal splint therapy.<sup>6,15</sup>

Occlusal splints are also beneficial in the management of myofascial pain and headache attributed to TMD. One of the most widely proposed mechanisms of action of occlusal splints is the modulation of masticatory muscle activity. A study demonstrated a statistically significant reduction in electromyographic activity of the masticatory muscles after six months of occlusal splint use,<sup>16</sup> a finding consistent with those reported by other investigators.<sup>17,18</sup>

In addition to occlusal splint therapy, management of myofascial pain and headache attributed to TMD may be supported by muscle conditioning and physical self-regulation. Counseling and cognitive behavioral therapy particularly help in conservative treatment approaches as psychological factors have a great impact on many cases of TMD. Among other therapies, cognitive behavioral therapy can help patients to quit parafunctional habits like bruxism. Physical exercises are crucial for maintaining muscle function and preventing hyperfunction. Patients are

advised to perform jaw exercises three times daily, including standard jaw exercises and resistance movement exercises.<sup>6,19</sup>

Emotional stress management was also recommended in this case, as stress was suspected to exacerbate the patient's condition. The patient was instructed in physical self-regulation techniques aimed at promoting relaxation, such as diaphragmatic breathing, brief relaxation pauses, and improving sleep hygiene by adopting earlier sleep times. Previous case reports have demonstrated significant improvement in TMD symptoms and a reduction in migraine frequency following similar interventions. Other treatment options may include pharmacological therapy (anti-inflammatory drugs, muscle relaxants, and antidepressants), physical therapy, hypnotherapy as a form of behavioral or cognitive behavioral therapy, and additional supportive modalities.<sup>6,19</sup>

## Conclusion

Disc displacement with reduction with intermittent locking is an intra-articular temporomandibular disorder characterized by episodic limitation of mandibular movement and is frequently accompanied by myofascial pain. Active myofascial trigger points may contribute to referred pain and tension-type headaches attributed to temporomandibular disorders. Definitive management aims to reduce both intracapsular pain and masticatory muscle pain. It is recommended to use a stabilization appliance whenever possible as it not only helps in relieving symptoms but also prevents the occurrence of adverse long-term occlusal effects. Adjunctive therapies such as muscle conditioning and physical self regulation contribute significantly to the success of the treatment and the comfort of the patient.

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## CASE REPORT

### Management of temporomandibular disorders on violinists

Arif Winursito,<sup>1\*</sup> Felix Anthony W. Wong,<sup>1</sup> Seto Pramudita,<sup>2</sup>  
Ista Meidarlina,<sup>2</sup> Lisda Damayanti<sup>2</sup>

#### ABSTRACT

**Keywords:** Immediate splint, Stabilization splint, Temporomandibular joint disorders, Violinist

Temporomandibular Joint Disorders (TMD) is musculoskeletal group syndrome involving temporomandibular joint, masticatory muscles, and related tissues. Symptoms that often appear are pain in the joint area, limited mouth opening, and jaw that locks easily. TMD is generally experienced by many violinists. The tilt of the head to one side when playing violin for a long period cause muscle tension and pain in the face and neck region. This case report aims to describe the treatment of TMD on violinist using occlusal splint. A 26 year old female violinist came to prosthodontic clinic with the main complaint of pain in the jaw when opening the mouth too wide and frequent pain in the facial muscles. The patient has a bruxism habit and anxiety for a long time, and had unbearable pain when opening her mouth. Dental impressions are preformed and an immediate splint was made at the first visit, then at the second visit the immediate splint was replaced with a stabilization splint which was used for 3 months and is given physical self-regulation instructions until the pain finally disappears. Occlusal splint therapy accompanied with physical self regulation can overcome TMD in violinist patient. (IJP 2025;7(1):37-42)

#### Introduction

The temporomandibular joint (TMJ) is a hinge joint that connects the upper and lower jaw bones between the temporal bone and the head of the mandibular condyle. The TMJ is a complex joint because it can move in all directions such as opening and closing like a hinge, shifting back and forth from one side to another during mastication, swallowing and speaking, also the TMJ provides stability to the position of the mandible and prevents dislocation due to excessive force.<sup>1-3</sup> The components of the TMJ are hard tissue (condylar bone, mandibular fossa, articular eminence) and soft tissue (articular disc; ligaments namely collaterals, capsular, temporomandibular, sphenomandibular, stylomandibular; masticatory muscles namely temporalis, masseter, medial pterygoid, lateral pterygoid and neck muscles (digastric)).<sup>4,5</sup>

Temporomandibular disorders (TMD) are a heterogeneous group of musculoskeletal and neuromuscular conditions involving the temporomandibular joint complex, and the surrounding muscles and skeletal components. TMD affects up to 15% of adults, with peak incidence at ages 20 to 40 years. TMDs are classified as intra-articular or extra-articular. Common symptoms include jaw pain or dysfunction, earache, headaches, and facial pain. The etiology of TMD is multifactorial and includes biological, environmental, social, emotional, and cognitive triggers.<sup>1,2,6,7</sup>

Diagnosis is most often based on history and physical examination. Diagnostic imaging may be useful when malocclusion or intra-articular abnormalities are suspected. Most patients improve with a combination of

non-invasive therapies, including patient education, self-care, cognitive behavioral therapy, pharmacotherapy, physical therapy, and occlusal devices. Nonsteroidal anti-inflammatory drugs and muscle relaxants are recommended initially, and benzodiazepines or antidepressants may be added for chronic cases.<sup>8-13</sup>

There are three major classes of TMD disorders: (1) disorders of the joint, including disorders of the disc; (2) disorders of the muscles used for chewing (masticatory muscles); and (3) headaches associated with TMD disorders.<sup>13</sup> TMD are the second most common cause (after dental pain) of orofacial pain, characterized by pain in the region of the temporomandibular joint and in the facial muscles. In addition to pain, patients may experience other signs and symptoms, such as clicking in the joints and limited mouth opening.<sup>14-16</sup> The prevalence of TMD is close to 29.5% globally, and women have a higher prevalence rate than men (36.7% vs. 26.7%).<sup>13</sup>

In a study conducted by Bitinine et al<sup>17</sup> found a direct correlation between temporomandibular disorders and lower quality of life.<sup>17</sup> This study confirms clinical studies conducted previously that chronic medical conditions have a strong negative effect on the patient's quality of life. In other studies, it was found that more women experience TMD and this also affects their quality of life.<sup>18-21</sup> Many instrumental music players experience TMD. The most frequently reported symptoms are clicking or popping sounds, followed by temporomandibular joint pain, muscle pain, crepitus, and limited

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

\*Corresponding author: arif23011@mail.unpad.ac.id



**Figure 1.** A midline shift of 2 mm to the left.



**Figure 2.** Study Model.



**Figure 3.** Immediate splint on the patient.



**Figure 4.** Stabilization splint .

mouth opening. Playing musical instruments related to the masticatory system, such as wind instruments and violin, is thought to be part of the group of etiological factors for TMD.<sup>22-24</sup> This case report aims to show the management of TMD, especially in violinists. We will explain the stages of treatment that need to be carried out for a violinist with TMD.

### Case Report

A 26 years old female patient came to the Prosthodontics Polyclinic at Oral and Dental Hospital Universitas Padjadjaran with complaints of pain in her jaw when she opened her mouth too wide and frequent aches in her facial muscles. The patient had the right upper back molar and lower 2nd premolar extracted for orthodontic purposes. The patient often feels anxious and the patient is a violinist. The patient also has a habit of bruxism. 14 days after the first visit, the patient came in with complaints of unbearable pain when opening his mouth and chewing on the left side of his jaw, his weight had dropped drastically due to his inability to chew. The patient has recently had problems that have caused increased anxiety. The patient wants to open and close the mouth without pain. The patient also felt pain in the head.

The results of the patient's examination showed that the movement to open the mouth without pain was 32 mm, the maximum mouth opening without assistance was 45 mm, the maximum mouth opening with assistance was 50 mm, pain during the movement to open the mouth in the masseter, temporal and TMJ. When the patient makes right lateral movement, it is 7 mm (without pain), left lateral movement is 7 mm (without pain), protrusion is 4 mm (without pain). There is a clicking sound accompanied by pain in the left TMJ when opening and closing the mouth. There is no clicking sound and pain in the TMJ during lateral movement, pain when palpating the right temporalis and masseter (origin, body and insertion). There is pain when palpating the left masseter (body and insertion). There is pain on palpation of the lateral pterygoid, posterior mandible, temporalis, and submandibular.

The patient experienced disc displacement with reduction with intermittent locking. The treatment plan for this patient is to eliminate bad habits by reducing violin playing activities during the treatment period and referring to a psychologist if necessary to deal with the patient's anxiety. A stabilization splint was made on the lower jaw, OHI, Home care (supportive therapy), physical self regulation (PSR), clinical evaluation of the final results of TMJ splint treatment.

At the first visit, the patient underwent an intra-oral and extra-oral examination [figure 1](#), filling out the DC/TMD form. The patient also underwent impression of the upper and lower jaw [figure 2](#), and was then referred for an X-ray.

On the second visit, the patient came in feeling unbearable pain in the left jaw when opening his

mouth and biting, so his weight dropped drastically. On intraoral examination, the patient was only able to open his mouth 2 fingers (19 mm) and felt pain. The patient underwent immediate splinting [figure 3](#).

At the third visit, the patient's pain had subsided 1 day after using the immediate splint. The next step is that the patient undergoes impressions again to make a stabilization splint. At the fourth visit, a stabilization splint was installed.

On the fifth visit, the patient came for the first control which was carried out 1 week after the previous visit. The patient feels the clicking decreases. Stabilization splint reduction was carried out.

On the sixth visit, the patient came to undergo a second control carried out 1 week after the previous visit. The patient's TMJ condition is not yet stable, the pain in the muscles has begun to decrease. Stabilization splint reduction was carried out.

On the seventh visit, the patient came to undergo a third control carried out 1 week after the previous visit. The patient feels that the pain in the muscles is decreasing. Stabilization splint reduction was carried out.

On the eighth visit, the patient came to undergo a fourth control carried out 1 week from the previous visit. The patient no longer has any complaints, the patient's clicking is no longer there, the mouth opens up to 4 fingers (4 mm), the right masseter muscle no longer feels tense.

On the ninth visit, the patient came to undergo the fifth control carried out 1 week from the previous visit. The patient has no subjective complaints, mouth opening is 39 mm. At the tenth visit, the patient came to undergo the sixth control carried out 1 week from the previous visit. The patient had no subjective or objective complaints.

## Discussion

Musical instruments can be divided into two groups, which are wind instruments and string instruments. The viola, violin, cello, lyre, and double bass are classified as string instruments.<sup>22</sup> The violin is a four-stringed wooden plucked musical instrument that can be played using a bow. In general, violins are right-handed instruments and have been designed for use only by right-handed people. However, a left-handed person can play a specially made violin that allows them to hold the bow using the left hand. Based on research conducted by Mizuho and Sugiura,<sup>25</sup> the violin is one of the most popular string instruments in the world.<sup>25,26</sup> Professional violinists have been linked to a predisposition to developing TMD. There are a number of risk factors, including physical trauma due to playing posture and the presence of parafunctional habits. Musical performance anxiety (MPA) and emotional stress may also be a factor, as it is associated with playing-related musculoskeletal disorders (PRM-

D).<sup>23,24,27</sup>

Playing musical instruments regularly can trigger or aggravate TMD, as it is an activity that, in most cases, requires improper use of the orofacial muscles and joints.<sup>22,24</sup> Violins are predominantly designed for right-handed players; therefore, standard playing technique requires the instrument to be supported on the left clavicle. During performance, the violin is positioned horizontally between the left shoulder and the lower jaw and maintained with sustained pressure. To stabilize the instrument, violinists commonly adopt a posture involving lateral neck inclination and increased mandibular force against the violin. This playing posture results in continuous physical contact and repetitive mechanical loading on the craniofacial and cervical regions. Prolonged exposure to such mechanical forces, combined with sustained flexion of the neck and shoulder during extended playing periods, may generate excessive stress in these areas and contribute to the development of TMD.<sup>28-31</sup>

The playing position and posture adopted by violinists may contribute to the initiation of temporomandibular joint disorders, particularly joint pain and dysfunction of the masticatory muscles, such as the masseter and temporalis, due to sustained clenching required to stabilize the instrument. Furthermore, prolonged shoulder and cervical flexion during violin performance can lead to fatigue of the trapezius and sternocleidomastoid muscles, potentially resulting in muscle spasms and discomfort in the shoulder and neck regions.<sup>28,31</sup> The American Academy of Orofacial Pain defines TMD as a group of disorders involving masticatory muscles, the temporomandibular joint, and related structures. It is characterized by pain in the masticatory muscles and/or TMJ, articular sounds, and limited mandibular movement. However, there is no unique etiological factor that can explain the emergence of this disease from TMD.<sup>32-24</sup>

Headache is a frequently reported complaint among patients with TMD. Headache disorders are recognized as one of the most prevalent pain conditions worldwide, with epidemiological evidence indicating that the majority of individuals experience at least one episode of headache during their lifetime. It is estimated that a significant proportion of the general population, close to 90%, experiences at least one episode of headache within a one-year period, highlighting the widespread nature of this symptom.<sup>34-36</sup> Migraine and tension-type headache (TTH) represent the headache disorders most frequently associated with TMD, often presenting in their chronic forms. Migraine is commonly observed in patients with painful myogenous TMD. In fact, most individuals diagnosed with primary headache disorders also exhibit symptoms or signs of TMD, although the prevalence of specific TMD subtypes in the headache population remains unclear. Overall, migraine and TTH appear to be the headache

conditions most closely associated with TMD.<sup>33,37</sup>

In this case, the patient experienced a headache. This pain increases when the stress experienced by the patient increases. This finding is consistent with the results reported by Gadd et al.<sup>38</sup> who demonstrated a high prevalence of psychiatric comorbidities in a tertiary referral clinic for TMDs. The study highlighted that patients with chronic pain have a higher prevalence of mood disorders with depression and anxiety contributing to higher pain intensity, emotional allodynia, and neuro-anatomical changes. Psychological distress also plays a significant role in the modulation and amplification of TMD-related pain, including headache complaints. Stress is known to increase parafunctional activities and sustained muscle tension, which may exacerbate myogenous pain and contribute to headache intensity in TMD patients. Therefore, the stress-related worsening of headache observed in the present case supports the concept that psychosocial factors are important contributors to symptom severity in TMD.<sup>38</sup> Resende et al.<sup>39</sup> also concluded that there is a relationship between sociodemographic aspects, anxiety, quality of life, and TMD. Patients with TMD have higher levels of anxiety and lower quality of life, and this can interfere with the treatment process, thereby reinforcing the need for therapy that considers various factors related to the disorder.<sup>39</sup>

Occlusal splint therapy has been shown to reduce muscular load in the masseter, temporalis, trapezius, and sternocleidomastoid muscles during musical performance. A similar reduction in muscle activity has also been observed in asymptomatic violinists, indicating that occlusal splints may serve not only as a therapeutic intervention but also as a preventive strategy against overuse-related symptoms, particularly in individuals with preexisting craniomandibular disorders.<sup>40-43</sup> In addition, when physical selfregulation techniques are performed with appropriate movements and sufficient duration, excessive muscle tension in patients with temporomandibular disorders can be alleviated. Muscle relaxation achieved through PSR is associated with a reduction in pain intensity, thereby improving overall patient comfort and functional well-being.<sup>44</sup>

Patient can finally experience reduced clicking, headaches and muscle pain when opening and closing the mouth after undergoing treatment in the form of installing an occlusal splint and performing PSR. Recent clinical evidence supports the use of occlusal splints in conjunction with physical therapy or exercise modalities as an effective approach for managing TMD symptoms. In a 2025 pilot randomized controlled trial by Ferrillo et al.<sup>45</sup> patients receiving occlusal splints in addition to physical therapy demonstrated significantly greater pain reduction, improved neck disability scores, and enhanced quality of life compared with physical therapy alone.<sup>45</sup>

Furthermore, research conducted by Romeo et al.<sup>46</sup> shows that a combination of occlusal splint therapy and musculoskeletal physiotherapy produces better results in reducing pain and improving lower jaw range of motion compared to occlusal splint therapy alone. This further reinforces the synergistic benefits of self-regulated physical exercise combined with occlusal stabilization.<sup>46</sup> Cahyani et al.<sup>47</sup> also found that both occlusal splints and exercise therapy were effective in reducing symptoms and improving functional outcomes in TMD patients, thus supporting their use as the primary conservative intervention. The implications of these combined therapy results can produce better outcomes, allowing patients to perform exercises at home under professional guidance, while receiving medical interventions adapted based on thorough clinical examination and diagnosis.<sup>47</sup>

## Conclusion

Treatment of patients with disc displacement with reduction accompanied by intermittent locking using occlusal splints and physical self-regulation (PSR) demonstrated favorable clinical outcomes, with a gradual reduction in pain until complete symptom resolution was achieved. Based on this case, several clinical considerations can be suggested. First, occlusal splint therapy combined with PSR may be considered as an effective conservative treatment option for violinists presenting with temporomandibular disorders, particularly in cases associated with repetitive functional loading. Second, ergonomic modifications, including optimization of head, neck, and mandibular positioning during violin performance, should be emphasized to minimize excessive mechanical stress on the temporomandibular joint and associated musculature. Third, stress management strategies should be incorporated into the treatment plan, as psychological stress may exacerbate parafunctional activities and contribute to symptom recurrence. Finally, a multidisciplinary approach is recommended to optimize long-term symptom control and minimize the risk of relapse.

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## CASE REPORT

### Management of fully edentulous with flabby ridge using double spacer custom tray and modified impression techniques

Sara Stefany,<sup>1\*</sup> Taufik Sumarsongko,<sup>2</sup> Rasmi Rikmasari<sup>2</sup>

#### ABSTRACT

**Keywords:** Complete denture, Double spacer custom tray, Flabby ridge, Selective pressure impression technique

A flabby ridge refers to an area of alveolar ridge with hypermobile and fibrous soft tissue that typically forms as a result of prolonged pressure or unstable occlusion, which posing difficulties in achieving proper denture retention, support, and stability. A precise impression is essential for ensuring the stability of complete dentures with flabby ridge. The fundamental principle for impressions of a flabby ridges is to apply minimal pressure on the flabby area to prevent distortion impression outcome. To achieve that, double spacer custom tray along with selective pressure impression techniques was employed. This case report aims to gain impression with minimum pressure on flabby ridge to enhance retention, support, and stability of the complete denture. A 70-year-old male patient came to the Polyclinic Prosthodontics Oral dan Dental Hospital Universitas Padjadjaran complaining that his old 10-years-used denture felt loose and uncomfortable. Intraoral examination showed that both maxillary and mandibular arches were fully edentulous, with flabby ridges present. Following the assessment, it was decided to make a new complete denture using double spacer custom tray and selective pressure impression techniques. Double spacer custom tray and selective pressure impression techniques have been effective in minimizing pressure that could lead to tissue compression during impression procedures, resulting more comfortable dentures with greater retention and stability. (IJP 2025;7(1):43-47)

#### Introduction

Abnormalities of the denture-supporting tissues present a challenge for dentists, particularly in the fabrication of complete dentures.<sup>1</sup> The primary objective of complete denture treatment is to restore function, aesthetics, and patient comfort with a prosthesis that provides adequate retention, stability, and support to replace the lost teeth and surrounding bone.<sup>2,3</sup> The residual ridge, as a denture-supporting structure, should ideally be covered by a mucosal layer measuring 1.5–2 mm in thickness.<sup>3,4</sup> In cases of flabby tissue, the mucosal layer consists of hyperplastic, mobile fibrous tissue located on the surface of the alveolar ridge. Flabby tissue occurs in approximately 24% of cases in the maxilla and 5% in the mandible, more frequently in the anterior maxillary region, and is often associated with combination syndrome.<sup>1-5</sup>

The Glossary of Prosthodontic Terms 9th edition (GPT-9)<sup>6</sup> defines flabby tissue as excessive tissue that is movable. This condition occurs due to the replacement of alveolar bone with fibrous tissue. It commonly develops in the anterior maxilla, especially when natural anterior teeth remain in the mandible—a condition known as combination syndrome—which results in unstable occlusal forces from the remaining natural teeth, thereby creating excessive loading on the residual ridge.<sup>7</sup> Other etiological factors contributing to flabby tissue include long-term denture wear without periodic maintenance, trauma from the denture base, ill-fitting dentures, malocclusion, and abnormal pressure on the denture.<sup>8,9</sup>

Flabby tissue forms as a result of excessive pressure or unstable occlusion on the alveolar bone supporting the denture, leading to the replacement of alveolar bone with hyperplastic fibrous soft tissue. This condition complicates denture retention, stability, and support.<sup>9,10</sup> Complete denture support is compromised when the mobile flabby tissue is displaced more than 2 mm under pressure.<sup>4,11</sup> The excessive movement caused by flabby tissue may result in clinical problems such as denture dislodgement and pain during function.<sup>11</sup> Because flabby tissue provides inadequate support, it easily displaces under pressure, reducing retention by disrupting the peripheral seal of the denture.<sup>12</sup>

Impression procedures in complete denture cases involving flabby tissue require special attention. During impression making, the applied pressure may cause displacement or distortion of the flabby tissue, making it difficult to obtain an accurate anatomical form. This can adversely affect the retention, stability, and support of the final complete denture.<sup>11-13</sup>

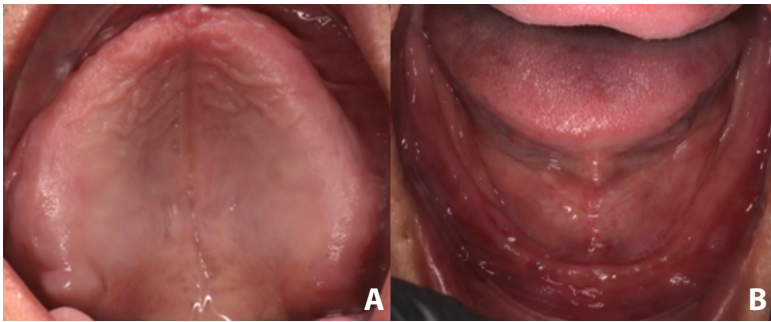
Management of flabby tissue is generally divided into three approaches. First, a surgical approach involving excision of the flabby tissue prior to denture fabrication. Second, fabrication of implant-supported dentures. Third, a non-surgical approach using conventional dentures with modified impression techniques.<sup>5,13,14</sup> Surgical removal

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

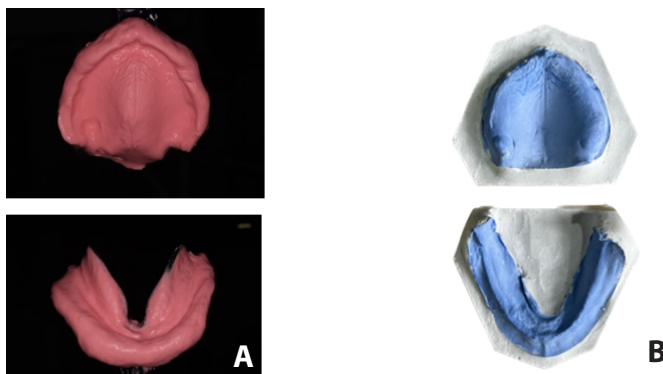
\*Corresponding author: sara11003@mail.unpad.ac.id



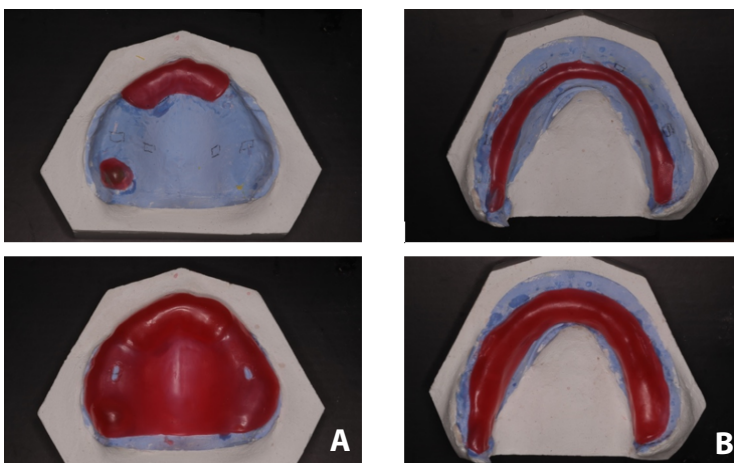
**Figure 1.** Extraoral profile of the patient.



**Figure 2.** Intraoral findings of the patient: A. Maxillary occlusal view, B. Mandibular occlusal view.



**Figure 3.** A. Preliminary impression with alginate, B. Cast study.



**Figure 4.** Fabrication of double spacer on; A. Maxilla and B. Mandible.

of flabby tissue is considered an effective method to create a firm denture-bearing area. However, this approach may reduce vestibular depth, thereby decreasing denture retention. Implant-supported prostheses provide additional support from the underlying bone and minimize reliance on soft tissue support, but they require higher costs and longer treatment time. Compared with the two approaches above, the non-surgical method using conventional prostheses with modified impression techniques and balanced occlusal contacts is more commonly selected, particularly for patients with compromised general health or limited financial resources.<sup>15,16</sup>

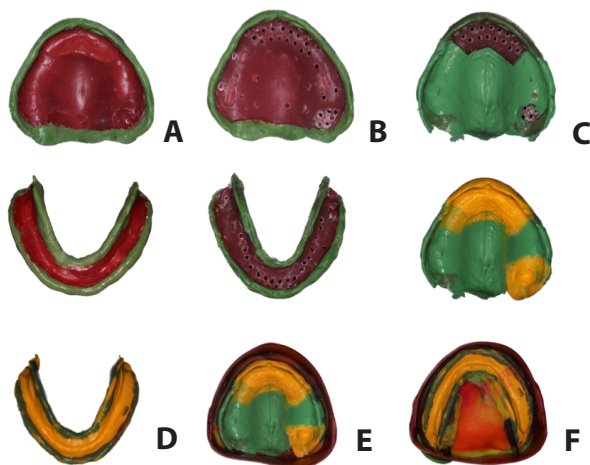
### Case Report

A 70-year-old male patient came to the Prosthodontics Clinic of Oral and Dental Hospital (RSGM) Universitas Padjadjaran with a chief complaint of difficulty chewing due to the loss of all teeth in both the maxilla and mandible. The patient had been wearing complete dentures for the upper and lower jaws for 10 years; however, the dentures had become loose and painful, especially during mastication. The patient reported no systemic conditions. He expressed a desire to have new dentures fabricated that would be more comfortable and free of pain during use [figure 1](#).

Intraoral examination showed that the patient had lost all teeth in the maxilla and mandible with flabby ridges present on region anterior and right tuberosity of maxilla, and the entire mandible [figure 2](#). Due to economic factor, patient refuse to do a treatment with surgical approach or implant-supported complete denture. After discussing, it was decided to make a new conventional removable complete denture.

Following the patient's approval of the treatment plan and completion of informed consent, a preliminary impression was made using irreversible hydrocolloid/alginate to produce a cast study. The obtained impression was subsequently poured with dental stone [figure 3](#). On the cast study, a double wax spacer was fabricated, with additional spacer placed over the flabby areas in both the maxilla and mandible [figure 4](#). A custom tray was then constructed using light-cured resin material. The borders of the custom tray were designed to be 2 mm short of the muco-buccal fold to provide space for muscle activation during border molding. The lips, cheeks, and tongue were evaluated during the intraoral try-in of the custom tray.

Border molding of both the maxilla and mandible was performed using greenstick compound along the borders of the custom tray [figure 5A](#). The wax spacer was then carefully removed from the custom tray without damaging the greenstick compound. Escape holes were subsequently created in the custom tray. In the flabby areas, the escape holes were made more numerous and wider to reduce pressure during the final impression [figure 5B](#). The final impression was taken



**Figure 5.** A. Border molding, B. Creating escape holes, C. Final impression of the maxilla, D Final impression of the mandible, E-F. Beading and boxing of the maxilla and mandible.



**Figure 6.** Determination of the parallelism of the maxillary bite rim from A. Left side, B. Front view, and C. Right side.



**Figure 7.** A. Determination of the parallelism of maxillary and mandible bite rim, B. Rest position of the patient, C. Establishment of vertical dimension in patient on centric relation.

using polyvinyl siloxane (PVS), with light-body material applied to the flabby areas and regular-body material to the non-flabby areas figure 5C – figure 5D. Beading and boxing procedures were carried out on the impression, which was then poured with dental stone to obtain the master cast figure 5E – figure 5F.

Record bases and bite rims were done on the master casts. The maxillary and mandibular bite rims were tried in the patient's mouth. First, the parallelism of the maxillary bite rim was assessed using a Fox plane. At this stage, orientation lines were also determined on the bite rim, including the high lip line, low lip line, midline, and canine lines figure 6.

Subsequently, the mandibular bite rim was tried in, followed by determination of the patient's

vertical dimension and centric relation figure 7. The patient's vertical dimension at rest was measured at 76 mm, and the vertical dimension of occlusion was established at 73 mm. After determining the vertical dimension and centric relation, a facebow transfer was performed to transfer the maxillomandibular relationship to the cranial base onto the articulator. The bite rims were then secured using a stapler and removed from the patient's mouth. The master casts with the bite rims were mounted on a semi-adjustable articulator figure 8. During this visit, the shade and shape of the artificial teeth were selected according to the patient's skin tone, facial form, age, and gender, followed by the arrangement of the maxillary and mandibular artificial teeth figure 9.

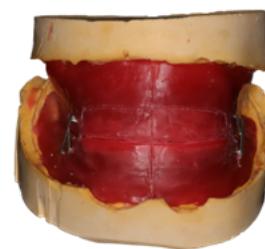
Next step was a wax try-in of the dentures in the patient. Aesthetics, midline, low lip line, smile line, as well as centric and eccentric occlusion were evaluated. After confirming satisfactory results, the laboratory procedures for complete denture fabrication were carried out, including packing, finishing, and polishing figure 10.

The completed complete dentures were evaluated for any sharp edges, unpolished, or rough surfaces figure 11. Afterward, the complete dentures were inserted into the patient's mouth. During insertion, retention, stability, adaptation, denture base extension, centric and eccentric occlusion, as well as aesthetics were assessed figure 12. The patient was also re-educated on the proper insertion and removal of the prostheses, as well as instructions for cleaning and maintenance.

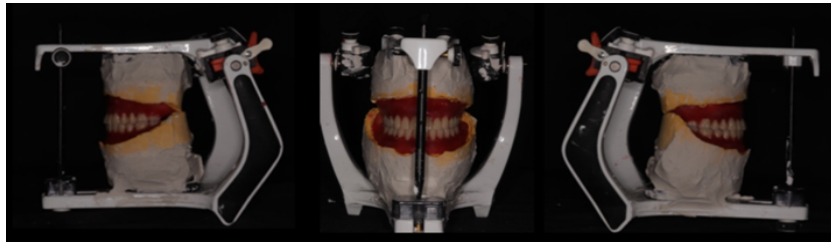
The patient then returned for a one-week post-insertion follow-up to evaluate the condition of the oral cavity and assess the patient's adaptation to the new dentures. During this visit, both subjective complaints and objective examination of the oral soft tissues were performed. The patient reported that the new dentures were more comfortable and did not cause pain or pressure on the gums.

**Discussion**

Compression of flabby tissue during conventional impression procedures can distort the fibrous tissue, resulting in poor stability during denture insertion.



**Figure 8.** Bite rims after fixation.



**Figure 9.** Arrangement of artificial teeth for the maxilla and mandible on semi-adjustable articulator.



**Figure 10.** Evaluation of the wax denture try-in: A. Low lip line, B. Occlusion, C. Smile line, D-F. Patient's occlusion from the left, front, and right views.



**Figure 11.** Complete dentures of the maxilla and mandible A. Left side, B. Frontal view, C. Right side.



**Figure 12.** Insertion of the complete dentures of the maxilla and mandible.

Movement of flabby tissue during function may alter the position of the denture and affect the peripheral seal, leading to inadequate retention and frequent dislodgement.<sup>5,16</sup> To obtain optimal support, impression technique plays a crucial role in the fabrication of dentures in cases with flabby tissue. The impression should apply pressure to the non-flabby tissues while avoiding pressure on the flabby areas.<sup>8</sup> Modified custom trays are

specifically fabricated as an alternative approach to manage edentulous cases with flabby tissue.<sup>17</sup>

The selective pressure impression technique is an important method designed to optimize denture function and comfort. By selectively applying pressure to primary stress-bearing areas and reducing pressure on non-load-bearing areas, this technique aims to distribute masticatory forces evenly. It involves the use of custom trays, selective relief methods, and dual-viscosity impression materials to ensure precise tissue recording.<sup>18</sup>

Flabby tissue should be recorded in a mucostatic condition, meaning in a resting state. Impression technique and impression material are two factors that can conservatively address this issue.<sup>19</sup> Several methods are used to provide relief to flabby tissue, including custom trays with additional escape holes, double spacers, and window techniques in custom trays.<sup>11</sup> Previous studies have reported that using custom trays with escape holes greater than 1 mm in diameter or a spacer thickness of 1.4 mm can effectively reduce pressure in edentulous areas. Pressure on flabby tissue can be minimized by providing additional relief space in the flabby area through the placement of two layers of baseplate wax as spacers and by increasing the number or size of escape holes in the custom tray.<sup>11-20</sup> The wax spacer placed in the custom tray provides sufficient space for the flow of low-viscosity final impression material, while the additional escape holes create an outlet pathway for excess material, thereby reducing pressure on the flabby area during impression making.<sup>21</sup>

Impression material selection is also a critical aspect in managing flabby tissue. The flow properties of the material significantly influence impression success. Polyvinyl siloxane (PVS) is an elastomeric impression material commonly used in clinical practice. PVS is available in various viscosities, including extra light, light (wash), medium (regular), heavy, and putty (extra heavy).<sup>1</sup> These different viscosity forms allow adaptation to the selected impression technique.

In this case, the flabby tissue in both the maxilla and mandible was most likely caused by long-term use of ill-fitting dentures and unstable occlusion over a 10-year period without regular follow-up. Management was performed using a non-surgical approach with modification of the impression technique through the use of a double spacer. The non-surgical approach was chosen by the patient considering cost and treatment duration. Custom trays were fabricated with a double spacer and additional escape holes in the flabby areas of both the maxilla and mandible. The final impression was made using dual-viscosity PVS impression material, with regular-body applied to non-flabby areas and light-body applied to flabby areas. Tooth arrangement was carried out until balanced occlusal contacts were achieved to prevent unstable occlusion

during function. After denture insertion, the patient reported satisfaction and improved comfort compared to the previous dentures. This demonstrates that the double spacer impression technique is effective in managing complete edentulism cases with flabby tissue during the fabrication of complete dentures.

This case report has several limitations. It presents the management of a single patient, limiting the generalizability of the findings to broader populations with flabby ridge conditions. The follow-up period was relatively short, and long-term evaluation is necessary to assess the stability, retention, and tissue response of the dentures over time. In addition, the clinical outcomes were primarily based on subjective patient feedback and conventional examination, without quantitative assessment of pressure distribution or tissue displacement. Further studies with larger sample sizes and longer observation periods are needed to support the effectiveness of the double spacer impression technique.

## Conclusion

The impression technique using a double spacer and additional escape holes in a custom tray has been proven effective in reducing pressure that may cause compression of flabby tissue during the impression procedure. This is an important factor in producing precise and comfortable complete dentures for patients with flabby tissue.

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## CASE REPORT

### Prosthetic rehabilitation of a severely resorbed mandibular ridge using the effective suction method

Novita Gabriela Andreas,<sup>1\*</sup> Taufik Sumarsongko,<sup>2</sup> Rasmi Rikmasari<sup>2</sup>

#### ABSTRACT

**Keywords:** Closed-mouth impression, Complete dentures, Edentulism, Effective suction impression, Mandibular ridge resorption

Mandibular ridge resorption commonly occurs after tooth loss and progressively reduces ridge height and contour, often resulting in a flat ridge. Severe resorption in edentulous patients creates challenges in complete denture fabrication, particularly in achieving adequate retention and stability. The mandibular suction effective denture technique was developed to improve retention by establishing a complete border seal and negative pressure beneath the denture base. This case report aims to describe prosthetic rehabilitation of a patient with a flat mandibular ridge using the effective suction impression technique. A 67-year-old female with complete edentulism and a flat mandibular ridge complained of difficulty in mastication and speech due to a loose, fractured denture. Rehabilitation was performed using the effective suction impression technique with a frame cut-back (FCB) tray and a closed-mouth impression method. Procedures included final impression making, jaw relation recording, artificial teeth arrangement, and insertion of complete dentures for both arches. Post-insertion evaluation showed good retention and stability, with improved comfort and masticatory function. The effective suction technique can provide improved retention, stability, and patient comfort in patients with flat mandibular ridges. Further clinical studies are needed to confirm its long-term success. (IJP 2025;7(1):48-54)

#### Introduction

Edentulousness results from the cumulative effects of oral diseases and is considered a state of poor oral health. Nearly one in ten elderly Indonesians (50 years and older) is edentulous.<sup>1</sup> Missing teeth can result in multifactorial changes in the mouth, including alveolar bone resorption, tongue enlargement, and facial muscle weakness.<sup>2</sup> This can lead to decreased masticatory function, phonetics, and aesthetics, thereby impacting the patient's quality of life.<sup>3</sup>

Residual ridge resorption is a complex and common biophysical process following tooth extraction. Ridge resorption occurs most rapidly in the first year after tooth loss, characterized by a series of changes in shape and height. This process is followed by a slower but more progressive rate of resorption.<sup>4,5</sup> The rate and direction of alveolar bone resorption vary in the upper and lower jaws. The rate of resorption in the mandible is approximately twice that of the maxilla. More rapid and dramatic changes occur in the mandible. In the mandible, resorption occurs more in the labiolingual and vertical directions.<sup>4,6</sup>

Mandibular ridge resorption can cause loss of sulcus depth, decreased vertical dimension, and reduced lower facial height. Dentures become passive due to complex neuromuscular control and create difficulties in impression making, mastication, and swallowing, ultimately leading to loss of retention and stability in complete dentures.<sup>7,8</sup>

Retention and stability are critical factors in the success of

complete dentures. Retention provides psychological comfort, stability provides physiological comfort, and support provides long-term denture wear. These factors must complement each other to achieve a successful denture.<sup>2,9</sup> Retention and stability of mandibular dentures are relatively more difficult to achieve due to the much smaller surface area of the mandible compared to the maxilla and the active muscle movements caused by the presence of the tongue and floor of the mouth. Consequently, achieving a border seal in the lower jaw becomes more difficult.<sup>10,11</sup>

Insertion of complete dentures in patients with flat ridges can cause problems for the patient, such as unstable, non-retentive dentures, pain, and discomfort.<sup>12,13</sup> This is due to muscle insertions near the apex or edge of the ridge, which may lead to muscle-induced displacement of the denture. Another problem is the difficulty in achieving retention and stabilization of the mandibular denture because the base only covers approximately half the mucosal surface compared to the maxillary denture. Therefore, modifications to the impression procedure are necessary to prevent excessive pressure and distortion of the abnormal tissue. One technique that can be applied is the mandibular suction-effective denture, developed by Dr. Jiro Abe in 1999.<sup>6</sup>

The effective suction impression technique can ensure the formation of a border seal according to the patient's anatomical conditions.<sup>14</sup> The concept of this treatment is to create negative

<sup>1</sup>Specialist Program, Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

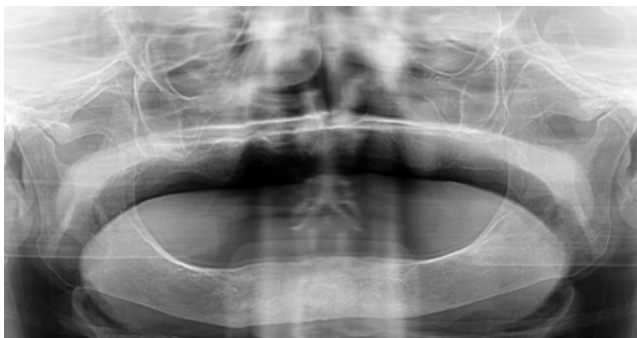
\*Corresponding author: novita15001@mail.unpad.ac.id



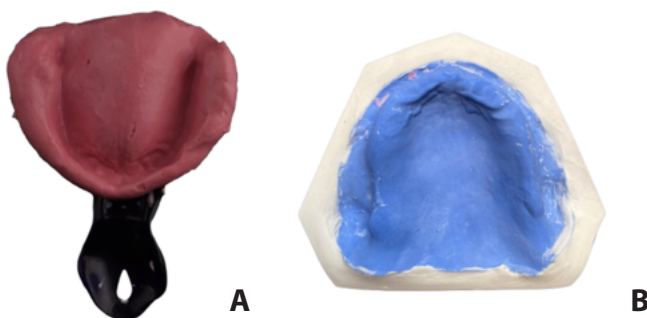
**Figure 1.** Extraoral profile of the patient.



**Figure 2.** Intraoral findings of the patient: A. Maxillary occlusal view, B. Mandibular occlusal view, C. Left lateral view, D. Frontal view, E. Right lateral view.



**Figure 3.** Panoramic radiograph of the patient.



**Figure 4.** Preliminary maxillary impression: A. Result of the preliminary maxillary impression, B. Study model.

pressure between the denture and the alveolar mucosa, resulting in a strong and effective seal around the border of the denture and the mobile mucosa. Suction-effective dentures are a type of retentive and stable denture because they are able to withstand occlusal forces and

are held in place by the buccal mucosa and lips.<sup>15</sup> This method has high predictability, thereby improving the patient's quality of life because it can restore function and aesthetics.<sup>16</sup> This case report describes the effective suction technique in a case of severely resorbed mandibular ridge of a 67-year-old female patient.

## Case Report

A 67-year-old female patient presented to the Prosthodontics Clinic of Oral and Dental Hospital (RSGM) Universitas Padjadjaran with a chief complaint of difficulty chewing and speaking due to the loss of all teeth in the upper and lower arches. The patient had been wearing complete dentures for 11 years; however, the dentures had fractured, become loose, and caused pain, especially during chewing. The patient desired new, more comfortable dentures. Extraoral examination revealed an elongated face, a concave profile, hypotonic lips, and no glandular enlargement *figure 1*.

Intraoral examination revealed that the patient had lost all teeth in the mandible and maxilla. The alveolar ridge in the mandible appeared flat *figure 2*. The examination also revealed low anterior and posterior vestibules, accompanied by a low frenulum. The patient's retromylohyoid space was moderately deep. The patient was then referred for a radiographic examination *figure 3*. The diagnosis in this case was complete tooth loss accompanied by a flat mandibular ridge. The treatment plan was complete dentures, with a good prognosis for success.

After the patient agreed to the treatment plan and signed the informed consent, an initial impression of the maxilla was taken using irreversible hydrocolloid (alginate) to obtain a study model. The resulting maxillary impression was then cast in stone plaster *figure 4*.

Initial impressions of the mandible were taken using the effective suction method with a cut-back impression tray and impression materials of two consistencies. The materials used included a liquid-consistency irreversible hydrocolloid placed in a syringe and a thick-consistency irreversible hydrocolloid placed in a tray. The procedure began with the application of the syringe material to the lingual area, retromolar pad, mucobuccal fold, and ridge crest, followed by the insertion of the tray filled with the thick material. The impression was taken using a closed-mouth technique, in which the patient was instructed to close her mouth throughout the procedure until the material hardened. The mandibular impression was then cast in stone plaster *figure 5*.

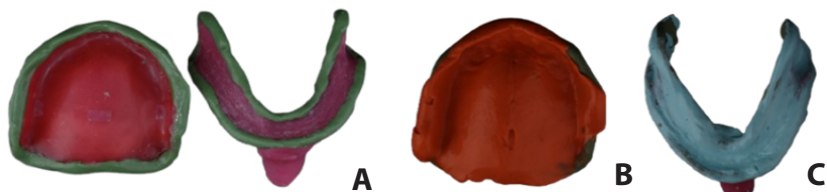
On the study model, a custom impression tray with a spacer was fabricated using light-cured resin. The custom impression tray was extended to cover the labial, buccal, and sublingual areas. The excess edges of the custom impression tray were carefully reduced. The custom impression trays for the upper and lower jaws



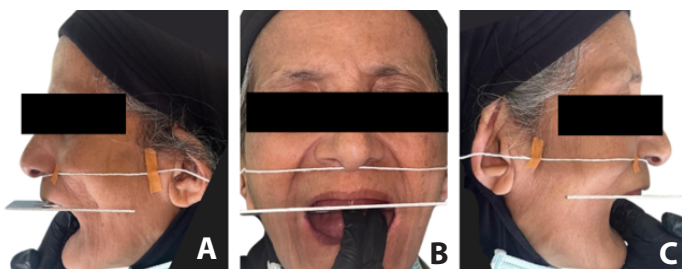
**Figure 5. Preliminary mandibular impression: A. Frame cut-back impression tray, B. Result of the impression, C. Study model.**



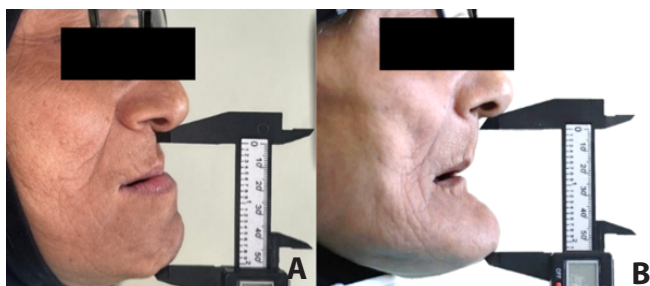
**Figure 6. Mandibular custom impression tray.**



**Figure 7. Final impression results: A. Muscle trimming/border molding, B. Final impression of the maxilla using PVS, C. Final impression of the mandible using ZnOE.**



**Figure 8. Assessment of maxillary bite rim parallelism: A. Left lateral view, B. Frontal view, C. Right lateral view.**



**Figure 9. Establishment of vertical dimension: A. Centric relation, B. Rest position.**

were positioned 2 mm above the mucobuccal fold to allow for muscle activation during border molding. The lips, cheeks, and tongue were evaluated during the trial insertion of the custom impression tray into the patient's mouth [figure 6](#).

A thin layer of tray adhesive was applied to the inner surface and edges of the upper and lower impression trays. Muscle trimming was performed on the patient's upper and lower jaws using greenstick compound along the edges of the impression trays [figure 7A](#). Excess compound from muscle trimming was then reduced. The wax spacer on the impression tray was carefully removed without damaging the greenstick compound. An escape hole was then created in the impression tray. Final impressions were made using polyvinyl siloxane (PVS) light body for the upper jaw and ZnOE paste for the lower jaw [figure 7B](#) and [figure 7C](#). Beading and boxing were performed on the impressions, which were then cast in stone plaster to obtain the working models.

The denture base and bite rim were fabricated on the working model. The upper and lower bite rims were tried in the patient's mouth. First, the alignment of the upper bite rim was assessed using a fox plane [figure 8](#). The lower bite rim was then tried in, followed by the determination of the patient's vertical dimension and centric relation. The patient's vertical dimension at rest was measured at 55 mm, and the vertical dimension of occlusion was determined to be 52 mm [figure 9](#). At this stage, the orientation lines, namely the high lip line, low lip line, midline, and canine line, were also marked on the bite rim. The bite rim was then fixed using bite registration paste and removed from the patient's mouth [figure 10](#). A facebow transfer was performed to transfer the jaw relationship to the cranial base from the patient to the articulator. The working model with the bite rim was mounted on a semi-adjustable articulator. During this visit, the color and shape of the teeth were selected to suit the patient's skin tone, facial shape, age, and gender, followed by the arrangement of the upper and lower artificial teeth [figure 11](#).

During this visit, the patient underwent a wax denture try-in. The patient was evaluated for aesthetics, midline, low lip line, smile line, and centric and eccentric occlusion. Once the dentures were deemed satisfactory, laboratory procedures for the complete dentures were performed, including packing, finishing, polishing [figure 12](#).

The laboratory-processed complete dentures were evaluated for sharp, unpolished, or rough areas [figure 13](#). The complete dentures were then inserted into the patient. During insertion, retention, stability, adaptation, base extension, centric and eccentric occlusion, and aesthetics were evaluated [figure 14](#). The patient was also re-instructed on how to remove and clean the dentures.

The patient returned for a checkup one week



**Figure 10. Bite rim evaluation: A. Assessment of labial support, B. Orientation lines, C. Stabilized bite rim.**



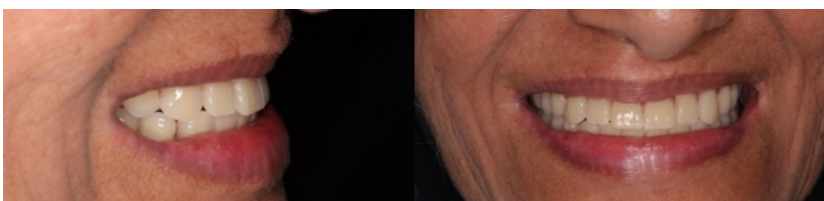
**Figure 11. Arrangement of artificial teeth for the maxilla and mandible.**



**Figure 12. Wax denture try-in evaluation: A. Low lip line, B. Occlusion, C. Smile line.**



**Figure 13. Complete dentures of the maxilla and mandible.**



**Figure 14. Insertion of the complete dentures of the maxilla and mandible.**



**Figure 15. Clinical appearance at the one-week follow-up.**

after insertion to evaluate her oral condition and monitor her adaptation to the new dentures [figure 15](#). During this visit, a subjective assessment of the patient's complaints and an objective assessment of her oral soft tissues were performed. The patient stated that the new dentures were more comfortable and did not cause pain or pressure on her gums.

## Discussion

Alveolar ridge resorption is the process of reduction in the quantity and quality of residual ridges after tooth extraction. Changes in the anatomical structure of the alveolar process inevitably occur after tooth extraction.<sup>17</sup> Alveolar ridge resorption is most evident in the first year after tooth loss, followed by a slower but continuous resorption process. Severely resorbed ridges are more common in the mandible than in the maxilla. This is because resorption in the mandible occurs at a higher rate than in the maxilla.<sup>18</sup>

Many factors contribute to alveolar bone resorption. Parafunctional habits, as well as misuse of dentures such as intensive denture wear, unstable occlusion, and inappropriate denture design, can accelerate bone resorption.<sup>19</sup> Metabolic and systemic factors also significantly influence the rate of bone resorption, including age, race, the presence of systemic diseases such as osteoporosis, nutritional status, especially calcium and vitamin D intake, and the length of time the patient has been edentulous. Chronic and progressive bacterial infections of the gingival tissue can cause alveolar bone destruction and loss of tooth attachment. The rate of bone resorption is much higher in postmenopausal women due to inadequate new bone formation resulting from estrogen deficiency.<sup>17,20,21</sup>

While teeth are still in the mouth, pressure from masticatory muscle contractions is transmitted as tensile forces to the bone through the periodontal membrane. This pressure is absorbed by the alveolar bone and can even stimulate bone remodeling. However, after tooth extraction, the force distribution pattern changes completely. The load is no longer distributed throughout the bone but is concentrated only on the bone surface. The alveolar bone can withstand this compressive force only to a certain extent. Over the long term, denture use can cause changes in the form of flattening of the residual ridge.<sup>17</sup>

After tooth extraction, sharp bone edges are flattened by osteoclastic resorption, resulting in a high, rounded residual ridge. Resorption continues labially and lingually, narrowing the ridge apex until it becomes knife-edge, then shortening, and finally transforming into a low, flat ridge.<sup>22</sup> The initial resorption phase lasts approximately 8–10 days, consistent with the life cycle of osteoclasts. The rate of resorption is most rapid in the first three months, and then gradually slows. The rate of resorption varies between individuals, varies at specific locations within the same individual, and affects denture

function, which depends on the quality of the jawbone.<sup>21,23</sup>

The main difficulty in achieving retention, stabilization, and support is often found in complete dentures with flat ridges.<sup>24</sup> Retention and stability of dentures can be achieved effectively if the denture has an adequate border seal.<sup>25</sup> According to The Glossary of Prosthodontic Terms, 9th Edition, a border seal is the contact between the denture and the underlying tissue that prevents air or other materials from entering beneath the denture. Therefore, the impression technique is a key factor in the success of a flat ridge denture, utilizing as much surrounding tissue as possible to achieve an adequate border seal.<sup>24,26</sup>

The purpose of denture impressions is to capture the supporting tissue structure and establish a peripheral border, resulting in a tight border seal.<sup>24</sup> The impression is expected to accommodate normal muscle function and ensure peripheral adaptation, preventing air penetration between the denture base and the mucous membrane. This can provide maximum retention and stability for the denture.<sup>27</sup>

In this case of a flat mandibular ridge, the initial impression was taken using the effective suction impression technique. This aligns with a study by Joewana and Kusdhany,<sup>28</sup> which stated that effective suction impressions were developed specifically for cases of severely resorbed mandibles that struggle to achieve stabilization and retention. Dogra et al.<sup>15</sup> stated that conventional dentures have limitations in treating edentulous patients with severe ridge resorption. To address this, it is recommended to use the effective suction method for mandibular complete dentures.

The effective suction impression technique is performed using a frame cut-back tray (FCB) and alginate impression material. A frame cut-back tray is a specially designed prefabricated impression tray used for flat ridge cases. The design difference lies in the retromolar pad and buccal shelf areas of the tray being cut, allowing the operator to record the retromolar pad in a resting, undeformed position and to record the retromylohyoid depth due to the extension of its wings.<sup>15,28</sup> In addition, the frame cut-back impression tray used in the effective suction technique is reduced by approximately two-thirds in the vestibular shelf area to avoid excessive buccal extension. This is because the mucosa may be overstretched buccally and tends to lose its ability to seal against the mandibular denture base in the area around the retromolar pad.<sup>15</sup>

The most challenging part is achieving a seal in the posterior part of the mouth by ensuring tight contact between the denture and the tissue in the retromolar pad area. The retromolar pad area is easily deformed. To overcome this, the use of an FCB tray is recommended for the initial impression. Alginate is chosen because it can produce good impressions with adequate anatomical detail and is inexpensive. Howev-

er, alginate can exert excessive pressure on the patient's vestibule.<sup>29,30</sup>

Making a personalized impression tray using the effective suction method requires consideration of eight key points: identify and mark the retromolar pad; avoid the sinew string; draw a line at the most inferior point of the buccal shelf; draw a line from the retromylohyoid fossa extending 2–3 mm beyond the mylohyoid muscle line; avoid the buccal frenulum; avoid the mentalis muscle attachment; avoid the midpoint of the inferior labial frenulum; draw a line along the convexity and avoid the lingual frenulum.<sup>28</sup>

Sinew strings appear when pressure is applied and are formed in the buccal retromolar pad area toward the second molar. They are present in 10–20% of edentulous patients. Their function is to pull the buccal mucosa inward during swallowing and to close the space posterior to the second molar. This area is usually the site of the BTC.<sup>14</sup>

A thin layer of tray adhesive was applied to the inner surface and edge of the personalized impression tray in this case. Elastomeric impression materials require a tray adhesive to provide an effective bond between the tray and the impression material.<sup>4,31</sup> The final impression material used for the maxillary impression in this case was a light-body PVS impression material. This aligns with Mehra's research,<sup>32</sup> which stated that light-body PVS impression material is very suitable for complete denture impressions. The low pressure applied by this material provides an accurate impression of the mucosa. The complete denture will have adequate retention, stabilization, and support. The advantages of this material include better results, shorter working time, easy application, and increased patient comfort.<sup>33,34</sup>

The impression material used to create the mandibular impression in this case was zinc oxide eugenol paste. A survey by Vohra et al.<sup>35</sup> indicated that ZnOE impression material is one of the most frequently used final impression materials in complete denture cases. ZnOE is mucostatic and easily adapts to soft tissue due to its water-based system. Therefore, this material is capable of producing detailed impressions of soft tissue anatomical surfaces without causing tissue displacement. This impression material is easy to apply, affordable, and has good flow consistency.<sup>8</sup>

Closed-mouth impressions were performed in this case. A closed-mouth impression is a method in which the patient's mouth is closed and relies on functional movement. This method allows the impression to be taken during functional patient movement, creating negative pressure that encloses the denture perimeter. Saliva is released under the denture base during biting, creating negative pressure by covering the perimeter of the denture.<sup>36</sup> Patients are instructed to move their tongue left and right, swallow, and perform movements while the mouth is closed.<sup>28</sup>

Conventional dentures aim to expand the denture-bearing surface area by emphasizing muscle attachment. Effective suction dentures, on the other hand, focus on complete border coverage.<sup>37</sup> For successful denture placement, the BTC point must be formed. Ichikawa<sup>38</sup> explained that two-thirds of the retromolar pad area must be covered to ensure strong and stable denture retention. Another crucial area is the spongy tissue found in the sublingual fold. This area is crucial because the mucosa there stretches during secondary impressions, resulting in a thick groove at the periphery of the denture. This contact remains virtually unchanged during tongue function and contributes to stable border closure.<sup>15</sup>

Conventional complete dentures primarily rely on expanding the denture-bearing area and emphasizing muscle attachment to achieve retention and stabilization.<sup>37</sup> However, in cases of severely resorbed mandibular ridges, the limited supporting surface area and unfavorable muscle dynamics often lead to retention failure.<sup>15</sup> In contrast, effective suction techniques focus on achieving complete border closure and establishing a BTC point to create negative pressure within the denture. Functionally, this improves denture retention in cases of severe ridge resorption.<sup>37</sup> Furthermore, Ichikawa<sup>38</sup> explained the importance of covering two-thirds of the retromolar pad area with the effective suction technique to ensure strong and stable denture retention. Retention with the effective suction technique also utilizes the sublingual fold, as the mucosa in this area stretches during secondary impressions, creating a thick groove at the periphery of the denture. This contact remains virtually unchanged during tongue function and contributes to stable border closure.<sup>15</sup>

After applying the effective suction impression technique in this case, the patient was satisfied and comfortable with the newly inserted denture. The patient reported that the denture did not loosen when chewing or speaking. The maxillary complete denture also did not cause excessive pressure or pain when worn. Compared to her previous denture, the patient found the new denture much more comfortable and reported increased self-confidence. This demonstrates that the effective suction impression technique is an effective technique for fabricating complete dentures in flat ridge cases.

This case report has several limitations that should be considered. First, this report involved only one patient, so the findings may not be representative of the entire population of edentulous patients. Second, the follow-up period was relatively short, so the long-term stability of denture retention and function could not be fully evaluated. Furthermore, the evaluation of treatment outcomes was largely based on the patient's subjective perception of comfort and masticatory function, without objective measurements such as retentive force or

masticatory efficiency. In addition, this technique is highly dependent on operator skill, so clinical outcomes may vary between clinicians. Therefore, further research with a larger sample size and a longer-term study design is needed to evaluate the effectiveness and predictability of this technique in cases of severe mandibular ridge resorption.

## Conclusion

Mandibular complete denture fabrication using the mandibular suction-effective denture technique in edentulous patients with a flat mandibular ridge yields good results in terms of retention, stability, and patient comfort. The effective suction impression technique produces optimal base adaptation and an adequate border seal, thereby improving masticatory function and comfort. This technique can be considered as an alternative in cases of severely resorbed mandibular ridges. However, further clinical research is needed to confirm the long-term efficacy of this suction-effective denture technique.

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## CASE REPORT

### Maxillofacial esthetic rehabilitation using bilateral custom ocular prosthesis in a case of anophthalmia and phthisis bulbi

Tu Bagus Satria Pajajaran,<sup>1\*</sup> An-Nissa Kusumadewi<sup>2</sup>

#### ABSTRACT

**Keywords:** Anophthalmia and phthisis bulbi, Bilateral ocular prosthesis Custom ocular prosthesis

Bilateral loss of the eyeballs is a condition that not only causes visual impairment but also significantly impacts the patient's aesthetic appearance and psychosocial well-being. Rehabilitation through the fabrication of custom ocular prostheses can help restore facial appearance and patient self-confidence. This case report aims to describe the fabrication process and clinical outcomes of bilateral custom-made acrylic ocular prostheses in a patient with right-sided anophthalmia and left-sided phthisis bulbi. A 54-year-old male patient presented to the Prosthodontics Department at RSGM UNPAD, Bandung, with complaints of loose and uncomfortable right and left ocular prostheses. The patient had undergone enucleation of the left eye and had been wearing prostheses for the past five years. A new pair of custom ocular prostheses was planned. The treatment procedure included socket impression using polyvinyl siloxane (PVS), fabrication of a positive model, wax pattern try-in followed by acrylic sclera construction, manual iris painting, and application of clear acrylic as the final layer. The prostheses were inserted following a comprehensive evaluation of adaptation, retention, symmetry, and the psychological response of the patient and family. Custom ocular prostheses provide an effective rehabilitative solution for bilateral ocular loss. With an individually tailored design, they restore facial symmetry, enhance self-esteem, and reduce psychological distress. (IJP 2025;7(1):55-59)

#### Introduction

The human eye is a vital sensory organ that plays a crucial role in daily functioning and quality of life. However, the eye is also highly susceptible to various pathologies that can lead to functional impairment, permanent blindness, or the loss of the eyeball itself. Eyeball loss can result from several factors, including congenital defects or surgical removal necessitated by tumors, trauma, or other severe ocular diseases. Such a loss is a traumatic event, encompassing both medical challenges—specifically visual impairment—and psychological distress, such as the development of an inferiority complex due to altered social perception and appearance.<sup>1,2</sup>

Rehabilitative care through the fabrication of an ocular prosthesis is essential to restore the patient's aesthetic appearance and self-confidence. The primary advantage of an ocular prosthesis is its ability to return the patient's eye to a natural appearance, thereby mitigating the psychological trauma associated with eyeball loss and facilitating social reintegration. Furthermore, failure to promptly replace a lost eyeball with a prosthesis can lead to long-term complications, including the atrophy of surrounding tissues and eyelids. Functionally, an ocular prosthesis also serves to close the space between the upper and lower eyelids, preventing foreign bodies from entering the empty orbital cavity.<sup>3,4</sup>

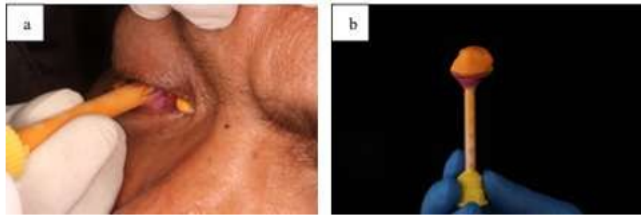
Surgical interventions for eyeball removal include enucleation, evisceration, and exenteration.<sup>5</sup> Enucleation involves the removal of the

eyeball from the orbital cavity while preserving the attached extraocular muscles and the eyelids. Evisceration involves the removal of the internal contents of the globe, leaving the sclera (and occasionally the cornea) intact. Exenteration is the most extensive procedure, involving the removal of the entire eyeball along with all surrounding soft tissues within the orbit.<sup>4,6</sup> The success of an ideal ocular prosthesis, particularly following enucleation, depends on precise surgical execution, the formation of a near-normal conjunctival or mucosal environment, adequate prosthetic mobility, and the presence of functional, aesthetically normal eyelids.<sup>7,8</sup>

Ocular prostheses are categorized into two types: prefabricated (stock) and custom-made. The primary advantage of prefabricated ocular prostheses is the reduced clinical time, as they do not require laboratory processing stages. However, their disadvantages include a frequent lack of conformity to the patient's orbital socket and suboptimal aesthetic outcomes. In contrast, custom-made ocular prostheses offer superior comfort because they are fabricated to follow the precise contours of the orbital socket. Furthermore, custom-made prostheses provide better results as the scleral characterization and iris painting are tailored to match the contralateral eye using the aid of patient photography. Consequently, custom-made ocular prostheses are more acceptable to patients due to their precise

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

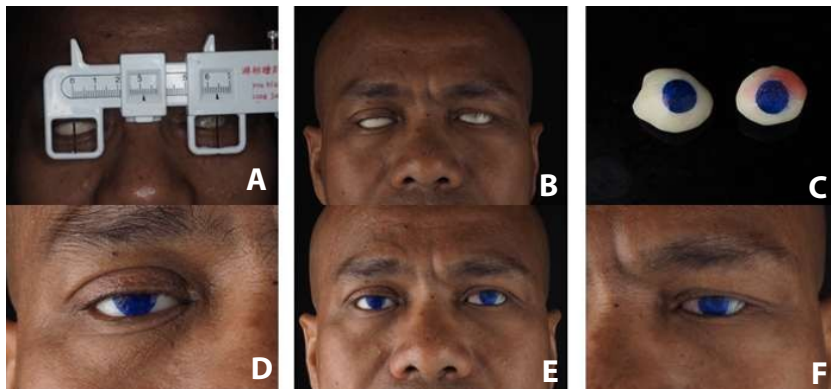
\*Corresponding author: bagus23003@mail.unpad.ac.id



**Figure 1. A and B. Impression using polyvinyl siloxane to capture the anatomy of eyeball socket.**



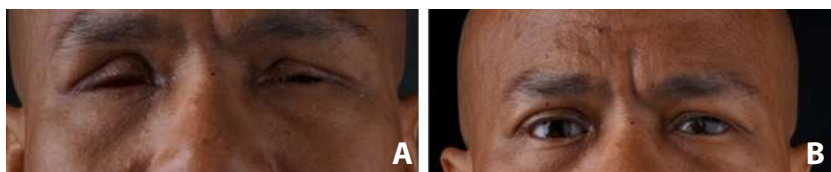
**Figure 2. Laboratory procedure: A. Investing, B. Application of separating agent, and C. Deflasking the acrylic sclera.**



**Figure 3. A. Measurement of pupil position using pupillary distance ruler, B. Try in the sclera, C. Mock-up of pupil and iris, D. Until, F. Try-in position of pupil and iris on both eyeball socket.**



**Figure 4. A and B. Iris area was reduced, C. Final ocular prosthesis after finishing.**



**Figure 5. A. Clinical condition before insertion and B. Insertion of ocular prosthesis**

fit and enhanced aesthetic appearance.<sup>4,9,10</sup>

Phthisis bulbi represents an advanced stage of ocular pathology characterized by progressive globe shrinkage due to the cessation of aqueous humor production; the term 'phthisis' itself denotes 'wasting' in clinical terminology. This condition is marked by atrophy, shrinkage, and internal structural irregularities, leading to both visual loss and aesthetic distortion. Common etiologies include chronic uveitis (post-traumatic or otherwise), surgical complications, or end-stage glaucoma following intensive treatment.<sup>11,12</sup>

In cases of eyeball loss, immediate rehabilitation using an ocular prosthesis is needed. This prosthesis is parts of an imperative maxillofacial prosthesis designed for orbital rehabilitation.<sup>13</sup> The primary objectives are to maintain a healthy socket, preserve eyelid blink function and lash position, prevent eyelid malposition, and ensure normal lid closure, all of which are critical for an ideal prosthetic outcome.<sup>14,15</sup> This case report discusses the fabrication of a custom acrylic ocular prosthesis for a patient with right-eye anophthalmos and left-eye phthisis bulbi, further complicated by a hypotonic and ptotic left eyelid.

### Case Report

A 54-year-old male patient presented to the Prosthodontics Department at Oral and Dental Hospital (RSGM) UNPAD, Bandung, with complaints of loose and uncomfortable right and left ocular prostheses. The patient had undergone enucleation of the left eye and had been wearing prostheses for the past five years. The patient's medical history revealed that he had undergone enucleation of the left eye and had been wearing ocular prostheses for the past five years. He requested the fabrication of new ocular prostheses to improve both comfort and fit. Patient prosthesis display iris and pupil asymmetry as well as inadequate retention. Extraoral clinical assessment revealed orbital sockets both left and right were wide and exhibited adequate depth. There is no sign of inflammation in bilateral conjunctiva and extraocular muscle movements were within normal limits for both side. Left palpebra shown significant drooping (ptosis) compared to the right side. Based on the clinical history and physical examination, the definitive diagnosis for this patient was right-sided anophthalmos post-enucleation and left-sided phthisis bulbi. The treatment plan involved the fabrication of bilateral custom ocular prostheses.

The initial clinical appointment focused on the fabrication of the custom ocular prosthesis. Prior to the commencement of the procedure, written informed consent was obtained from the patient as part of the ethical protocol. The procedure began with the irrigation and cleaning of the orbital cavity using sterile saline solution (0.9% NaCl) to remove any debris or tissue remnants. Subsequently, the fit of a custom-made impression tray, fabricated from self-cured acrylic resin, was evaluated. This tray was equipped with a Polyvinyl

Siloxane (PVS) mixing tip to serve as an injection port for the impression material. The impression was recorded with the patient in a relaxed, upright sitting position using a PVS-based elastomeric material. The material was slowly injected through the port until it completely filled the anatomical structures of the socket, including the orbital and palpebral areas. This step aimed to obtain a precise negative impression of the socket, serving as the foundation for an accurate, individualized prosthesis [figure 1A](#). During the impression process, the patient was instructed to maintain an open-eye gaze and perform functional ocular movements—such as opening, closing, and looking in various directions—to capture the dynamic anatomy of the orbital cavity. Once the PVS material had fully set, the impression was carefully retrieved from the socket [figure 1B](#). The cavity was then clinically inspected to ensure that no material residue remained. The retrieved impression was disinfected with an alcohol spray before proceeding to the laboratory phase. The impression was then cast using Type III dental stone to produce a definitive positive model of the orbital cavity.

After the stone had set, a wax pattern was fabricated to form the initial prosthetic sclera. This wax pattern will be utilized in subsequent stages for contour refinement, iris positioning, and final characterization [figure 2A](#).

During the second visit, a clinical try-in of the scleral wax pattern was performed. The wax pattern was inserted into the orbital socket for a comprehensive evaluation of its adaptation, retention, and the conformity of the scleral contour to the orbital anatomy. The assessment also included the convexity of the scleral surface and the functional mobility of the eyelids during opening and closing movements. Refinements were made while observing the patient from multiple perspectives to ensure maximum aesthetic resemblance to the natural eye. During the second visit, a clinical try-in of the scleral wax pattern was performed. The wax pattern was inserted into the orbital socket for a comprehensive evaluation of its adaptation, retention, and the conformity of the scleral contour to the orbital anatomy. The assessment also included the convexity of the scleral surface and the functional mobility of the eyelids during opening and closing movements. Refinements were made while observing the patient from multiple perspectives to ensure maximum aesthetic resemblance to the natural eye. The resulting mold was coated with Cold Mold Seal (CMS) as a separating medium and allowed to dry completely. Subsequently, an acrylic resin—specifically selected to match the patient's predetermined scleral shade—was packed into the mold [figure 2B](#). The flask was then submerged in a water bath and processed (cured) at 80°C for approximately one hour. Following the cooling period, the acrylic sclera was recovered from the flask (deflasked). Any excess material (flash) was trimmed, and all sharp

edges were meticulously smoothed and polished [figure 2C](#).

During the third visit, the processed acrylic sclera was evaluated using the same criteria as the wax pattern try-in. The pupil position was determined using a Pupillary Distance (PD) ruler and marked on the scleral surface [figure 3](#).

The iris diameter was then outlined, and the facial surface of the sclera was reduced by 1.5–2 mm using a fraser bur to accommodate the clear acrylic overlay. A 2 mm-deep iris seat with convergent walls was created using a fissure bur to ensure optimal retention [figure 4A](#). To achieve a natural appearance, the limbal area was painted circumferentially with black pigment. The iris was manually characterized using acrylic paints to match the contralateral eye and allowed to dry thoroughly [figure 4B](#). Vascularization was simulated by selectively applying red nylon fibers fixed with epoxy resin [figure 4C](#). The characterized sclera was then re-invested in the flask, and clear acrylic resin was applied over the painted surface. After pressure-packing and flash removal, the prosthesis was cured in a water bath at 80°C for 90 minutes. Following a cooling period, the final prosthesis was deflasked, trimmed to remove sharp edges, and polished to a high-gloss aesthetic finish [figure 4C](#).

The final ocular prosthesis was delivered during the fourth visit. The patient was seated in an upright, relaxed position for the insertion. The clinician then evaluated the prosthesis for fit, aesthetics, and comfort, following the same criteria established during the acrylic sclera try-in phase. Patient and family education was provided regarding the proper maintenance, removal, and insertion of the prosthesis. The specific instructions were as follows: (1) Instruction for removal the lower eyelid should be retracted downward while the patient looks upward, allowing the inferior margin of the prosthesis to be gently pulled out with a finger, and (2) Insertion of the prosthesis should be pre-moistened before placement to facilitate easier entry into the orbital socket. Follow-up appointments were scheduled at 24 hours and one week post-delivery. During these reviews, the patient reported being highly satisfied and comfortable, noting a significant restoration of self-confidence and social acceptance [figure 5](#).

## Discussion

The fabrication of individualized ocular prostheses, also known as the custom ocular prosthesis technique, is a rehabilitative approach aimed at restoring both functional and aesthetic aspects in patients who have lost an eyeball.<sup>16</sup> In cases of bilateral ocular loss, rehabilitation becomes significantly more complex as it involves both orbital cavities. This condition profoundly impacts the patient's facial expressions and psychosocial wellbeing; therefore, an individualized approach to the design and fabrication of the prosthesis is essential to

ensure long-term clinical success and patient satisfaction.<sup>3,17-19</sup>

The custom-made technique offers several advantages over stock (prefabricated) ocular prostheses, particularly regarding anatomical adaptation and color matching. While stock ocular prostheses offer immediate availability, custom-fabricated alternatives are clinically superior as their precise adaptation to the ocular tissue bed eliminates the dead space associated with prosthetic-related infections and allows for the accurate anatomical restoration of iris positioning and periorbital aesthetics, including the correction of ptosis and palpebral fissure narrowing.<sup>20</sup> These prostheses are specifically tailored to the patient's unique orbital morphology, taking into account the shape, volume, and condition of the residual soft tissues. Besides, custom prostheses are designed to provide the illusion of a perfectly healthy eye and surrounding tissue and allow for precise iris button centralization, ensuring a symmetrical.<sup>21</sup> This precision is vital for bilateral cases, where achieving a balance between both sides of the face is the primary determinant of facial harmony and aesthetic symmetry.<sup>22,23</sup>

In the present case, given the diagnosis of a right anophthalmic socket (postenucleation) and left-phthisis bulbi, custom-made ocular prostheses were indicated. This modality provides superior contouring and more accurate color matching compared to mass-produced alternatives. Another advantage is optimal aesthetic outcomes were achieved by characterizing the iris color and positioning it to replicate a natural appearance. This case report uses pupillary distance ruler to navigate the position of pupil position. Studies from Bhoohibhoya et al.<sup>24</sup> also utilized a pupillary distance ruler for iris positioning ensures an objective and accurate registration of prosthetic alignment, significantly reducing the margin of error associated with subjective conventional visual assessment.<sup>24</sup>

Furthermore, the psychosocial aspect is a primary concern in bilateral loss. Beyond the physical deficit, the loss of bilateral ocular structures impacts the patient's self-identity and social integration. Moreover, radical procedures from the surgical procedures can impact patient mental state. The prosthesis is a critical tool for the emotional rehabilitation of the patient, specifically designed to boost their psychological and mental state following those procedures by providing an aesthetic replacement, the prosthesis helps the patient cope with the trauma of losing a sense organ.<sup>25</sup> Consequently, a successful prosthesis must provide more than just aesthetic restoration; it must also restore the patient's self-esteem and emotional well-being, as measured by their ability to reintegrate into their community without fear of being viewed as different.<sup>26</sup> In this context, pre- and post-operative counseling are considered integral components of the holistic

treatment plan.<sup>15,27</sup>

The prognosis for bilateral ocular prostheses depends on several factors, including the volume and condition of the residual soft tissue, the depth of the fornices, patient compliance with maintenance, and the frequency of follow-up care. Comprehensive education regarding the insertion, removal, and hygiene of the prosthesis is mandatory. Also, Rokohl et al.<sup>29</sup> stated that less frequent cleaning of ocular prostheses is generally better and recommend a monthly cleaning schedule rather than daily or weekly maintenance, advising patients to leave the prosthesis in place for as long as possible and to consult with the doctor.<sup>28</sup> Periodic evaluations are necessary to monitor tissue adaptation and to perform adjustments if required, especially as orbital dimensions may change over time due to tissue resorption or alterations in eyelid morphology.<sup>29</sup>

Given these complexities, rehabilitating bilateral ocular loss with custom techniques requires a multidisciplinary approach. Collaboration between maxillofacial prosthodontists, ophthalmologists, and clinical psychologists is highly recommended to guarantee optimal functional, aesthetic, and psychosocial outcomes. It should be noted that in this specific case, the shrunken state of the left globe (phthisis bulbi) prevented the prosthesis from filling the socket as optimally as the right side. This resulted in minor asymmetry and limited muscle motility in the left socket. To address ongoing changes, it is generally recommended that ocular prostheses be replaced every 2 to 5 years. This ensures the appliance continues to adapt to anatomical changes in the socket, maintains color stability, and ensures healthy contact with the surrounding tissues.<sup>30</sup>

## Conclusion

Custom ocular prostheses represent a superior rehabilitative option for patients with bilateral ocular loss, as they can be precisely adapted to the individual morphology of each socket. Bilateral loss of the eyes not only results in visual deficits but also has a significant impact on the patient's psychosocial well-being. Through a precision design approach, custom ocular prostheses enable aesthetic restoration that closely mimics natural eyes, including iris and eyelid symmetry. This ultimately enhances the patient's comfort, self-confidence, and social acceptance in their daily life.

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## CASE REPORT

### Digital copy reference denture: enhancing accuracy and comfort in edentulous geriatric patients: Case report

Aditia Kencana Tanuwijaya,\* Gian Nur Alamsyah

#### ABSTRACT

**Keywords:** Copy reference denture, Digital dentures, Geriatric patient

Prosthetic rehabilitation in geriatric patients is often complicated by systemic frailty, reduced neuromuscular adaptability, and limited tolerance for prolonged dental procedures. Conventional denture fabrication frequently requires multiple clinical visits and extended chairside time, which may increase treatment burden and compromise patient comfort. Advances in digital dentistry have enabled streamlined workflows that improve efficiency and predictability. The digital copy reference denture technique allows replication of an existing prosthesis while enabling controlled modification of functional and esthetic parameters, thereby facilitating patient adaptation and reducing clinical complexity. A 93-year-old woman presented with poor denture retention and instability, leading to impaired mastication. Clinical examination revealed a maxillary complete denture with a suction cup causing palatal mucosal trauma and a mandibular partial denture retained by wire clasps on extruded teeth 33 and 43. Treatment involved fabrication of a new maxillary complete denture using a digital copy denture workflow while reestablishing vertical dimension and centric relation with a leaf gauge. A mandibular overdenture with magnetic attachments was planned. The digital workflow comprising intraoral scanning, digital design, and 3D printing enabled delivery of the definitive prostheses at the second visit while preserving familiar denture contours to facilitate adaptation. A fully digital copy reference denture workflow represents a predictable and patient-centered treatment strategy for prosthetic rehabilitation in elderly patients. By reducing clinical visits and improving prosthesis retention, stability, and comfort, this approach offers an effective alternative for managing complex geriatric cases. (IJP 2025;7(1):60-64)

#### Introduction

Global population aging represents one of the most significant demographic transitions in modern healthcare. The proportion of individuals aged 65 years and older continues to increase worldwide, leading to a higher prevalence of age-related oral health problems, including edentulism. Severe tooth loss remains a major public health concern because it negatively affects mastication, phonetics, facial esthetics, and overall quality of life.<sup>1</sup> In elderly individuals, the absence of teeth may also contribute to nutritional deficiencies and social limitations.<sup>2</sup>

Prosthetic rehabilitation in geriatric patients presents unique clinical challenges. Age-related physiological changes such as reduced neuromuscular adaptability, decreased salivary flow, thinning oral mucosa, and systemic comorbidities can complicate denture treatment.<sup>3</sup> In addition, elderly patients often exhibit limited tolerance to lengthy clinical procedures and repeated dental appointments. Conventional complete denture fabrication typically requires multiple clinical and laboratory steps, which may increase physical and psychological stress for medically compromised patients.<sup>4</sup>

Recent advances in digital dentistry have introduced alternative workflows that may improve efficiency and accuracy in denture fabrication. Computer-aided design and computer-aided manufacturing (CAD/CAM) technologies allow clinicians to digitally design and manufacture prostheses

with improved reproducibility and reduced material distortion.<sup>5</sup> Additive manufacturing techniques such as 3D printing further enhance precision and reduce production time.<sup>6</sup>

The copy denture concept has gained renewed interest with the development of digital workflows. Unlike conventional denture replacement, which often involves significant changes in prosthesis morphology, the copy denture technique replicates the external contours and occlusal relationships of an existing prosthesis while allowing modifications to improve fit, retention, and tissue compatibility.<sup>7</sup> This approach is particularly advantageous for elderly patients because it preserves neuromuscular familiarity and facilitates adaptation.<sup>8</sup>

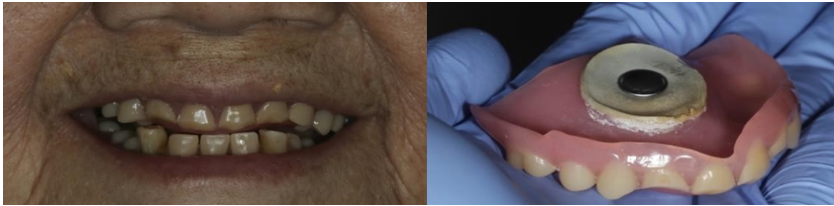
The purpose of this case report is to describe the clinical application of a fully digital copy reference denture workflow combined with mandibular magnetic overdenture support in the prosthetic rehabilitation of a 93-year-old patient.

#### Case Report

A 93-year-old female patient presented with complaints of poor retention and instability of her maxillary denture accompanied by discomfort in the palatal region. The patient reported progressive difficulty in mastication, particularly when consuming solid foods.

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

\*Corresponding author: aditia23003@mail.unpad.ac.id



**Figure 1.** Preoperative intraoral view showing the maxillary complete denture with suction cup and the mandibular removable partial denture.

Although the patient had received a new set of dentures approximately six months prior to the consultation, she continued to experience discomfort and instability, which significantly affected her daily oral function and confidence during eating.

Extraoral examination revealed no significant abnormalities or temporomandibular joint dysfunction. Intraoral examination demonstrated several prosthesis-related problems.

The patient was wearing a maxillary complete denture incorporating a suction cup chamber, an outdated retention mechanism historically used to enhance denture stability [figure 1](#). The palatal mucosa underlying the suction chamber appeared erythematous and inflamed, suggesting chronic irritation caused by prolonged negative pressure on the palatal tissues [figure 2](#).

In the mandibular arch, the patient used a removable partial denture retained by wire clasps on teeth #33 and #43. Clinical examination revealed that both mandibular canines were extruded, contributing to occlusal disharmony and compromised denture stability [figure 3](#). In addition, evaluation of the occlusion indicated a reduced vertical dimension of occlusion (VDO), which likely contributed to impaired masticatory efficiency and decreased prosthesis retention.

Based on these findings, the patient was diagnosed with an ill-fitting maxillary complete denture associated with palatal mucosal trauma and a functionally compromised mandibular removable prosthesis.

Considering the patient's advanced age and limited neuromuscular adaptability, a treatment strategy that preserved familiar denture morphology while improving biological compatibility and retention was selected. A digital copy reference denture workflow was planned for the maxillary arch to maintain the external contours of the existing prosthesis while correcting its internal deficiencies.

As part of the clinical procedure, the patient's existing maxillary denture was utilized as a custom impression tray. A functional impression was made using elastomeric impression material while the patient performed functional movements such as swallowing, lip movement, and tongue positioning. This functional impression technique allowed accurate recording of the dynamic anatomy of the denture-bearing area while maintaining the familiar external morphology of the

prosthesis.

Following the impression procedure, the denture and impression were digitized using an intraoral scanner to generate a digital reference model. This step preserved the original tooth arrangement and polished surface contours, which were considered acceptable from a functional standpoint. Jaw relation records were then obtained. The vertical dimension of occlusion and centric relation were re-established using a leaf gauge technique, allowing controlled mandibular positioning and minimizing abrupt occlusal alterations that could compromise patient adaptation [figure 4](#).

During the digital design phase, the denture base was modified to eliminate the suction chamber and improve tissue support while maintaining the external contours of the prosthesis. The intaglio surface was refined digitally to enhance adaptation to the palatal tissues.

The definitive maxillary denture was fabricated using additive manufacturing (3D printing) technology, which offers high dimensional accuracy and reduces polymerization distortion commonly associated with conventional processing methods [figure 5](#).

For the mandibular arch, a mandibular overdenture supported by magnetic attachments was planned to improve prosthesis retention and stability [figure 6](#) and [figure 7](#). Magnetic attachments were selected because of their self-aligning properties, passive retention, and simplified insertion, which are advantageous for elderly patients with limited manual dexterity. The use of a fully digital workflow significantly streamlined the treatment process, enabling fabrication and delivery of the definitive prostheses within two clinical visits. Preservation of the familiar denture contours facilitated rapid neuromuscular adaptation, while elimination of the suction chamber resolved the source of palatal mucosal irritation and improved overall prosthesis comfort and stability.



**Figure 2.** Palatal mucosal inflammation associated with the suction chamber of the maxillary denture

## Discussion

The rehabilitation of edentulous geriatric patients requires a treatment approach that balances biological preservation, functional restoration, and procedural efficiency. Aging is associated with reduced neuromus-



**Figure 3. Panoramic radiograph showing remaining teeth.**



**Figure 4. Reline the old upper denture using impression material; Find the ideal DVO using a leaf gauge; Make temporary occlusal stop using composite.**

cular plasticity, decreased salivary flow, and compromised mucosal resilience, all of which may impair adaptation to newly fabricated dentures. Therefore, maintaining prosthetic familiarity becomes a critical consideration in elderly patients.<sup>9</sup>

The digital copy reference denture workflow implemented in this case aligns with contemporary prosthodontic principles emphasizing minimally disruptive treatment. Unlike conventional denture replacement, which often introduces significant changes in contour and occlusal relationships, the copy denture approach preserves previously established neuromuscular patterns. This preservation reduces the adaptation period and enhances patient acceptance, particularly in advanced-age individuals.<sup>10</sup>

Recent systematic reviews have demonstrated that CAD/CAM dentures exhibit improved intaglio surface accuracy compared to conventionally processed dentures. The reduction of polymerization shrinkage and human error during laboratory procedures contributes to better tissue adaptation and retention.<sup>11</sup> In addition, digital workflows allow standardized reproduction of denture morphology, which is essential when the original prosthesis has functionally acceptable features.<sup>12</sup>

The presence of a suction cup chamber in the patient's existing maxillary denture represented a

biologically unfavorable design. Although historically used to enhance retention, suction cups have been strongly associated with chronic palatal inflammation and underlying bone resorption.<sup>13</sup> Eliminating this feature during digital redesign allowed preservation of familiar external contours while improving internal tissue compatibility.

Re-establishing vertical dimension in geriatric patients must be approached cautiously to avoid temporomandibular discomfort or functional instability. The digital workflow facilitated controlled modification without altering the patient's accustomed occlusal scheme excessively.<sup>14</sup>

Magnetic overdenture attachments were selected for the mandibular arch due to their clinical advantages in elderly populations. Compared to mechanical retention systems, magnetic attachments offer passive seating, reduced need for precise alignment and simplified insertion mechanics.<sup>15</sup>

These characteristics are particularly beneficial for patients with limited manual dexterity or cognitive decline. From a broader clinical perspective, digital denture workflows significantly reduce the number of patient visits. Conventional denture fabrication typically requires four to six appointments, whereas digital protocols may enable delivery within two visits.<sup>16</sup> This reduction is especially valuable in geriatric patients with limited mobility, systemic frailty, or dependence on caregivers.

Emerging literature from 2023–2025 supports the clinical reliability of digital dentures, reporting comparable or improved patient satisfaction and retention relative to conventional prostheses.<sup>17</sup> Furthermore, digital data storage allows future reproduction or modification without restarting the entire fabrication process.<sup>18</sup>

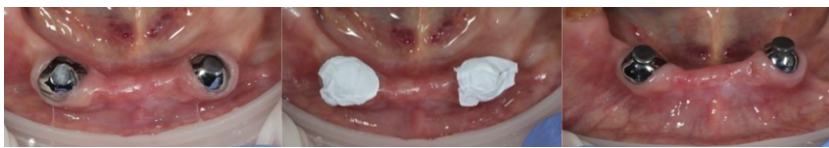
However, certain limitations should be acknowledged. Digital denture fabrication requires access to specialized equipment and technical expertise, which may not be universally available. Additionally, initial setup costs may be higher compared to conventional methods.<sup>19</sup> Nevertheless, the long-term benefits in precision, efficiency, and patient comfort may



**Figure 5. Digital denture design**



**Figure 6.** Decapitation and preparation of lower overdenture abutments.



**Figure 7.** Overdenture coping and magnet insertion.

justify these investments.

Overall, this case supports the growing body of evidence suggesting that digital copy denture workflows represent a biologically respectful and patient-centered approach for geriatric prosthodontic rehabilitation.<sup>20</sup>

### Conclusion

This case highlights the clinical value of a fully digital copy reference denture workflow for prosthodontic rehabilitation in geriatric patients. By utilizing the existing denture as a reference and custom tray for functional impression, established denture morphology and neuromuscular familiarity were preserved while correcting biological and mechanical deficiencies. The integration



**Figure 5.** Insertion of digital copy reference denture

of digital scanning, CAD design, and additive manufacturing enabled accurate denture fabrication with reduced clinical visits and chairside time. Combined with magnetic overdenture support, this approach provided improved prosthesis stability, tissue compatibility, and patient comfort, demonstrating a predictable and patient-centered strategy for managing complex elderly patients.

Based on the clinical outcomes observed in this case, several practical considerations may be proposed for prosthodontic rehabilitation in geriatric patients. Treatment planning for elderly individuals should prioritize approaches that minimize physiological stress while preserving prosthetic familiarity. Maintaining the external morphology of an existing denture through a copy denture technique may facilitate neuromuscular adaptation and improve patient acceptance, particularly in individuals with reduced adaptive capacity.

The use of the patient's existing denture as a custom tray for functional impression may also provide an effective method for accurately capturing the functional anatomy of the denture-bearing tissues while preserving established polished surface contours. This approach allows clinicians to improve the internal fit of the prosthesis without drastically altering the patient's accustomed denture form.

Furthermore, digital denture workflows incorporating intraoral scanning, computer-aided design, and additive manufacturing can significantly reduce clinical chairside time and the number of patient visits. Such efficiency is particularly beneficial for geriatric patients with limited mobility, systemic comorbidities, or dependence on caregivers.

In addition, the use of simplified retention systems such as magnetic overdenture attachments may enhance prosthesis stability while facilitating easier insertion and removal for elderly patients with reduced manual dexterity. Future clinical studies with larger patient populations are recommended to further evaluate the long-term clinical performance and patient satisfaction associated with digital copy reference denture workflows in geriatric prosthodontic rehabilitation.

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## CASE REPORT

### Complete denture rehabilitation in a patient with flabby ridge using an open-Window impression technique and double-spacer custom tray: A case report

Richard Austeen Halim,<sup>1\*</sup> Taufik Sumarsongko,<sup>2</sup> Rasmi Rikmasari<sup>2</sup>

#### ABSTRACT

**Keywords:** Complete denture, Double spacer custom tray, Flabby ridge, Impression techniques, Open-Window technique

A flabby ridge is an area of mobile soft tissue found superficially, which affects both maxillary and mandibular alveolar ridges. It is a common finding in long term denture wearers, where the rate of bone resorption is very fast leading to development of hyperplastic soft tissue over the alveolar bone. These mobile, hyperplastic tissues compromise denture stability and retention, leading to patient discomfort and functional limitations. A precise impression is essential for ensuring the stability of complete dentures with flabby ridge. The fundamental principle for impressions of a flabby ridges is to apply minimal pressure on the flabby area to prevent distortion impression outcome. To achieve that, open-window technique and double spacer custom tray along with selective pressure impression techniques was employed. This case report aims to gain impression with minimum pressure on flabby ridge to enhance retention, support, and stability of the complete denture. A 63-year-old male patient came to the Department of Prosthodontics, Padjadjaran University, complaining that his old 10-years-used denture felt loose and uncomfortable. Intraoral examination showed that both maxillary and mandibular arches were fully edentulous, with flabby ridges present. Following the assessment, it was decided to make a new complete denture using double spacer custom tray and open-window impression techniques. Double spacer custom tray and open-window impression techniques helped in recording flabby tissue with minimal displacement and hence enhanced the stability, support, and retention of the denture. (IJP 2025;7(1):65-70)

#### Introduction

The main aim of complete denture prosthodontics is to rehabilitate the patient's missing teeth and adjacent bone by providing a stable prosthesis, which in turn restores function, esthetics and comfort in the patient. The success of a complete denture prosthesis is often determined by its retention, stability, and support during function. Ideally, the alveolar ridge should be covered by masticatory mucosa of 1.5–2 mm thickness for adequate soft tissue support for the denture.<sup>1-3</sup>

In cases of a flabby ridge, the normal tissue support is absent, and instead, there is highly movable soft tissue on the surface of the alveolar ridge. It affects both maxillary and mandibular alveolar ridge but it is most commonly seen in the maxillary anterior ridge. Studies have shown that flabby ridge occurs in 24% of maxillary and in 5% of mandibular edentulous ridge. It is developed when hyperplastic soft tissue replaces the alveolar bone. Leading to an unstable denture positioning and dissatisfaction for the wearer while also compromising the quality of the denture bearing tissue. Therefore, proper prosthodontic management is essential to restoring the patient's function, esthetics, and speech.<sup>2,4</sup>

Flabby tissue occurs due to the replacement of alveolar bone with fibrous tissue. It commonly develops in the anterior maxilla, especially when natural anterior teeth remain in the mandible—a condition known as combination syndrome—which results in unstable occlusal forces from the

remaining natural teeth, thereby creating excessive loading on the residual ridge.<sup>5</sup> Among the various etiological factors proposed by Desjardin and Tolman, bone resorption, excessive atrophy of alveolar bone, nutritional deficiencies, improper forces were considered detrimental for flabby ridge development.<sup>1</sup>

Flabby tissue develops due to excessive pressure or unstable occlusion acting on the alveolar bone that supports the denture. This continuous stress leads to the resorption of alveolar bone, which is subsequently replaced by hyperplastic fibrous soft tissue. As a result, the presence of flabby tissue can interfere with denture retention, stability, and support.<sup>6,7</sup> Complete denture support becomes compromised when mobile flabby tissue is displaced by more than 2 mm under functional pressure.<sup>8,9</sup> Excessive movement of this tissue can lead to clinical complications, including denture dislodgement and pain during function.<sup>9</sup> Due to its poor supportive capacity, flabby tissue is easily displaced under load, which may reduce denture retention by interfering with the peripheral seal.<sup>10</sup>

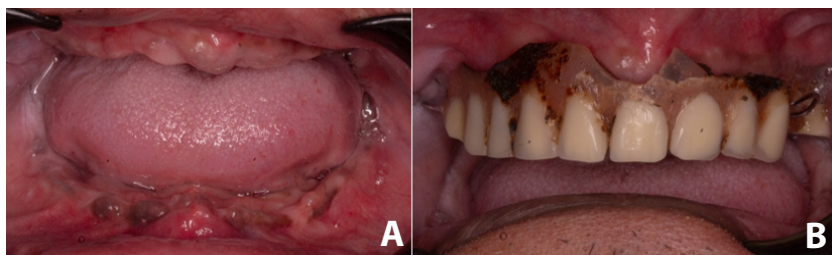
Management of flabby tissue is generally divided into three approaches. First, a surgical approach involving excision of the flabby tissue prior to denture fabrication. Second, fabrication of implant-supported dentures. Third, a non-surgical approach using conventional dentures with modified impression techniques.<sup>4,11,12</sup> Surgical removal

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

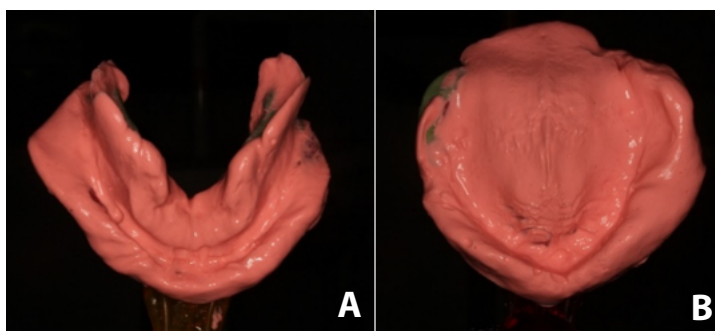
\*Corresponding author: richard23004@mail.unpad.ac.id



**Figure 1.** Extraoral profile of the patient.



**Figure 2.** Intraoral findings of the patient; A. Without denture, B. With denture.



**Figure 3.** Preliminary impression with alginate; A. Maxillary impression, B. Mandibular impression.

of flabby tissue is considered an effective method to create a firm denture-bearing area. However, this approach may reduce vestibular depth, thereby decreasing denture retention. Implant-supported prostheses provide additional support from the underlying bone and minimize reliance on soft tissue support, but they require higher costs and longer treatment time. Compared with the two approaches above, the non-surgical method using conventional prostheses with modified impression techniques and balanced occlusal contacts is more commonly selected, particularly for patients with compromised general health or limited financial resources.<sup>13</sup>

Problem with flabby ridge is as if a flabby ridge is compressed during impression making, it will later tend to recoil and dislodge the resulting overlying denture. So, an impression technique is required which will compress the non-flabby tissues to obtain optimal support and as well as not displace the flabby tissues. Many techniques have been recorded in literature to deal with flabby ridge as:<sup>14</sup> mucostatic impression technique; double spacers; multiple relief holes; and window tray technique.

Watson described the 'window' impression technique

where a custom tray is made with a window or opening over the (usually anterior) flabby tissues.<sup>14</sup> A mucocompressive impression is first made of the normal tissues using the custom tray and zinc oxide and eugenol. Once set, it is removed, trimmed, and re-seated in the mouth. A low viscosity mix of 'plaster of Paris' is then painted onto the flabby tissues through the window. Once set, the entire impression is removed. Nowadays, more easy to use materials like polyvinylsiloxanes (silicones) are being used. This article describes a case report using polyvinylsiloxane impression material and different impression techniques.<sup>14</sup>

## Case Report

A 63-year-old male patient presented to the Prosthodontics Clinic of Oral and Dental Hospital (RSGM) Universitas Padjadjaran with a chief complaint of difficulty chewing due to the loss of all teeth in both the maxilla and mandible. The patient had been wearing maxillary and mandibular complete dentures for approximately 10 years; however, the dentures had become loose and caused pain, particularly during mastication. The patient reported no relevant systemic conditions. He expressed a desire to have new dentures fabricated that would provide greater comfort and eliminate pain during use [figure 1](#).

Intraoral examination revealed complete edentulism in both the maxilla and mandible. Flabby ridges were observed in the anterior region and right tuberosity of the maxilla, as well as in almost the entire mandibular ridge [figure 2](#). Due to financial constraints, the patient declined treatment options involving a surgical approach or implant-supported complete dentures. After discussion, it was decided to fabricate a new conventional removable complete denture.

Following the patient's approval of the treatment plan and completion of informed consent, a preliminary impression was made using irreversible hydrocolloid (alginate) [figure 3](#) to obtain a study cast. The impression was subsequently poured with dental stone [figure 4](#). On the study cast, a double wax spacer was fabricated, with additional spacer placed over the flabby tissue areas in both the maxilla and mandible [figure 5](#). A custom tray was then constructed using a light-cured resin material. The borders of the custom tray were designed to be 2 mm short of the mucobuccal fold to allow space for muscle activation during border moulding. The lips, cheeks, and tongue movements were evaluated during the intraoral try-in of the custom tray.

Border moulding of both the maxillary and mandibular arches was performed using greenstick compound along the borders of the custom tray [figure 6](#). The wax spacer was then carefully removed from the custom tray without disturbing the greenstick compound. Escape holes were subsequently created in the custom tray; in the flabby areas, the holes were

made more numerous and wider to minimize pressure during the final impression procedure.

The outline of the flabby ridge was marked intraorally using an indelible marker [figure 7](#). The final impression was made using polyvinyl siloxane (PVS), with light-body material applied over the flabby areas and regular-body material over the non-flabby areas [figure 8](#). Beading and boxing procedures were then performed on the impression, which was subsequently poured with dental stone to obtain the master cast [figure 9](#).

Record bases and wax occlusion rims were fabricated on the master casts [figure 10](#). The maxillary and mandibular occlusion rims were then tried in the patient's mouth. First, the parallelism of the maxillary occlusion rim was evaluated using a Fox plane. At this stage, orientation lines were also marked on the occlusion rim, including the high lip line, low lip line, midline, and canine lines.

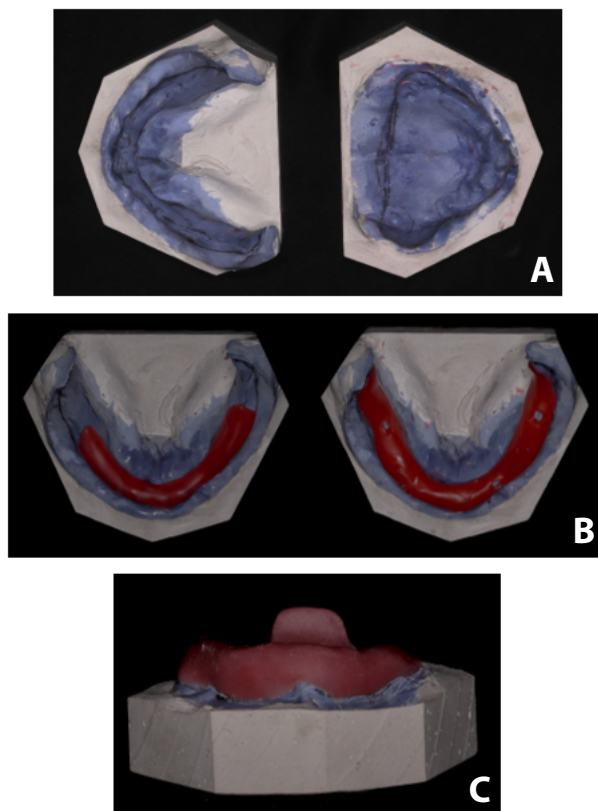
Subsequently, the mandibular occlusion rim was tried in, followed by the determination of the patient's vertical dimension and centric relation. The vertical dimension at rest was measured at 76 mm, and the vertical dimension of occlusion was established at 73 mm. After recording the vertical dimension and centric relation, a facebow transfer was performed to transfer

the maxillomandibular relationship to the cranial base onto the articulator. The occlusion rims were then secured using a stapler and removed from the patient's mouth.

The master casts with the occlusion rims were mounted on a semi-adjustable articulator [figure 11](#). During this visit, the shade and shape of the artificial teeth were selected according to the patient's skin tone, facial form, age, and gender, followed by the arrangement of the maxillary and mandibular artificial teeth [figure 12](#).

The next step was the wax denture try-in in the patient's mouth [figure 13](#). At this stage, aesthetics, midline position, low lip line, smile line, as well as centric and eccentric occlusion were evaluated. After confirming that the results were satisfactory, the dentures were processed in the laboratory, which included packing, finishing, and polishing procedures [figure 14](#).

The completed dentures were evaluated for any sharp edges, unpolished areas, or rough surfaces. Subsequently, the dentures were inserted into the patient's mouth. During insertion, retention, stability, adaptation, denture base extension, centric and eccentric occlusion, as well as aesthetics were assessed [figure 15](#). The patient was also re-instructed on the proper insertion and removal of the prostheses, along with instructions regarding denture hygiene and maintenance.

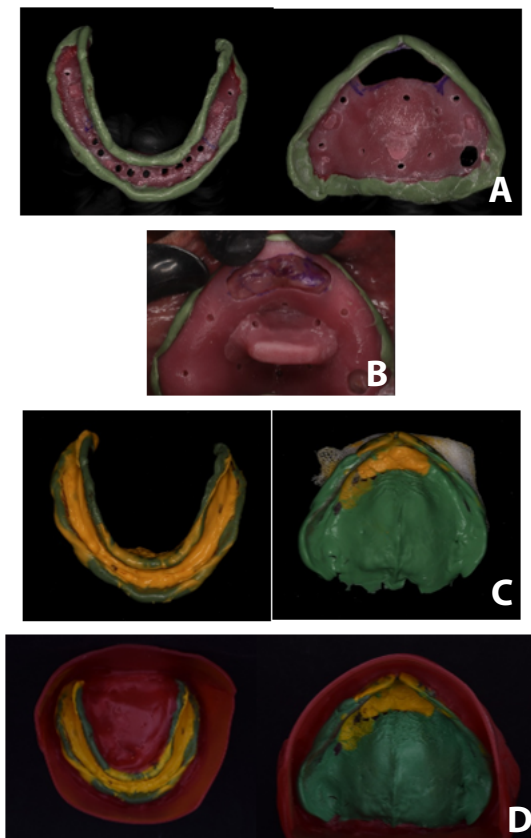


**Figure 4.** A. Cast Study; Fabrication of double spacer on, B. Mandible, C. Maxilla

## Discussion

The success of complete denture treatment largely depends on obtaining an accurate impression of the edentulous ridge and functional sulcus. The presence of flabby tissue can compromise denture retention and stability due to the elastic recoil of the fibrous soft tissue within the flabby ridge during function. In the selective pressure technique, tissues are intentionally compressed during impression making. However, when conventional impression techniques are used in cases with flabby ridges, the flabby tissue may also become compressed. Fabricating a denture over compressed flabby tissue can lead to compromised retention and stability, resulting in frequent denture dislodgement.<sup>10,12</sup>

Several impression techniques and methods have been described in the literature for recording flabby tissue during impression making. However, there is no evidence to support that one impression technique will provide a stable and retentive denture on flabby ridges as compared to others. To obtain optimal support, impression technique plays a crucial role in the fabrication of dentures in cases with flabby tissue. The impression should apply pressure to the non-flabby tissues while avoiding pressure on the flabby areas.<sup>15</sup> Modified custom trays are specifically fabricated as an alternative approach to manage edentulous cases with flabby tissue.<sup>2</sup> This report presents an innovative win-



**Figure 5.** A. Border moulding, removing wax spacer and creating escape holes, B. The outline of the flabby ridge was marked in the patient's mouth, C. Final impression; Mandible; Maxilla, D. Beading and boxing; Mandible; Maxilla.

dow technique for the impression of anterior maxillary flabby ridge and double spacer for the impression of mandibula flabby ridge using PVS impression material.<sup>1</sup>

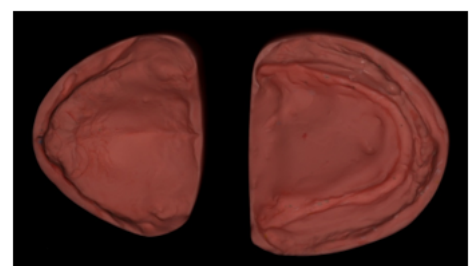
In addition to the continuous debate between mucostatic and selective impression techniques, the literature also addresses the use of modified or alternative procedures and the use of other materials. Several techniques have been documented, including spacers or perforations, sectional trays, and split trays. Nevertheless, there is no proof that one method is better than another for producing a stable and retentive denture on flabby ridges.<sup>10</sup>

The window technique for taking an impression of the anterior maxillary flabby ridge is explained in this article. Normal tissues are subjected to a mucocompressive / selective pressure impression technique, and the tissue is captured in its static state by the impression plaster covering the window. Choosing a window is likely the best way to ensure that the flabby tissue is not under any pressure. Recent studies on various tray designs have shown that the tray with a window causes the fewest tissue alterations. Using impression plaster during the imprinting process may cause the tissues to be compressed or moved. The flabby tissue can fully return while the plaster is setting, as the tray design includes a window to prevent the plaster from being

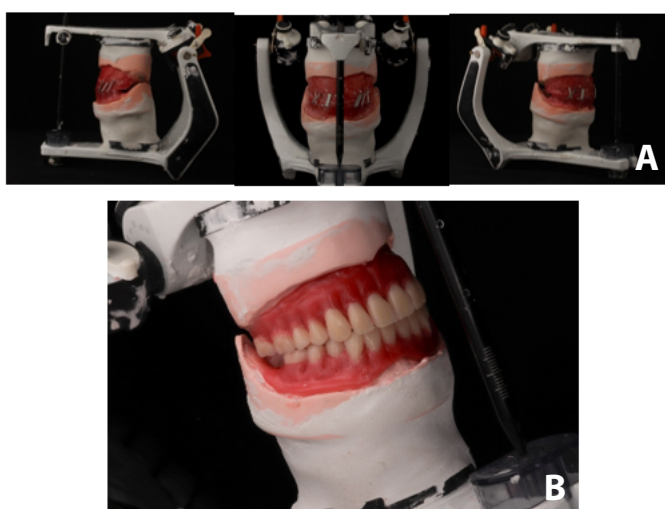
restricted to the tray. Additionally, the therapist can observe how the impression material is adjusting to the flabby tissue due to the open tray. It is crucial that the flabby area be recorded while at rest, without any compression or displacement. Another benefit of the window is that, even under pressure, the flabby tissue can return to its resting position. Therefore, a window and impression materials such as impression plaster are crucial for documenting the resting condition of a flabby ridge. Moreover, this modified impression method decreases chairside time and the requirement for extra clinical steps/appointments. This easy, affordable, and simple method can reduce the amount of movement of the flabby tissue during the impression procedure.<sup>10</sup>

The selective pressure impression technique is a widely used approach aimed at improving denture function and patient comfort. This technique works by selectively applying pressure to primary stress-bearing areas while minimizing pressure on non-stress-bearing regions, thereby promoting a more even distribution of masticatory forces. It typically involves the use of custom trays, selective relief of specific areas, and dual-viscosity impression materials to achieve accurate recording of the oral tissues.<sup>16</sup>

Flabby tissue should be recorded in a mucostatic condition, meaning in a resting state. Impression technique and impression material are two factors that can conservatively address this issue.<sup>12</sup> Several methods are used to provide relief to flabby tissue, including custom trays with additional escape holes, double spacers, and window techniques in custom trays.<sup>9</sup> Previous studies have reported that using custom trays with escape holes greater than 1 mm in diameter or a spacer thickness of 1.4 mm can effectively reduce pressure in edentulous areas. Pressure on flabby tissue can be minimized by providing additional relief space in the flabby area through the placement of two layers of baseplate wax as spacers and by increasing the number or size of escape holes in the custom tray.<sup>9,17</sup> The wax spacer placed in the custom tray provides sufficient space for the flow of low-viscosity final impression material, while the additional escape holes create an outlet pathway for excess material, thereby reducing pressure on the flabby area during impression making.<sup>18</sup>



**Figure 6.** Master cast



**Figure 7. A. Mounting on articulator, B. Arrangement of artificial teeth for the maxilla and mandible on semi-adjustable articulator.**



**Figure 8. A. Evaluation of wax denture try-in: (a-c) occlusion from the left, front and right views, B. Complete dentures of the maxilla and mandible, C. Insertion of the complete dentures of the maxilla and mandible**

Impression material selection is also a critical aspect in managing flabby tissue. The flow properties of the material significantly influence impression success. Polyvinyl siloxane (PVS) is an elastomeric impression material commonly used in clinical practice. PVS is available in various viscosities, including extra light, light (wash), medium (regular), heavy, and putty (extra heavy).<sup>19</sup> These different viscosity forms allow adaptation to the selected impression technique.

In this case, the flabby tissue in both the maxilla and mandible was most likely caused by the long-term use of ill-fitting dentures and unstable occlusion over a 10-year period without regular

follow-up. Management was performed using a non-surgical approach by modifying the impression technique through the use of a double spacer. This non-surgical approach was selected based on the patient's preference, considering both treatment cost and duration.

Custom trays were fabricated with a double spacer and additional escape holes in the flabby areas of both the maxilla and mandible. The final impression was made using dual-viscosity polyvinyl siloxane (PVS) impression material, with regular-body material applied to the non-flabby areas and light-body material applied to the flabby areas. Tooth arrangement was performed until balanced occlusal contacts were achieved to minimize unstable occlusion during function. Following denture insertion, the patient reported satisfaction and improved comfort compared with the previous dentures. This case demonstrates that the double spacer impression technique can be an effective approach for managing complete edentulous patients with flabby tissue during the fabrication of complete dentures.

This case report has several limitations. First, it describes the management of a single patient, which limits the generalizability of the findings to a wider population with flabby ridge conditions. Second, the follow-up period was relatively short, and longer-term evaluation is required to assess the stability, retention, and tissue response to the dentures over time. Additionally, the clinical outcomes were primarily based on subjective patient feedback and conventional clinical examination, without quantitative measurements of pressure distribution or tissue displacement. Therefore, further studies with larger sample sizes and longer observation periods are needed to better evaluate the effectiveness of the double spacer impression technique.

**Conclusion**

The impression technique utilizing a double spacer and additional escape holes in a custom tray has been shown to effectively reduce pressure that may otherwise compress flabby tissue during the impression procedure. This approach plays an important role in obtaining an accurate tissue record and contributes to the fabrication of more precise and comfortable complete dentures for patients with flabby ridge conditions.

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## CASE REPORT

### Management of disc displacement with reduction and local myalgia using the wax record technique with aluminum wax on stabilization splints and infrared therapy: A case report

Nabilah Fajri Damanik,<sup>1\*</sup> Ismet Danial Nasution,<sup>2</sup> Ricca Chairunnisa<sup>2</sup>

#### ABSTRACT

**Keywords:** Aluminum wax, Arthralgia, Disc displacement with reduction, Infra-red therapy, Myalgia

Disc Displacement with Reduction (DDWR) is one of the most common temporomandibular disorders (TMD), characterized by anterior displacement of the articular disc during mouth opening, typically accompanied by clicking sounds and masticatory muscle pain. DDWR is frequently associated with local myalgia, often worsened by stress and parafunctional habits. Stabilization splints and infrared therapy have demonstrated effectiveness in reducing symptoms. The use of aluminum wax in bite registration helps achieve a stable centric relation, enhancing splint fabrication accuracy. This case report aims to describe the management of DDWR with local myalgia and arthralgia through bite registration using aluminum wax to support centric relation during stabilization splint fabrication, complemented by infrared therapy. A 40-year-old male reported pain in the left cheek and ear, along with clicking during jaw movement for six months. DC/TMD Axis I assessment confirmed DDWR with local myalgia and arthralgia, Axis II revealed psychological stress. Treatment consisted of behavioral counseling, infrared therapy applied to the left masseter, and splint fabrication with bite registration using aluminum wax. Registration was performed using baseplate wax combined with aluminum wax on the occlusal surface to achieve centric relation during articulator mounting. After two weeks, the patient experienced increased mouth opening from 45 mm to 46 mm, reduced muscle tenderness, and improved muscle relaxation. The combination of behavioral counseling, aluminum wax-assisted bite registration for splint fabrication, and infrared therapy proved effective in reducing symptoms and improving mandibular function in a patient with DDWR and local myalgia. (IJP 2025;7(1):71-76)

#### Introduction

Temporomandibular disorders (TMD) are a group of conditions involving the temporomandibular joint, masticatory muscles, and associated structures, resulting in pain and functional impairment of the jaw.<sup>1</sup> The prevalence of TMD in the adult population is reported to range from 10% to 15%, predominantly affecting individuals in their productive age.<sup>2</sup> One of the most commonly encountered forms of TMD is disc displacement with reduction (DDWR), which is characterized by anterior displacement of the articular disc that returns to its normal position during mouth opening, often producing a clicking sound. Clinically, DDWR is typically associated with joint clicking during mandibular movement and may be accompanied by jaw deviation or joint discomfort.<sup>1,3</sup>

DDWR is frequently associated with local myalgia, defined as muscle pain resulting from hyperactivity of the masticatory muscles, particularly the masseter and temporalis.<sup>4</sup> This muscle tension is often exacerbated by psychoemotional factors such as stress, as well as parafunctional habits like unilateral chewing. Excessive muscle activity may lead to local ischemia and accumulation of inflammatory mediators, such as prostaglandins and substance P, which contribute to pain. In addition, behavioral factors, including unilateral chewing habits and poor posture, also play a role in the

development of TMD.<sup>5</sup>

A comprehensive diagnosis of TMD is established using the DC/TMD protocol, which includes both Axis I (clinical assessment) and Axis II (psychosocial evaluation) components.<sup>6</sup> Axis I examination facilitates the identification of structural abnormalities of the joint and muscles, while Axis II evaluates emotional factors and psychological burden influencing symptom presentation. Previous studies have demonstrated that patients with high levels of stress and anxiety are more susceptible to persistent muscle pain.<sup>7,8</sup> Therefore, treatment planning should adopt a multifactorial approach to achieve optimal outcomes, often requiring a combination of occlusal and physical therapies.<sup>9</sup>

The fabrication of a stabilization splint is one of the primary treatment modalities for TMD and requires accurate bite registration to achieve a stable centric relation.<sup>9</sup> The use of aluminum wax as an adjunct to baseplate wax can help maintain jaw position due to its rapid setting and dimensional stability. Consequently, aluminum wax improves the accuracy of model mounting and the success of splint design, allowing for more even occlusal load distribution and enhanced mandibular stability during treatment.<sup>10</sup>

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

\*Corresponding author: ismetdanial@yahoo.com

**Table 1. Results of the objective examination.**

Examination	Region	
	Right	Left
Temporalis	Ant : 0 Med : 0 Post : 0	Ant : 0 Med : 0 Post : 0
Tendon temporalis	0	1
Lateral pterygoid	0	1
Masseter	Superior : 0 Middle : 0 Inferior : 0	Superior : 1 Middle : 1 Inferior : 1
Regio submandibula	0	1
Sternocleidomastoideus	Posterior : 0 Anterior : 0 Klavikula : 0	Posterior : 0 Anterior : 0 Klavikula : 0
Splenius Capitis	1	-
Trapezius	1	0
Maximum mouth opening without pain (mm)	145 mm	
Maximum mouth opening with pain (mm)	475 mm	
Maximum assisted opening (mm)	56.2 mm	
Lateral Movement	6 mm	5mm
TMJ Pain	0	1
TMJ Noises	Open : - Close : -	Open : Cliking Close: Cliking
Headache	-	-
Tinnitus	-	-
Static Occlusion		
	Right : Klas I Angle (molar relationship) Left : Klas I Angle (molar relationship)	
Dinamic Occlusion	Group function Overbite : 3 mm Overjet : 2 mm	
Midline deviation during maximum mouth opening	Deviation to the left during maximum mouth opening.	

**Table 2. Treatment outcome evaluation.**

Parameter	Initial Condition	2 Weeks Follow Up	6 Weeks Follow Up
Maximum mouth opening without pain (mm)	45 mm	46 mm	48 mm
Lateral Movement	Right: 6 mm Left: 5 mm	Right: 6 mm Left: 5 mm	Right: 6 mm Left: 6 mm
Muscle Examination			
Tendon temporalis	Left: 1	Left: 1	Left: 0
Lateral Pterygoid	Left: 1	Left: 1	Left: 0
Masseter	Left	Left	Left
	Superior: 1 Middle: 1 Inferior: 1	Superior: 1 Middle: 1 Inferior: 1	Superior: 0 Middle: 0 Inferior: 1
Regio Submandibula	Left: 1	Left: 0	Left: 0

In addition to occlusal therapy, infrared therapy is an effective non-invasive intervention for reducing muscle pain in patients with myogenic TMD.<sup>11,12</sup> This modality works by increasing local circulation, relieving muscle spasms, and lowering pain thresholds.<sup>11</sup> Several studies have shown that infrared therapy can significantly reduce pain intensity and improve mandibular function in TMD patients.<sup>12</sup>

The aim of this case report is to describe the management of a TMD case diagnosed as DDWR accompanied by local myalgia and arthralgia, through the fabrication of a stabilization splint using a wax record technique with aluminum wax to enhance centric relation accuracy, as well as the adjunctive use of infrared therapy.

### Case Report

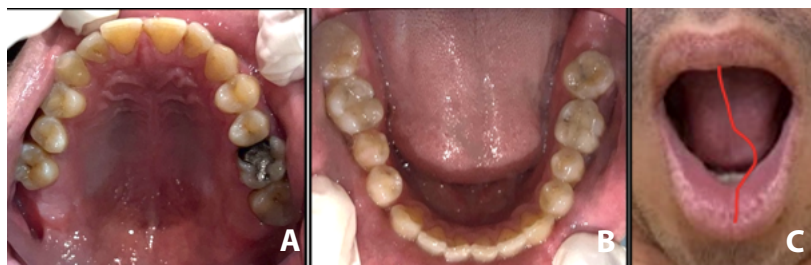
A 40-year-old male patient presented to the Department of Prosthodontics at the Dental and Oral Hospital, Universitas Sumatera Utara (USU), with a chief com-

plaint of pain and discomfort in the left cheek and the left preauricular region, which had persisted for the past six months. The patient also reported fatigue during mastication on the left side, accompanied by a clicking sound during mouth opening and closing. There was no history of trauma; however, the patient reported experiencing significant academic stress and had parafunctional habits, including unilateral chewing and sleeping in a left lateral position [figure 1](#).

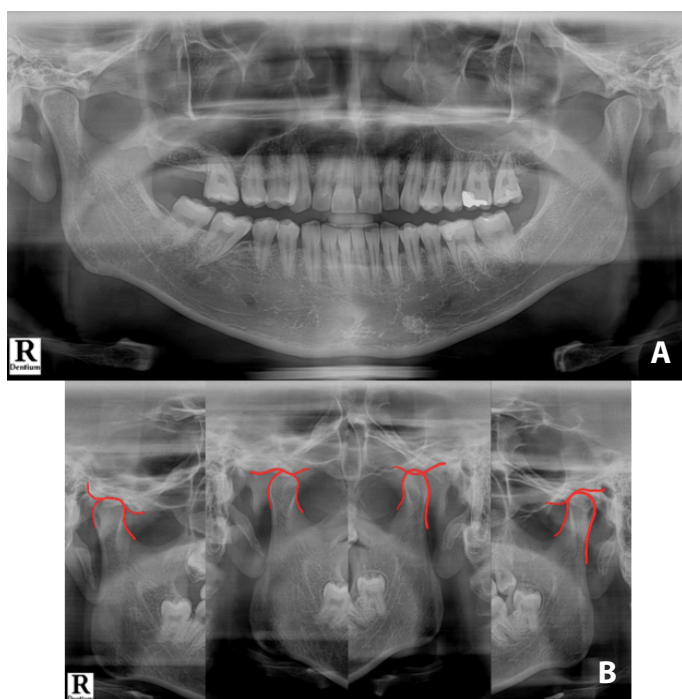
At the first visit, a comprehensive objective examination was performed, including extraoral and intraoral assessments, evaluation of the masticatory muscles, temporomandibular joint (TMJ), and head and neck muscles. A series of questions based on the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) were administered to obtain the patient's TMJ-related medical history and to assist in classifying the type of temporomandibular disorder (TMD). Axis I examination included extraoral assessment, which revealed no abnormalities in facial form, nasal breathing, lips, or eyes. Intraoral examination showed a maximum mouth opening without pain of 45 mm and a maximum mouth opening with pain of 47.5 mm. Lateral movement was 6 mm to the right and 5 mm to the left. Protrusive movement was 5 mm and associated with pain. Joint clicking was present, while crepitation was absent, and mandibular deviation to the left side was observed. Palpation of the left masseter muscle, stylohyoid muscle, pterygoid muscles, temporalis tendon, and lateral pterygoid area elicited pain [figure 2](#). Based on the psychosocial evaluation (Axis II), the anxiety questionnaire yielded a score of 9, indicating moderate anxiety (score range: 6–9). The results of the clinical examination are summarized in [table 1](#).

Panoramic and temporomandibular joint (TMJ) radiographic analyses were performed. The panoramic radiograph revealed radiopaque areas on the occlusal surfaces of nearly all molar teeth, as well as generalized horizontal alveolar bone resorption affecting most dental elements. On TMJ radiographic evaluation [figure 3A](#), it was observed that in the closed-mouth position, both mandibular condyles were located within the glenoid fossa. During mouth opening, the right

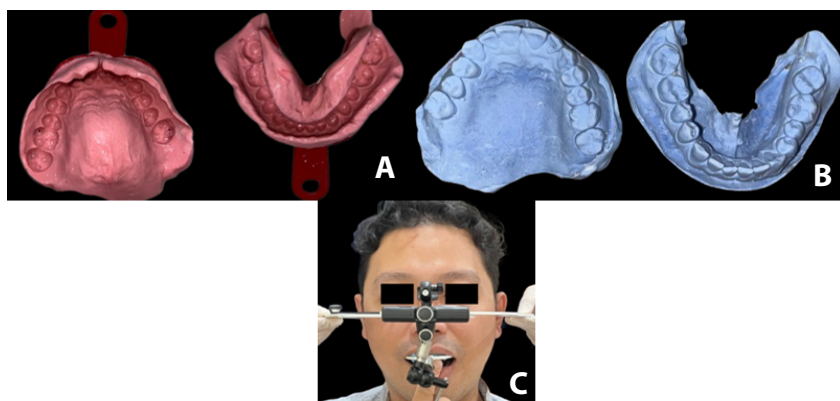
**Figure 1. Extraoral photographs, frontal and left lateral views**



**Figure 2.** Intraoral photographs A. Maxillary arch, B. Mandibular arch, and, C. Left deviation during mouth opening



**Figure 3.** A. Panoramic radiograph, B. TMJ Radiograph



**Figure 4.** A. Impression result, B. Working model, C. Initial bite registration procedure

mandibular condyle was positioned at the level of the articular eminence, whereas the left mandibular condyle was located anterior to the articular eminence.

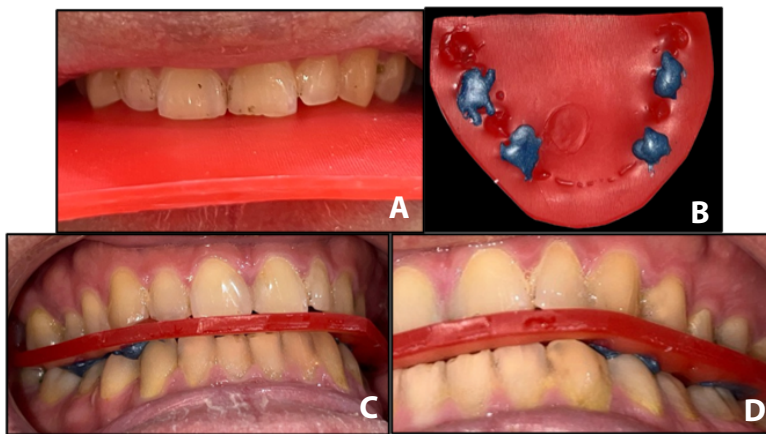
The diagnosis was established as disc displacement with reduction (DDWR) accompanied by

local myalgia and arthralgia. The etiological factors included parafunctional habits such as unilateral chewing on the left side, sleeping in a left lateral position, and carrying a bag on the left shoulder, in addition to psychological stress. DDWR was diagnosed based on the presence of a clicking sound in the left temporomandibular joint during mouth opening and closing, along with mandibular deviation to the left. Local myalgia was determined due to pain upon palpation of the masticatory muscles (masseter) without referred pain. Arthralgia was identified based on pain elicited during palpation of the left intra-auricular region.

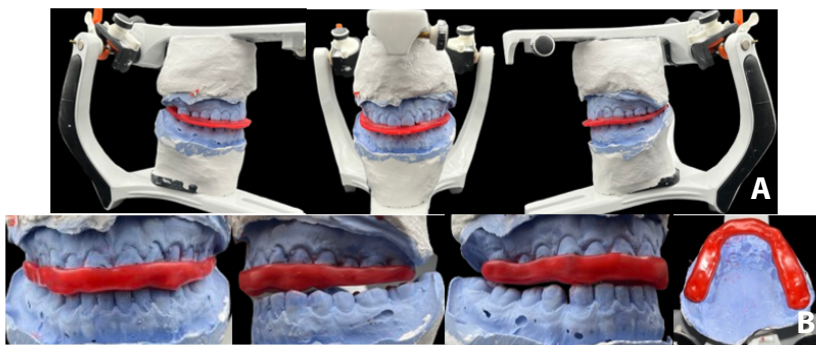
Phase I treatment consisted of patient education regarding the avoidance of parafunctional habits, such as unilateral chewing, bruxism, and sleeping on the left side. This was followed by infrared therapy applied to the left masseter and temporalis muscles. In addition, occlusal splint therapy was initiated, with a stabilization splint selected due to the absence of limitation in mouth opening and the lack of jaw locking during mandibular movements. The fabrication of the stabilization splint began with dental impressions using irreversible hydrocolloid material in a stock tray, followed by the preparation of working models using type III dental stone [figure 3B](#). Subsequently, an initial bite registration was performed using an elastomeric bite registration material (polyvinyl siloxane) to mount the maxillary cast on a semi-adjustable articulator [figure 4A](#) and [figure 4B](#).

Subsequently, a working bite registration was performed for mounting the mandibular cast. The registration was obtained using three layers of baseplate wax, with a thickness adjusted to the patient's freeway space, previously determined through assessment of the vertical dimension at rest and occlusion (3 mm). The wax was softened in warm water and adapted onto the occlusal surfaces of the maxillary arch without applying pressure. Excess wax was trimmed according to the patient's arch form, followed by intraoral try-in. Marking points were then created on the inferior surface of the wax at the canine and molar regions using the tip of a tweezer. The working bite registration was recorded in centric relation. The patient was first trained to perform mandibular movements, including protrusive and retrusive motions, with or without operator assistance, repeated 2–3 times. Once the patient became accustomed to the movement, aluminum wax was applied to the marking points, and the patient was instructed to occlude without operator assistance. After the material had hardened and a stable mandibular position was achieved, the registration record was removed and evaluated for accuracy [figure 4C](#).

The maxillary and mandibular casts were subsequently mounted on a semi-adjustable articulator based on the obtained bite registration [figure 5](#). Occlusal analysis was then performed, followed by the fabrication of a stabilization splint wax-up on the maxillary cast with a thickness corresponding to the wax record (3 mm),



**Figure 5.** A. Maxillary occlusal registration using 3 mm wax thickness, B. Aluminum wax applied to the marking points, C and D. Working bite registration procedure.



**Figure 6.** A. Mounting of maxillary and mandibular casts on a semi-adjustable articulator, B. Wax-up of the stabilization splint on the cast.



**Figure 7.** Insertion of the occlusal splint.



**Figure 8.** Application of infrared therapy on the left facial region.

incorporating canine guidance and a flat occlusal surface [figure 6](#). After completion of the wax-up, the splint was processed using clear heat-cured acrylic resin through flasking and curing procedures. This was followed by finishing and polishing to achieve a smooth surface and ensure patient comfort during use. Once completed, the splint was inserted intraorally, and necessary adjustments were made to ensure even distribution of occlusal contacts and to eliminate any interferences [figure 7](#). In addition, infrared therapy was administered to the left side of the face as an adjunctive treatment [figure 8](#).

Physical therapy in the form of infrared therapy was applied to the left masseter and temporalis muscles starting from the initial visit, with a duration of 15–20 minutes per session, three times per week for two weeks. The patient was instructed to wear the splint during nighttime and to continue infrared therapy while avoiding parafunctional habits. Follow-up evaluations were conducted two weeks after splint insertion and continued periodically to reassess symptoms from the initial to subsequent visits until the patient's complaints resolved.

Outcome evaluation at 2 and 6 weeks demonstrated a significant improvement in mouth opening and a reduction in muscle tenderness, as summarized in [table 2](#).

## Discussion

The management of disc displacement with reduction (DDWR) accompanied by local myalgia requires a conservative approach that comprehensively addresses both joint and muscular abnormalities.<sup>6</sup> DDWR is characterized by a clicking sound resulting from disc recapture during mouth opening, whereas myalgia arises from prolonged hyperactivity of the masticatory muscles.<sup>3,4</sup> An accurate diagnosis can be established using the DC/TMD approach, which integrates clinical (Axis I) and psychosocial (Axis II) evaluations.<sup>6</sup> In the present case, the patient exhibited joint clicking and tenderness on palpation, along with parafunctional habits and stress as predisposing factors, thereby necessitating a multidisciplinary treatment approach.<sup>5</sup>

Psychosocial evaluation using DC/TMD Axis II plays an important role in identifying the contribution of stress and parafunctional habits to pain and dysfunction.<sup>6</sup> Previous studies have shown that TMD patients with mild to moderate psychological burden can achieve significant improvement through education and behavioral management.<sup>7</sup> Patient education aims to reduce parafunctional habits, such as unilateral chewing and improper sleeping posture, thereby decreasing masticatory muscle activity.<sup>5</sup> Therefore, initial management should focus on behavioral modification as a fundamental strategy for symptom control.<sup>8</sup>

Infrared therapy, as part of non-invasive physiotherapeutic modalities, has been widely used to

reduce muscle pain in patients with temporomandibular disorders, particularly those of myogenic origin. The mechanism of action of infrared therapy involves increased local vasodilation, which enhances blood circulation, improves oxygen supply, and facilitates the removal of pain-inducing metabolites. In addition, its thermal effect can decrease the activity of pain-related afferent nerves and reduce muscle spasm, thereby promoting relaxation of the masticatory muscles.<sup>12</sup> A clinical study by Kui et al. demonstrated that physical therapy, including infrared therapy, significantly reduced tenderness and improved mandibular function in TMD patients after several treatment sessions. These findings are consistent with other studies reporting that continuous heat therapy provides significant analgesic effects in musculoskeletal pain, including the masticatory muscles.<sup>11</sup>

A stabilization splint was selected due to its ability to evenly distribute occlusal forces, stabilize mandibular position, and reduce stress on the temporomandibular joint. The maxillary acrylic splint creates a more balanced occlusal surface, contributing to improved functional harmony. Regular use of the splint, particularly during nighttime, has been shown to reduce the frequency of joint clicking, alleviate joint pain, and enhance overall patient comfort.<sup>9</sup>

The use of aluminum wax in centric relation recording represents a technical modification aimed at improving the stability and accuracy of bite registration in the fabrication of stabilization splints.<sup>13</sup> Aluminum wax exhibits greater rigidity compared to conventional baseplate wax, allowing it to maintain the mandibular position without deformation during the recording procedure. This dimensional stability is particularly critical in TMD cases, where even minor inaccuracies in centric relation registration may lead to occlusal discrepancies and reduce the effectiveness of the splint.<sup>14</sup> The literature suggests that more stable registration materials provide better reproducibility of mandibular position on the articulator and enhance the accuracy of prosthodontic outcomes. Furthermore, a study by Abduo and Lyons reported that the accuracy of vertical dimension and maxillomandibular relationship recording is highly influenced by the stability of the material used during bite registration procedures.<sup>10</sup> Aluminum wax was selected in this case due to its rapid setting properties and its ability to maintain the mandible in centric relation without distortion. This technique contributes to a more precise mounting of the working models on the articulator.<sup>13</sup>

The determination of the vertical dimension was based on the patient's freeway space to maintain comfort during speech and at rest. Mounting was performed in centric relation as the foundation for fabricating the acrylic splint. The splint was designed to provide even occlusal contact distribution in the centric position, along with canine guidance during eccentric

movements. This design aims to reduce excessive loading on the temporomandibular joint and masticatory muscles.<sup>9</sup>

Evaluation at two weeks post-therapy demonstrated an increase in maximum mouth opening and a reduction in tenderness upon palpation. The patient also reported improved comfort during mastication, speech, and sleep quality. These findings are consistent with previous studies indicating that a combination of patient education, physical therapy, and stabilization splint therapy results in significant improvement in patients with non-traumatic TMD.<sup>9,11</sup>

## Conclusion

The management of disc displacement with reduction (DDWR) accompanied by local myalgia can be effectively achieved through a conservative approach. Infrared therapy plays a role in reducing masticatory muscle pain (myalgia), while a stabilization splint functions to stabilize occlusion and decrease the load on the temporomandibular joint. The working bite registration using a combination of baseplate wax and aluminum wax facilitates the achievement of a stable mandibular position in centric relation, in accordance with the patient's vertical dimension requirements. The treatment outcomes demonstrated a reduction in muscle pain, along with improved comfort and mandibular function. These findings suggest that a combination of patient education, physical therapy, and appropriate splint fabrication can provide significant clinical improvement in patients with temporomandibular disorders.

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## CASE REPORT

### Multidisciplinary approach with botulinum toxin (BTX) and 3D printing stabilization splint in cases of temporomandibular joint osteoarthritis exacerbated by bruxism

Dina Hudiya Nadana,<sup>1</sup> Ismet Danial Nasution,<sup>2\*</sup> Ricca Chairunnisa<sup>2</sup>

#### ABSTRACT

**Keywords:** Bruxism, Botulinum toxin, Digital splint, Temporomandibular disorder

Temporomandibular joint disorder (TMD) is a multifactorial condition involving the masticatory muscles and temporomandibular joint. Temporomandibular joint osteoarthritis (TMJ OA), is a degenerative joint disorder marked by articular surface erosion, crepitus, and joint pain. Parafunctional habits such as bruxism can exacerbate OA by increasing biomechanical load on the TMJ, accelerating joint degeneration, and worsening symptoms. Conservative treatments such as stabilization splints are commonly used in TMD management. Recently, botulinum toxin (BTX) type A has gained attention as an adjunct therapy for reducing excessive masticatory muscle activity. This report aims to describe the multidisciplinary management of a complex TMD case using 3D-printed stabilization splints combined with BTX type A injections. A 24-year-old female presented with jaw pain and crepitation sounds upon mouth opening. She reported a history of bruxism and unilateral mastication. Cone-beam computed tomography (CBCT) revealed condylar erosion, osteophyte formation, and flattening. Clinical and radiographic findings confirmed myofascial pain and arthralgia with TMJ OA exacerbated by bruxism. Treatment included a custom 3D-printed stabilization splint and BTX type A injection into the masseter muscle. After 1 week, mouth opening improved from 34 mm to 35 mm, and to 38 mm after 1 month. The patient reported decreased pain during mastication and waking, along with reduced bruxism frequency. A multidisciplinary approach involving 3D-printed stabilization splints and BTX type A injections is effective in alleviating pain and improving function in complex TMD cases associated with bruxism. (IJPD 2025;7(1):77-81)

#### Introduction

Temporomandibular joint disorder (TMD) is a musculoskeletal disorder involving the temporomandibular joint (TMJ), masticatory muscles, and supporting structures.<sup>1,2</sup> Temporomandibular joint disorder (TMD) is the second most common musculoskeletal condition after low back pain and can affect 5–12% of the population.<sup>3</sup> One of the most common forms of TMD is temporomandibular joint osteoarthritis (TMJ OA), a degenerative joint disorder characterized by damage to the articular cartilage, subchondral bone remodelling, osteophyte formation, and clinical symptoms such as pain, crepitus, and limited jaw movement.<sup>3,4</sup>

OA TMJ caused by excessive functional load can lead to joint tissue collapse and condylar resorption, resulting in morphological changes in the TMJ and subsequent ramus reduction. TMJ-OA can also be triggered by sleep bruxism (SB), awake bruxism (AB), and chewing-side preference (CSP), which cause increased muscle tension and excessive load on the temporomandibular joint. Bruxism is a physiologically dysfunctional chewing muscle activity that occurs unconsciously, both during sleep and while awake.<sup>3,5</sup> This activity causes increased biomechanical pressure on the TMJ and masticatory muscles, which in the long term can accelerate the degenerative process and exacerbate TMD symptoms.<sup>6</sup> Patients with bruxism or TMD often show abnormal biological mechanics in the TMJ, which can

trigger the development of osteoarthritis (OA) accompanied by pain and decreased mandibular function.<sup>3</sup> Given these various etiological factors, an appropriate approach to managing TMD is important to prevent the progression of joint damage and improve the patient's quality of life.

TMD management aims to relieve pain, restore joint function, and prevent further damage. Conservative approaches are the first choice in therapy, one of which is through the use of occlusal splints. Splints work by balancing occlusal relationships, reducing muscle load, and relieving pressure on the TMJ.<sup>7</sup> With advances in digital technology, splints can now be manufactured using 3D printing methods, which allow for high precision, more efficient production times, and optimal patient comfort.<sup>8</sup> In addition to mechanical therapy, pharmacological approaches have also been widely developed. Botulinum toxin type A (BTX-A) injections have proven effective in reducing excessive masticatory muscle activity and alleviating pain in TMD patients associated with bruxism. BTX-A works by inhibiting the release of acetylcholine at the neuromuscular synapse, causing muscle relaxation and reducing pain transmission.<sup>9,10</sup>

Based on this, this case report aims to describe a multidisciplinary approach in the treatment of OA TMJ aggravated by bruxism,

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

\*Corresponding author: ismetdaniel@yahoo.com

**Table 1. Results of muscle examination and functional manipulation related to TMD and TMJ examination .**

Examination	Region	
	KA	KI
Temporalis	Ant : 1 Medium : 0 Post : 0	Front : 0 Med : 0 Post : 1
Temporal Tendon	0	1
Lateral pterygoid	0	0
Masseter	Superior : 0 Middle : 0 Inferior : 0	Superior : 2 Middle : 2 Inferior : 1
Submandibular region	1	0
Sternocleidomastoideus	Posterior : 0 Anterior : 2 Clavicle : 0	Posterior : 1 Anterior : 0 Clavicle : 0
Splenius Capitis	1	-
Trapezius	1	0
Maximum pain-free mouth opening (mm)	34 mm	
Maximum mouth opening with pain (mm)	42.6 mm	
Maximum mouth opening with operator assistance (mm)	48.4 mm	
Lateral Movement	10 mm	12 mm
TMJ Pain	0	0
TMJ sounds	Open : + Close : -	Open : + Close : -
Headache	-	-
Tinnitus	-	-
Static Occlusion	Right : Class I Angle (molar relationship)	
Dynamic Occlusion	Canine Guidance Left : Class I angle (molar relationship); Class I angle (group function) Overbite : 4 mm Overjet : 2 mm Deviation to the left during maximum	
Midline RB at maximum opening		

with a combination of 3D-printed occlusal splints and BTX-A injections, and to evaluate its effectiveness in relieving clinical symptoms.

### Case Report

A 24-year-old female patient came to the Dental and Oral Hospital (RSGM) of the Universitas Sumatera Utara (USU) complaining of pain in the front and back of her left ear and a clicking sound when opening her mouth. The anamnesis examination revealed that the patient had a history of bad habits, including bruxism, chewing on the left side, and experiencing a brief locking of the jaw while yawning. Clinical examination revealed crepitus in the right and left TMJ when opening the mouth. The patient's maximum pain-free mouth opening was 34 mm, with pain at 42.6 mm, and with operator assistance at 48.4 mm.

Several questions were asked to patients based on the Criteria for Temporomandibular Disorder (DC/TMD) to obtain a TMJ health history with the aim of assisting in classifying the type of temporomandibular disorder (TMD) during examination of the muscles around the face, neck, and TMJ. Extraoral examination showed symmetry in facial shape [figure 1](#). On Axis I examination, palpation was performed on the extraoral and intraoral muscles. Palpation examination was performed on the extraoral muscles (such as the masseter, temporal, sternocleidomastoid, posterior stylohyoid, medial/suprahyoid/digastric anterior pterygoid, splenius capitis, and trapezius) and intraoral muscles (such as the temporal tendon and lateral pterygoid area) associated

with TMD, with scores recorded according to the DC/TMD criteria (0: no pain; 1: mild pain; 2: moderate pain; 3: severe pain). Additionally, various vertical movements are examined (such as maximum mouth opening with and without pain assistance, and without pain; left and right lateral movements; protrusive movements; and examination of the midline of the lower jaw and mouth opening pattern). Palpation examination for TMJ pain was also performed, including intra-auricular and extra-auricular palpation, as well as joint sound examination. Based on the Axis II examination, the Anxiety questionnaire yielded a score of 7, indicating moderate anxiety (score 6-9). The patient health questionnaire with physical symptoms produced a score of 11, indicating moderate physical symptoms (score 10-15), while the oral cavity behavior questionnaire produced a score of 18, indicating bad habits in TMD patients (score 17-24).

Intraoral examination [figure 2](#) and panoramic radiographic analysis [figure 3](#) show attrition of teeth 33-43. The patient's periodontal condition is good. Based on the panoramic radiograph, the size of the condyle on the left side is larger than on the right side, with no impacted teeth, no pathological abnormalities, and a curved antegonial line indicating a clenching habit [figure 3A](#). From the TMJ radiograph [figure 3B](#), it was observed that when the mouth was closed, both the right and left mandibular condyles were within the glenoid fossa. When the mouth was open, both the right and left mandibular condyles were located in front of the eminence. The CBCT examination results [figure 4](#) showed that there was an asymmetrical condyle position, flattening of the right and left condyles, erosion of the articular surface cortex of the right and left condyles, and osteophytes on the left condyle. Based on the occlusal classification, the molar relationship on the right and left sides is Angle Class I; the canine relationship on the right and left sides is Angle Class I; with an overbite of 4 mm and an overjet of 3 mm, there is a deflection to the left when opening the mouth. The results of the examination mentioned above are presented in [table 1](#).

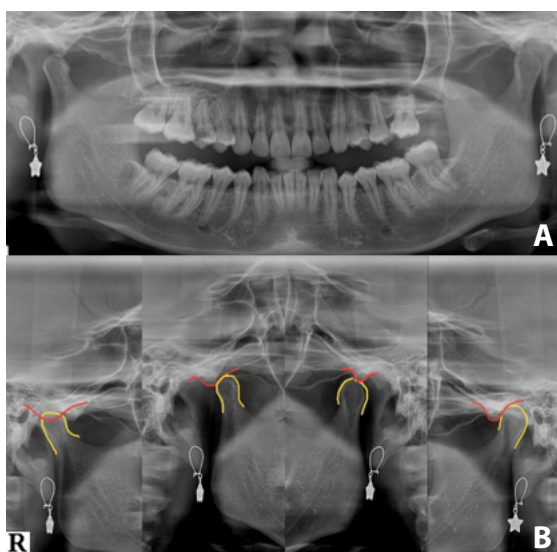
Based on the above examination results, the patient's diagnosis is myofascial pain and arthralgia accompanied by subluxation and osteoarthritis (OA)



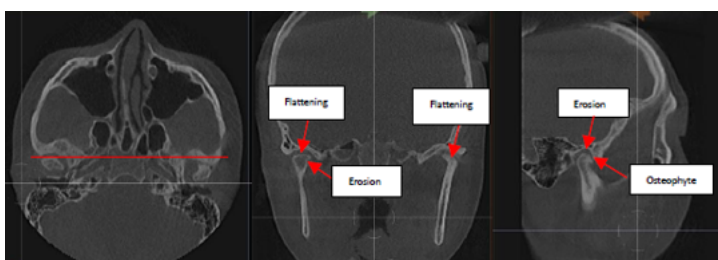
**Figure 1. Front and side profiles of the patient.**



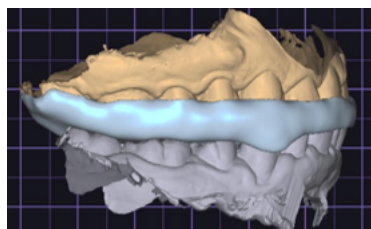
**Figure 2. Intraoral examination.**



**Figure 3. A. Panoramic radiograph, B. TMJ radiography**



**Figure 4. CBCT image.**



**Figure 5. Stabilization splint using 3D printing procedure.**

there was pain in the right masseter muscle, the temporalis muscle, the left temporalis tendon, and the right medial pterygoid muscle. On palpation of the extraoral muscles, there was pain in the right anterior and left posterior sternocleidomastoid muscles, the right splenius capitis muscle, and the right trapezius muscle. On palpation of the left extra-auricular area, there was pain. When opening the mouth, there was crepitus in the left TMJ.

The first treatment, called phase one treatment, performed on patients includes: Communication: discussing the anatomy related to crepitus sounds so that patients do not feel anxious and experience reversible disorders that may be related to bad habits such as grinding teeth while sleeping and chewing on one side; Physical therapy: botulinum toxin injections to relax the masseter and temporal muscles; Use of an occlusal splint: in this case, a stabilization splint is the treatment of choice for phase I because there are no restrictions on mouth opening and jaw locking when opening and closing the mouth.

The benefits of using a stabilization splint are to reduce the load on the temporomandibular joint (TMJ) during function; return the lower jaw to its normal position; restore the balance of jaw muscle tone; eliminate clicking sounds; and eliminate various complaints and symptoms of TMJ dysfunction.

The procedure for creating a 3D-printed stabilization splint is as follows: Creating a centric relation guide using Lucia/Anterior Jig with self-cure acrylic; Digital printing on the maxilla, mandible, and vestibular aspect (buccal registration) with the aid of an anterior jig; Importing the scan file into CAD software; Sending the STL file to the lab; Designing the splint using CAD; Processing the stabilization splint via 3D printing.

Placement of stabilization splints with attention to adaptation and retention; splint thickness must be appropriate for the free space; occlusal contact in the centric relation position and canine guidance occlusal scheme; instruct the patient to wear the splint for 24 hours. Stabilization splints are used for a minimum of 2 months and worn at all times except when eating figure 5. Patients are instructed to return for a follow-up one week after splint placement, and an examination is conducted to assess post-placement complaints, including: examination of complaints related to splint placement, checking for traumatic occlusal contact on the stabilization splint using articulating paper; examination for crepitus sounds; examination of deflection when opening and closing the mouth; a 2-week follow-up after placement to re-evaluate complaints from the first follow-up and subsequent follow-ups until the patient's complaints resolve.

Physical therapy is performed by injecting botulinum toxin (BTX) figure 6 as follows: Apply topical

caused by the bad habits of bruxism and chewing on only one side. On palpation of the masticatory muscles,



**Figure 6. BTX injection.**

anesthesia to the temporalis and masseter muscles; Dilute 100 U of botulinum toxin with 2 ml of saline solution; Position the patient sitting upright; Mark the injection sites on the temporal and masseter muscles; Inject 30 units into each side of the masseter muscle and 20 units into each side of the temporal muscle using a 1 ml syringe with a 26-gauge needle (13 mm long); Instruct the patient not to lie down for at least 4 hours after treatment.

The results of the examination after 2 weeks showed that, based on subjective assessment, there was a reduction in pain in the jaw joint area, and upon waking up, the patient no longer felt stiffness. The habit of grinding teeth was prevented by the use of a stabilization splint, so that the patient consciously remembered not to do this behaviour. Based on objective examination, pain-free mouth opening increased from 34 mm before treatment to 35 mm in the first week after the splint was applied. This demonstrates the effectiveness of using a stabilization splint in conjunction with botulinum toxin (BTX) injections in reducing pain in cases of temporomandibular joint disorder (TMD).

## Discussion

Temporomandibular joint osteoarthritis (TMJ OA) is a chronic degenerative disorder characterized by structural changes in the articular cartilage, subchondral bone, and surrounding soft tissues. The etiology of TMJ OA is multifactorial, including excessive functional load, trauma, occlusal abnormalities, and parafunctional habits such as bruxism. Repetitive and non-physiological biomechanical stress is the main trigger for local inflammatory responses and joint tissue degradation.<sup>3,4</sup> These factors trigger the molecular mechanisms underlying joint damage in TMJ OA.

Pathophysiologically, chronic mechanical stress on the joints activates inflammatory pathways that trigger the release of proinflammatory mediators such as TNF- $\alpha$  and IL-1 $\beta$ , stimulate the production of cartilage degradation enzymes (e.g., MMPs), and cause progressive damage to joint structures. This damage manifests as articular surface erosion, subchondral sclerosis, and osteophyte formation, which are clinically associated with pain, limited jaw movement, and crepitus.<sup>3,4</sup> The clinical presentation of OA-TMJ often

includes preauricular pain, clicking or crepitus when opening the mouth, and mandibular dysfunction. In this case, the patient exhibited typical symptoms of temporomandibular joint osteoarthritis such as mandibular deflection, limited mouth opening, and bilateral crepitus. Radiographic examination using CBCT showed flattening, articular erosion, and osteophyte formation, consistent with the characteristics of temporomandibular joint osteoarthritis.<sup>5</sup>

Bruxism is a predisposing and perpetuating factor, an unconscious parafunctional activity of the masticatory muscles that occurs both during sleep (sleep bruxism) and while awake (awake bruxism). Its etiology is complex, involving neurological, psychological, and peripheral aspects.<sup>5,6</sup> Bruxism activity increases static and dynamic loads on the TMJ and stimulates degenerative processes through increased intra-articular pressure and repeated microtrauma.<sup>4,6</sup>

The relationship between bruxism and TMJ-OA is close. Several studies have shown that the excessive load caused by bruxism can lead to maladaptive changes in joint tissue, accelerate the onset of degenerative changes such as osteophytes and cartilage erosion, and exacerbate symptoms of pain and mandibular dysfunction.<sup>3-5</sup> The patient in this case report also had a long-standing habit of bruxism, which likely exacerbated the TMJ osteoarthritis he experienced.

Conservative management is the recommended first step in the management of TMD and TMJ-OA. Occlusal splints are one of the main modalities, serving to balance occlusion, reduce masticatory muscle activity, and distribute pressure evenly on the joint.<sup>7</sup> The application of digital technology in the manufacture of 3D splints offers advantages in terms of precision, time efficiency, and patient comfort.<sup>8</sup>

In this case, a CAD-CAM-based stabilization splint was used and printed with 3D printing technology. The splint was used continuously to reduce the load on the TMJ and prevent traumatic contact that triggers bruxism. Evaluations after 1 week and 1 month showed significant improvement in terms of pain and mouth opening ability. As an additional therapy, botulinum toxin type A (BTX-A) injections into the masseter and temporalis muscles have proven to be an effective approach. BTX-A works by inhibiting the release of acetylcholine at the neuromuscular synapse, causing muscle relaxation and reducing hyperactive chewing muscle activity.<sup>9</sup> A meta-analysis shows that BTX-A provides short-term benefits in reducing pain and muscle tension in TMD patients associated with bruxism.<sup>10</sup>

The combination of stabilization splints and BTX-A injections in this case showed satisfactory results, with a reduction in subjective pain, an increase in pain-free mouth opening, and patient awareness of their parafunctional habits. This multidisciplinary approach is in line with the principles of modern TMD

therapy, which emphasizes individualization and integration of various therapeutic modalities.<sup>1,2,7</sup>

## Conclusion

Temporomandibular joint osteoarthritis (TMJ-OA) aggravated by bruxism requires multidisciplinary management. The combination of digital occlusal splints and type A botulinum toxin injections has been proven effective in reducing pain, improving mandibular function, and suppressing excessive masticatory muscle activity. This therapy is an efficient alternative treatment option that can improve the quality of life of patients with complex TMD.

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## CASE REPORT

### Posterior mandibular tooth replacement using a porcelain-fused-to-metal adhesive bridge with sanitary and conical pontic designs: A case report

Alyssa Salsabila,<sup>1\*</sup> Nathania,<sup>1</sup> Setyawan Bonifacius<sup>2</sup>

#### ABSTRACT

Posterior mandibular tooth loss can significantly impair masticatory function, occlusal stability, and overall quality of life. Among available treatment options, adhesive bridges offer a minimally invasive alternative that preserves tooth structure while restoring function. This case report describes posterior mandibular tooth replacement using a porcelain-fused-to-metal (PFM) adhesive bridge incorporating two different pontic designs, namely sanitary and conical pontics. A 50-year-old female patient presented with missing posterior mandibular teeth and complaints of discomfort during mastication. Clinical examination revealed a Kennedy Class III modification 1 condition with favorable abutment support. A conservative treatment plan was developed using a resin-bonded fixed dental prosthesis. Tooth preparation was performed within enamel, followed by impression procedures and laboratory fabrication. The pontic design was selected based on anatomical and hygienic considerations, with a sanitary pontic applied in one region and a conical pontic in another. Following coping try-in and evaluation of marginal fit and occlusion, final cementation was performed using dual-cure resin cement. Post-insertion evaluation demonstrated satisfactory function, stability, and esthetics, with good periodontal response. This case highlights that appropriate pontic design selection plays a crucial role in achieving functional efficiency, hygiene maintenance, and long-term success in adhesive bridge restorations. (IJP 2025;7(1):82-86)

**Keywords:** Adhesive bridge, Conical pontic, Minimally invasive dentistry, Porcelain-fused-to-metal, Posterior mandible, Sanitary pontic

#### Introduction

Tooth loss remains a prevalent oral health condition that significantly affects mastication, esthetics, and overall quality of life. Posterior mandibular tooth loss, in particular, reduces masticatory efficiency and occlusal stability and may lead to migration of adjacent teeth and supraeruption of opposing teeth if left untreated.<sup>1,2</sup>

Prolonged tooth loss may also result in alterations in occlusal relationships and temporomandibular joint function.<sup>1</sup> Therefore, appropriate prosthodontic rehabilitation is essential to restore function and prevent further complications. Early intervention is important to minimize progressive functional impairment and maintain occlusal harmony.

According to Kennedy classification, posterior edentulous areas bounded by natural teeth are categorized as Class III, which generally presents a favorable prognosis due to adequate abutment support. This condition allows for predictable load distribution and enhances the stability of fixed prosthetic restorations, making it suitable for adhesive bridge treatment.<sup>3,4</sup>

Various treatment options are available, including removable partial dentures, dental implants, and fixed dental prostheses. However, each modality presents limitations such as patient discomfort, surgical requirements, cost, or extensive tooth preparation.<sup>5,6</sup> Therefore, treatment selection should be based on clinical conditions, patient preferences, and long-term prognosis.

Resin-bonded fixed dental prostheses, also known as adhesive bridges, offer a minimally invasive alternative because preparation is confined mainly to enamel, preserving tooth structure while providing adequate retention. This approach is particularly beneficial in cases where conservation of tooth structure is a primary concern.<sup>7,8</sup>

Pontic design is a critical determinant of the biological and functional success of fixed dental prostheses. The sanitary pontic is commonly indicated in posterior regions due to its complete clearance from the residual ridge, allowing excellent hygiene maintenance and reducing the risk of plaque accumulation. In contrast, the conical pontic presents a convex surface with minimal contact at the center of the ridge, providing a balance between hygiene and esthetic contour.<sup>6</sup> The selection between these pontic designs should be based on ridge anatomy, esthetic demand, and patient oral hygiene capability.

Porcelain-fused-to-metal (PFM) remains a widely used material in fixed prosthodontics due to its favorable mechanical strength and durability, especially in posterior regions subjected to high occlusal loads. In addition, PFM restorations provide a combination of strength and acceptable esthetics, making them suitable for long-term clinical use in load-bearing areas.<sup>9,10</sup>

This case report aims to describe posterior mandibular

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Padjadjaran University, Bandung, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Padjadjaran University, Bandung, Indonesia

\*Corresponding author: alyssa15003@mail.unpad.ac.id

tooth replacement using a PFM adhesive bridge with sanitary and conical pontic designs, emphasizing the role of pontic selection in optimizing function, hygiene, and long-term prognosis. The selection of pontic design is essential balance between biological compatibility and functional efficiency.

facial profile, normal temporomandibular joint function, and good oral hygiene. Intraoral examination showed edge-to-edge occlusion with overbite and overjet of 4 mm. Radiographic findings confirmed missing posterior mandibular teeth with adequate abutment support. The condition was diagnosed as Kennedy Class III modification 1 [figure 2](#).

A treatment plan was developed using a porcelain-fused-to-metal (PFM) adhesive bridge. Pontic design selection was based on anatomical and hygienic considerations. A sanitary pontic was applied in one posterior region to facilitate cleaning and minimize tissue contact, while a conical pontic was used in another region to provide improved contour and acceptable hygiene access. Tooth preparation was performed conservatively within enamel with a depth of approximately 0.3–0.5 mm using a wrap-around design extending approximately 180° to increase bonding surface area. Supragingival chamfer margins were created to facilitate plaque control and reduce periodontal irritation. Occlusal rests were prepared to enhance support and prevent rotational movement [figure 3](#).

Impression procedures were carried out using polyvinyl siloxane material, followed by fabrication of the restoration. Shade selection was performed using the VITA Classical Shade Guide, resulting in shade C3. The selected shade was considered compatible with the adjacent dentition to achieve a harmonious esthetic outcome [figure 4](#).

Coping try-in demonstrated satisfactory marginal adaptation, proper seating, and stability. Occlusion was evaluated in both static and dynamic conditions to eliminate premature contacts and interferences. Final restoration try-in confirmed appropriate contour, esthetics, and adaptation, with no evidence of marginal discrepancy or instability. The prosthesis was able to be inserted along the planned path of insertion and remained fully seated without resistance, indicating adequate fit and retention prior to cementation [figure 5](#).

Prior to cementation, the abutment teeth were cleaned with pumice. The intaglio surface of the metal retainer was treated with sandblasting and metal primer. Enamel surfaces were etched with 37% phosphoric acid, followed by bonding agent application. The prosthesis was cemented using dual-cure resin cement, and excess cement was removed. Final occlusal adjustments were performed to ensure proper load distribution.

Follow-up evaluations at one week and one month demonstrated stable restoration, healthy periodontal tissues, and satisfactory patient comfort. Occlusal evaluation in both static and dynamic conditions revealed no premature contacts or interferences. No signs of debonding or marginal discrepancy were observed, and the patient reported improved masticatory function. Oral hygiene around the prosthesis was well maintained, and the patient was instructed to continue regular follow-up for long-term evaluation.



**Figure 1. Intraoral Photographs of the Patient: A. Right Lateral View, B. Occlusion, C. Left Lateral View, D. Maxillary Occlusal View, E. Mandibular Occlusal View.**

### Case Report

A 50-year-old female patient presented with missing posterior mandibular teeth, complaining of discomfort during mastication and difficulty chewing, particularly when consuming harder foods. The patient had previously used a removable partial denture but discontinued its use due to discomfort and poor adaptation. She expressed a preference for a fixed prosthetic solution with minimal tooth reduction. The patient reported that the teeth had been missing for approximately 15 years following extraction due to extensive caries. No complications were reported during healing, and no definitive prosthetic rehabilitation had been performed since then. Medical history was non-contributory [figure 1](#).

Clinical examination revealed a symmetrical

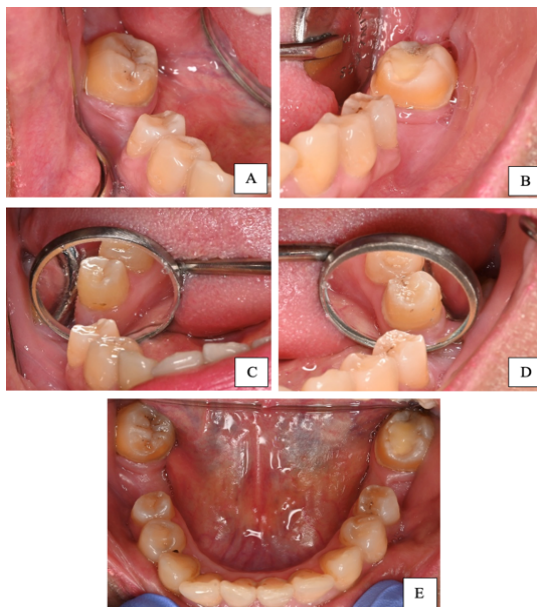


**Figure 2. Panoramic Radiograph of the Patient.**

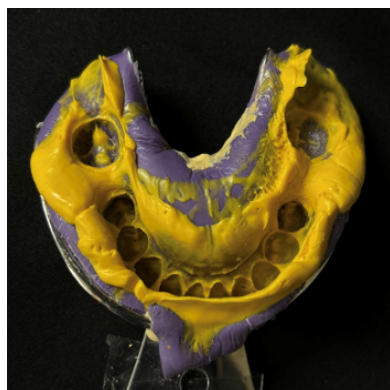
**Discussion**

Posterior mandibular tooth loss significantly affects masticatory function and occlusal stability, and if not rehabilitated properly, may lead to occlusal imbalance and functional disturbances.

In this case, the condition was classified as Kennedy Class III modification,<sup>1</sup> which provides favorable support for fixed prosthetic treatment due to the presence of abutment teeth on both sides of the edentulous space.<sup>3,11</sup>



**Figure 3. Abutment Tooth Preparation for Adhesive Bridge: A. Tooth 47, B. Tooth 37, C. Tooth 45, D. Tooth 35, E. Mandibular Occlusal View.**



**Figure 4. Two-Step Impression Technique Using Polyvinyl Siloxane.**

The use of an adhesive bridge allows a conservative approach, preserving tooth structure while restoring function. Resin-bonded prostheses rely on both chemical adhesion and mechanical design to achieve retention and stability. This approach enhances the preservation of enamel, which is essential for achieving optimal bonding strength.<sup>7</sup>

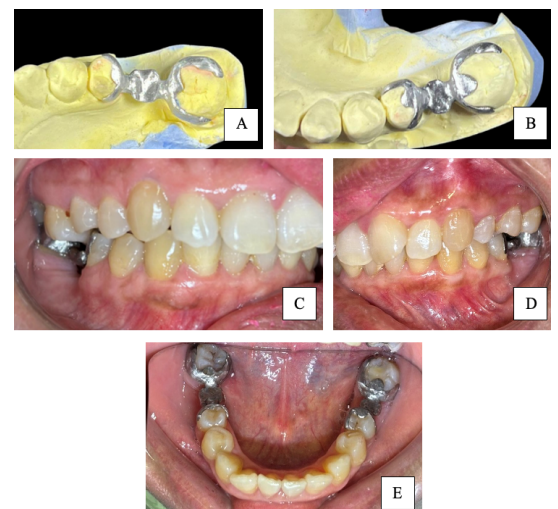
Pontic design plays a crucial role in both biological and mechanical success. The sanitary pontic, which does not contact the underlying ridge, provides superior hygiene by eliminating plaque-retentive areas and reducing the risk of soft tissue inflammation. This design is particularly suitable for posterior regions where esthetic demands are lower.<sup>6</sup>

In contrast, the conical pontic provides a convex surface with minimal ridge contact, offering improved esthetic contour compared to sanitary pontics while still allowing relatively easy cleaning. However, improper adaptation or excessive contact may increase plaque accumulation if oral hygiene is inadequate.<sup>6</sup>

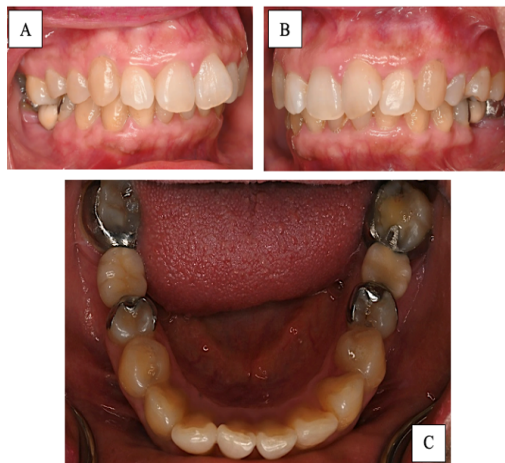
The combination of sanitary and conical pontic designs in this case allowed optimization of treatment outcomes. The sanitary pontic was selected in areas prioritizing hygiene, whereas the conical pontic was used in regions requiring better contour adaptation. This selective approach demonstrates that pontic design should be individualized rather than standardized.<sup>6</sup>

In this case, one of the abutment teeth (tooth 37) presented with a composite restoration. The presence of a composite restoration is not a contraindication for adhesive bridge placement, provided that the restoration is clinically sound and well-bonded. Composite restorations have demonstrated satisfactory longevity and bonding performance when appropriate adhesive protocols are followed.<sup>12</sup> Therefore, the use of tooth 37 as an abutment was considered clinically acceptable and did not adversely affect the prognosis of the restoration.

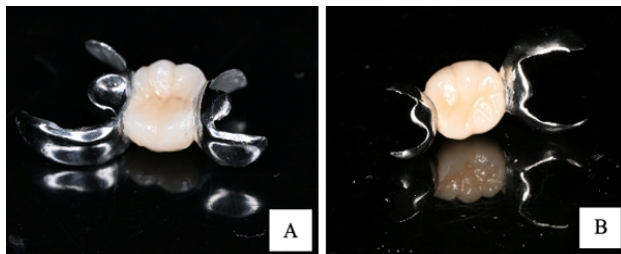
PFM material was selected due to its high



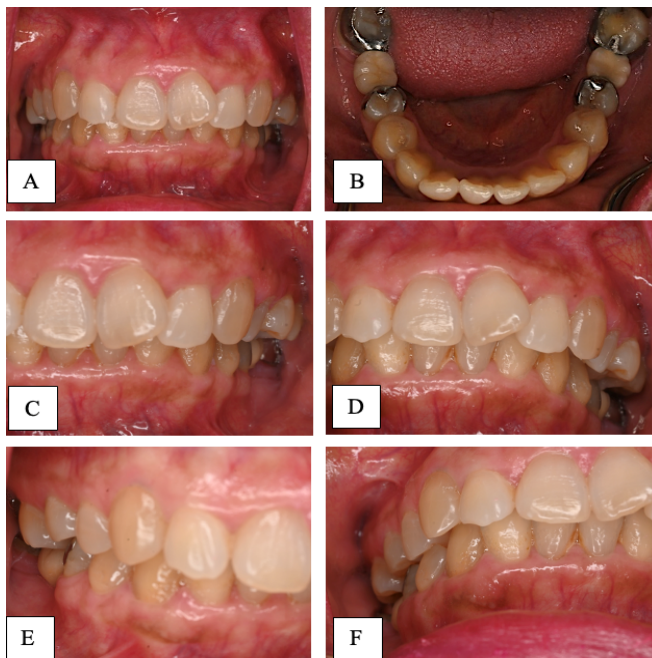
**Figure 5. Coping Try-In of the Adhesive Bridge: A. Coping in the Region of Tooth 46, B. Coping in the Region of Tooth 36, C. Occlusion in the Region of Tooth 46, D. Occlusion in the Region of Tooth 36, E. Mandibular Occlusal View.**



**Figure 6. Insertion and Cementation of the Adhesive Bridge: A. Occlusion in the Region of Tooth 46, B. Occlusion in the Region of Tooth 36, C. Mandibular Occlusal View.**



**Figure 7. Porcelain-Fused-to-Metal (PFM) Adhesive Bridge: A. Region of Tooth 36, B. Region of Tooth 46.**



**Figure 8. Post-Insertion Follow-Up of the Adhesive Bridge: A. Frontal View, B. Mandibular Occlusal View, C. Occlusion in the Region of Tooth 36, D. Inferior Intraoral View of Tooth 36 Region, E. Occlusion in the Region of Tooth 46, F. Inferior Intraoral View of Tooth 46 Region.**

mechanical strength and long-term clinical success in posterior regions. Dual-cure resin cement provides reliable polymerization and strong adhesion, particularly in metal-based restorations, ensuring optimal bonding even in areas with limited light penetration. This improved retention and overall longevity of the restoration.<sup>9,13</sup>

Post-insertion evaluation demonstrated satisfactory adaptation, stability, and periodontal health, with no signs of debonding or complications. Regular follow-up remains essential, as adhesive bridge failure is most commonly associated with debonding.<sup>14</sup> Overall, this case highlights that the success of adhesive bridge restorations is influenced not only by adhesive protocols but also significantly by appropriate pontic design selection and abutment condition.

**Conclusion**

The use of a porcelain-fused-to-metal adhesive bridge incorporating sanitary and conical pontic designs represents an effective and conservative approach for posterior mandibular tooth replacement. Differences in pontic design play an important role in determining hygiene maintenance, tissue response, and functional performance. The sanitary pontic provides superior hygiene due to the absence of ridge contact, while the conical pontic offers a balance between esthetics and cleanability. Proper selection and combination of pontic designs, along with appropriate evaluation of abutment teeth, including those with composite restorations, contribute significantly to long-term success. Careful treatment planning, precise adhesive procedures, and follow-up are essential to maintain restoration stability and periodontal health.

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## CASE REPORT

### Fabrication of a complete denture using a modified custom tray with a closed-mouth impression on a fully edentulous compromised mandibular flat ridge

Jhonson,<sup>1\*</sup> Ismet Danial Nasution,<sup>2</sup> Ricca Chairunnisa<sup>2</sup>

#### ABSTRACT

**Keywords:** Flat ridge, Full edentulism, geriatric, Modified closed-mouth impression, Muscle trimming

Severe mandibular alveolar ridge atrophy, common in geriatric patients, compromises the functional success of complete dentures due to a reduced denture-bearing area and the proximity of muscle attachments to the ridge crest. This condition increases denture displacement during function in both horizontal and vertical movements, leading to poor retention and stability of the denture. Accurate impression techniques are critical to overcoming these challenges. The closed-mouth functional impression technique allows for the recording of denture-bearing areas and peripheral seal under functional pressure, potentially enhancing retention. This case report aims to describe the procedure for fabricating a complete denture using a modified custom tray with a closed-mouth impression on a fully edentulous, compromised mandibular flat ridge. A 52-year-old woman presented with a loose and poorly fitting lower denture. Clinical examination revealed complete edentulism with a severely resorbed mandibular ridge. A custom tray was fabricated with a detachable handle to support the closed-mouth impression technique without interfering with occlusion during border molding and impression-making. The closed-mouth approach allowed for better muscle molding, recording of functional borders, and a more accurate reflection of the patient's oral dynamics. As a result, the final denture exhibited significantly improved retention and comfort during function. This case highlights the clinical advantage of the closed-mouth impression technique in managing challenging ridge conditions and emphasizes the practical benefit of modifying tray design to ease the procedure for both clinician and patient. Such adaptation is especially relevant in geriatric care, where functional and anatomical limitations are common. The use of a modified custom tray with the closed-mouth functional impression technique proved effective in managing a severely resorbed mandibular ridge. It resulted in a stable, retentive, and comfortable complete denture, contributing to enhanced patient satisfaction. (IJP 2025;7(1):87-89)

#### Introduction

Full edentulism is a condition characterized by the loss of all natural teeth or the absence of teeth in both the upper and lower jaws within the oral cavity. Tooth loss can result from dental caries, periodontitis, or trauma. Full edentulism can also be found even in younger elderly individuals. Early tooth loss can occur due to several factors such as low socioeconomic status, nutrition, level of oral health knowledge, systemic disease risk factors, and access to healthcare. Edentulism has a negative impact on quality of life, encompassing masticatory function, appearance, speech ability, and self-confidence.<sup>1</sup>

Complete dentures are a treatment option for patients with complete edentulism to replace all missing teeth in the upper and lower jaws, supported by the mucosa, connective tissue, and bone. The success of dentures is assessed based on retention, stabilization, occlusion, and aesthetics, which are prerequisites in denture fabrication to restore masticatory, phonetic, and aesthetic functions.<sup>1,2</sup>

A challenge for clinicians in providing full denture care to geriatric patients is when a flat mandibular alveolar ridge is encountered. Atrophy of the alveolar ridge initially occurs due to tooth loss, which then progresses as a result of a long period of inactivity and is accelerated by risk factors for

systemic diseases. Čelebić et al. evaluated alveolar ridge resorption and found that the degree of mandibular resorption was 2.5 times greater than that of the maxilla. In cases of a flat alveolar ridge, the smaller surface area affects the retention factors of complete dentures, namely adhesion, cohesion, surface tension, atmospheric pressure, and gravity acting on the base surface of the complete denture. Consequently, the denture shifts both horizontally and vertically during function. Complete denture treatment in cases of a flat margin can be addressed through accurate closed-mouth impression techniques to obtain support and denture margin boundaries in the patient's functional state. This case will discuss complete denture treatment with modifications to the closed-mouth impression technique in cases of a flat margin accompanied by a pterygomandibular raphe.<sup>3</sup>

#### Case Report

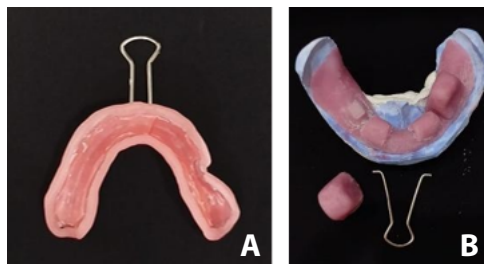
A 52-year-old woman presented to the University of North Sumatra Dental and Oral Hospital complaining of loose dentures accompanied by chewing difficulties. Clinical examination revealed edentulism with a flat marginal ridge on the mandible.

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, University of North Sumatra, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, University of North Sumatra, Medan, Indonesia

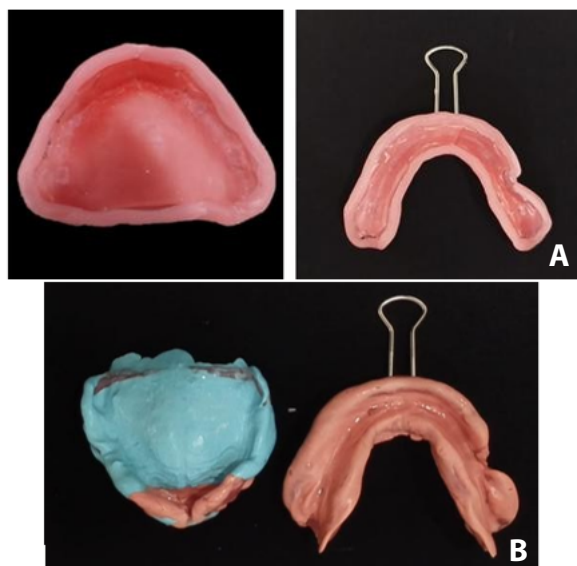
\*Corresponding author: zhoujhonson@yahoo.com



**Figure 1. Intraoral examination; A. Maxilla, B. Mandible.**



**Figure 2. A. Modified physiological mandibular impression tray, B. Removable handle and removable abutment.**



**Figure 3. A. Maxillary and Mandibular Border Molding, B. Physiological Impression.**

Anatomical impressions were taken using a manufacturer's impression tray and irreversible hydrocolloid to obtain a diagnostic model. Tentative vertical dimensions were established to determine the patient's jaw relationship as a prerequisite for the treatment plan. A physiological impression tray with removable handles and pillars was fabricated to support closed-mouth impressions without obstructing occlusion during border molding and impression-taking procedures. The anterior handle facilitates the operator when positioning the physiological impression tray into the mouth, and two posterior pillars assist the patient in closing the mouth.

The border molding procedure was performed using light-curing resin and polymerized both intraorally and extraorally. The physiological impression was taken using the closed-mouth impression technique on the lower jaw. During the impression process, the patient is instructed to close their mouth until the mandibular pillar rests against the occlusal rim of the maxilla, and the patient is directed to move their tongue to the left, right, and up, protrude the tongue, and suck in the cheeks to record the functional state of the oral structures until the impression material hardens. Facebow transfer, determination of the definitive jaw relationship, and neutral zone impression-taking are performed after this process.

Tooth arrangement was performed using a lingualized occlusion scheme in which the palatal cusp of the maxillary posterior teeth contacts the central fossa of the mandibular posterior teeth. Semi-anatomical tooth elements were used in the maxilla and non-anatomical ones in the mandible.

Complete dentures were fabricated using conventional techniques, with the mandibular prosthesis reinforced by a metal framework. Following the laboratory process, the dentures were fitted during the subsequent appointment. Instructions regarding maintenance and care were provided after placement, followed by periodic follow-up visits. The patient is satisfied with the results of the dentures in terms of function and aesthetics.

## Discussion

The success of complete dentures is based on the ability to meet the basic principles related to support, stability, and retention. Proper impression-taking is key to successful treatment in cases of mandibular marginal resorption. This case highlights the clinical advantages of the Closed-Mouth Impression technique in managing complex mandibular flat ridges and the practical benefits of modifying the design of the physiological impression tray during the fabrication of dentures with compromised margins.<sup>1,5</sup>

The advantage of the custom tray modification for the closed-mouth functional impression technique is that it facilitates the operator's handling through the inclusion of removable handle and post components during the border molding and physiological impression-taking processes, thereby achieving maximum support and extension of the denture base in accordance with the patient's function. This modified physiological impression tray design is suitable for novice operators.<sup>6</sup>

Shaping the impression material along the tray's edge area through functional or manual manipulation of the soft tissues around the margin to mimic the contours and dimensions of the vestibule—a process known as border molding—is necessary to achieve a peripheral seal and ensure denture retention. Although green stick compound remains the gold standard for

border molding procedures, this material has several drawbacks, such as a short manipulation time to perform movements and accurately record the vestibular tissue margins, varying pressure along the mucobuccal folds due to sectional molding, a long duration, and the risk of thermal injury, which may not be suitable for less experienced practitioners.<sup>7,8</sup>

border molding is its unsuitability for cases with severe tissue undercuts, which may not be indicated due to the material's rigidity.<sup>8</sup>

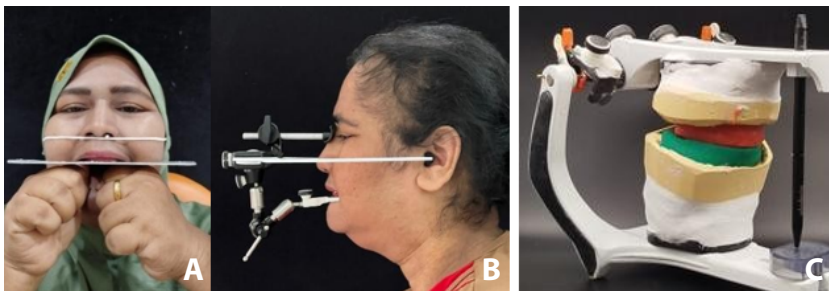
The closed-mouth impression technique has the advantage of minimizing the risk of over- and under-extension because the patient shapes the impression margins and the impression is taken in the occlusal position. This ensures that the denture base extends into both movable and immovable tissues during function and records the margins under functional pressure. Consequently, this approach enables the creation of impressions that more accurately reflect the patient's oral dynamics. This approach is highly relevant in geriatric care, where functional and anatomical limitations are frequently observed in geriatric patients. In conclusion, the final dentures demonstrate significantly better retention and comfort during function.<sup>8</sup>

## Conclusion

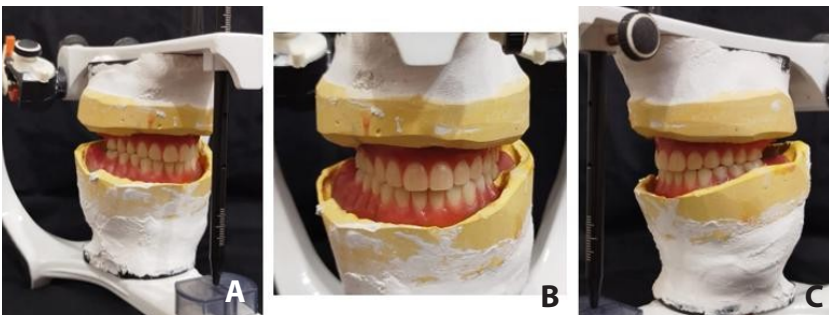
The use of a modified impression tray with the closed-mouth impression technique has proven effective in managing severe alveolar ridge resorption of the mandible, and demonstrates the practical benefits of modifying the impression tray design for procedural ease for clinicians and patient comfort, resulting in a stable, retentive, and comfortable denture for the patient.

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**Figure 4.** A. Determination of definitive jaw relationship, B. Facebow transfer, C. Impression of the neutral zone.



**Figure 5.** Dental arrangement with a modified lingualized occlusion scheme; A. Right lateral view, B. Frontal view, C. Left lateral view.



**Figure 6.** Complete dentures, A. Maxillary denture, B. Mandibular denture reinforced with a metal framework, C. Placement of complete dentures.

Alternative materials such as light-cure resin allow the operator to perform border molding in a single step, achieve uniform pressure across the entire marginal area, and provide ease of control over the material's working time. Additionally, high muscle attachment at the pterygomandibular raphe can be recorded, and marginal contour correction is also possible through the addition of new material. A limitation of light-cure resin

## ORIGINAL ARTICLE

### Heat-Cured Acrylic Resin Plates on Surface Roughness in A 6.25% Siwak (Salvadora Persica) Effervescent Tablet Solution

Mohammad Dharma Utama,<sup>1\*</sup> Chusnul Chotimah,<sup>1</sup> Rhezaldi Rusdi,<sup>2</sup> Aksani Taqwim,<sup>1</sup> Maqhfirah Amiruddin<sup>1</sup>

#### ABSTRACT

**Keywords:** Heat-cured acrylic resin, Siwak effervescent tablet (Salvadora persica), Surface roughness

Heat-cured acrylic resin is widely used as a denture base material due to its favorable aesthetic and biocompatible properties; however, denture hygiene must be maintained using cleaning agents that do not adversely affect surface characteristics. Siwak (*Salvadora persica*) contains antibacterial and antifungal compounds and has demonstrated inhibitory effects against *Candida albicans* at a concentration of 6.25%, indicating its potential as a natural denture cleanser. This study aimed to evaluate the effect of immersing heat-cured acrylic resin plates in a 6.25% siwak effervescent tablet solution on surface roughness. A true experimental study was conducted using 27 heat-cured acrylic resin plates (65 × 10 × 3.3 mm), divided into three groups: alkaline peroxide solution, 6.25% siwak effervescent tablet solution, and effervescent tablet solution without siwak. Immersion was performed for 15 minutes daily over an 8-day period at 37°C. Surface roughness was measured using a Surface Roughness Tester, and data were analyzed using Welch ANOVA. All groups exhibited an increase in surface roughness after immersion. However, statistical analysis showed no significant difference among the three groups ( $p > 0.05$ ). Immersion in a 6.25% siwak effervescent tablet solution did not significantly affect the surface roughness of heat-cured acrylic resin and can be considered safe for use as a denture cleaning agent. (IJP 2025;7(1):90-93)

#### Introduction

Oral health is an integral component of general health and plays a crucial role in mastication, speech, facial aesthetics, and overall quality of life. Tooth loss remains a prevalent oral health problem worldwide and is associated with functional impairment, reduced self-confidence, and diminished social interaction.<sup>1</sup> Removable prosthodontic treatment is commonly used to restore lost teeth and rehabilitate oral function while maintaining the health of surrounding tissues.<sup>2</sup>

Heat-cured acrylic resin is the most widely used denture base material because of its favorable physical properties, acceptable aesthetics, ease of manipulation, and relatively low cost.<sup>3</sup> However, acrylic resin is susceptible to surface alterations when exposed to the oral environment. Factors such as water sorption, chemical exposure, and routine cleansing procedures may alter surface characteristics, particularly surface roughness.<sup>4</sup>

Surface roughness is a critical property of denture base materials, as increased roughness facilitates plaque accumulation, microbial adhesion, and staining.<sup>5</sup> A rough denture surface has been strongly associated with colonization by *Candida albicans*, a major etiological factor in denture stomatitis.<sup>6</sup> Consequently, denture hygiene must be maintained using cleaning agents that are both effective against microorganisms and safe for denture materials. Chemical denture cleansers, including alkaline peroxide

solutions, are widely recommended due to their ability to remove biofilm and stains.<sup>7</sup> However, repeated exposure to these agents may negatively affect the surface integrity of heat-cured acrylic resin and increase surface roughness.<sup>8</sup> This limitation has encouraged the exploration of natural or herbal-based denture cleansers with antimicrobial activity and minimal adverse effects on denture materials.

Siwak (*Salvadora persica*) is a traditional herbal material known for its antibacterial, antifungal, antiplaque, and antioxidant properties.<sup>9</sup> Phytochemical studies have identified bioactive compounds such as flavonoids, tannins, alkaloids, and terpenoids that contribute to its antimicrobial mechanisms.<sup>10</sup> Experimental evidence indicates that siwak extract at a concentration of 6.25% can inhibit the growth of *Candida albicans*, suggesting its potential as a natural denture cleanser.<sup>11</sup> Effervescent tablet formulations further offer practical advantages for denture hygiene, including ease of use, rapid dissolution, and consistent dosing.<sup>12</sup>

Despite these promising properties, limited studies have evaluated the effect of siwak-based effervescent denture cleansers on the surface characteristics of heat-cured acrylic resin. Therefore, this study aimed to evaluate the effect of immersing heat-cured acrylic resin plates in a 6.25% siwak (*Salvadora persica*) effervescent tablet solution on surface roughness, compared with alkaline peroxide solution and effervescent tablets without siwak.

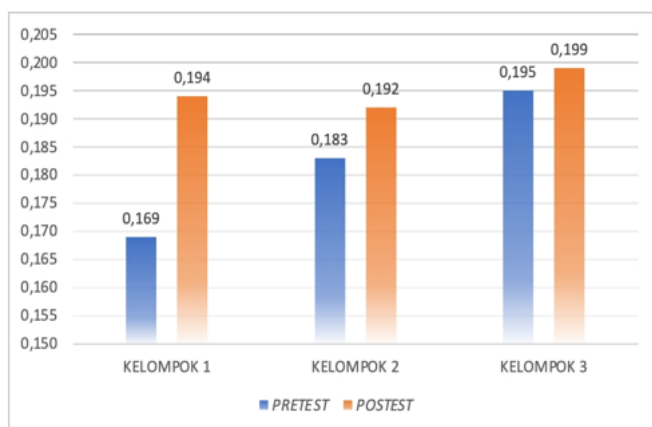
<sup>1</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Hasanuddin, Makassar, Indonesia

<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Muslim Indonesia, Makassar, Indonesia

\*Corresponding author: dharmautama@unhas.ac.id

**Table 1. Average Measurements.**

Group	Pre-test	Posttest	Difference
Group 1 (Alkaline Peroxide)	0,169	0,194	0,025
Group 2 (Effervescent Effervescent Siwak Wood)	0,183	0,192	0,009
Group 3 (Effervescent Tablet Effervescent Without Siwak)	0,195	0,199	0,004



**Figure 1. Bar Chart of Average Measurement Results.**

**Material and Methods**

This study employed a true experimental design with a pretest–posttest control group approach. The research was conducted from July to October 2025 at the Fisheries Product Technology Laboratory, Faculty of Science and Fisheries, Hasanuddin University, and the Makassar Vocational Training and Productivity Center.

A total of 27 heat-cured acrylic resin plates measuring 65×10×3.3 mm were prepared and allocated into three groups (n = 9 per group): immersion in alkaline peroxide solution (control group), immersion in a 6.25% siwak (*Salvadora persica*) effervescent tablet solution, and immersion in an effervescent tablet solution without siwak. The acrylic resin plates were fabricated using the conventional heat-curing technique and polished according to standardized procedures to obtain uniform surfaces prior to testing.

Siwak effervescent tablets were formulated using a 6.25% concentration of *Salvadora persica* extract combined with excipients including polyvinylpyrrolidone (PVP K30), citric acid, tartaric acid, and sodium bicarbonate. Effervescent tablets without siwak served as a comparative control to evaluate the effect of the herbal extract. Alkaline peroxide solution was prepared according to the manufacturer’s instructions.

All specimens were initially rinsed with distilled water to eliminate residual monomers and debris. Baseline surface roughness measurements (pretest) were obtained for each specimen using a Surface Roughness Tester. Subsequently, the

specimens were immersed in their respective solutions for 15 minutes daily at 37°C for a total duration equivalent to 8 days of cumulative immersion. After completion of the immersion protocol, final surface roughness measurements (posttest) were recorded using the same instrument and measurement parameters.

Surface roughness values were expressed in micrometers (µm). Statistical analysis was performed using SPSS software. Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was evaluated using the Levene test. Due to non-homogeneous variance, differences in surface roughness among groups were analyzed using Welch analysis of variance (ANOVA). A p-value of less than 0.05 was considered statistically significant.

**Results**

This study aimed to determine the effect of immersing heat-cured acrylic resin plates in a solution of siwak (*Salvadora persica*) effervescent tablets on surface roughness. The study was conducted at the Fisheries Product Technology Laboratory (THP) of the Faculty of Science and Fisheries, Hasanuddin University, and the Makassar Vocational Training and Productivity Center from July to October 2025. The research subjects were siwak (*Salvadora persica*) effervescent tablets, with a sample size of 27 heat-cured acrylic resin plates. The study used a pre-post test design with a control group, with data collection before and after immersion for 8 days. Surface roughness measurements were carried out using a Surface Roughness Tester at the Makassar Vocational Training and Productivity Center. The results of the average surface roughness measurements of heat-cured acrylic resin plates in groups 1, 2, and 3 are presented in the table.

Based on the table, all treatment groups showed an increase in surface roughness values after immersion. The largest increase occurred in the alkaline peroxide group at 0.025 µm, while the smallest increase was in the effervescent tablet without siwak group at 0.004 µm.

This increase indicates a change in the surface of the acrylic resin due to exposure to the cleaning solution. However, all roughness values are still below the ISO 1567 safety limit (<0.2 µm), so it can be concluded that all immersion solutions do not cause excessive surface changes or damage to the acrylic resin structure. The Levene test results showed a significance value (Sig) of 0.039, which means that the data between groups is not homogeneous (p<0.05). Nevertheless, the analysis can still be continued using the Welch ANOVA test to determine the differences in means between treatment groups.

Based on the Welch ANOVA test results, a significance value of 0.673 (p>0.05) was obtained. These results show that there are no significant differences between the three treatment groups in terms of chang-

es in the surface roughness of heat-cured acrylic resin. Therefore, the hypothesis zero ( $H_0$ ) is accepted, which means that the effervescent siwak tablet solution (6.25%) does not have a significant effect on the surface roughness of acrylic resin compared to alkaline peroxide and effervescent tablets without siwak.

## Discussion

The present study evaluated the effect of immersing heat-cured acrylic resin plates in a 6.25% siwak (*Salvadora persica*) effervescent tablet solution on surface roughness, compared with alkaline peroxide and effervescent tablets without siwak. The results demonstrated that all immersion solutions produced an increase in surface roughness; however, no statistically significant differences were observed among the three groups. Similar findings have been reported in previous studies evaluating the influence of chemical denture cleansers on acrylic resin surface properties.<sup>8</sup> This finding indicates that the incorporation of siwak extract at a concentration of 6.25% in an effervescent tablet formulation does not adversely affect the surface integrity of heat-cured acrylic resin.

The observed increase in surface roughness across all groups may be attributed to the hydrophilic nature of polymethyl methacrylate (PMMA), which allows water absorption and facilitates diffusion of cleaning solution components into the polymer matrix.<sup>4</sup> Water sorption can induce plasticization of the resin, weakening intermolecular forces and resulting in minor surface alterations. Similar mechanisms have been described in studies examining hydrolytic degradation and hygroscopic behavior of dental polymer networks.

The alkaline peroxide group exhibited the greatest increase in surface roughness among the tested solutions. This outcome may be explained by the oxidative mechanism of alkaline peroxide cleansers, which generate reactive oxygen species capable of disrupting polymer chains within acrylic resin materials.<sup>13</sup> Although alkaline peroxide solutions are effective in removing stains and biofilm, repeated exposure has been associated with increased surface roughness and material degradation, potentially compromising long-term denture performance.<sup>8</sup>

In contrast, immersion in the 6.25% siwak effervescent tablet solution resulted in a relatively small increase in surface roughness. The bioactive compounds present in siwak, including flavonoids, tannins, alkaloids, and terpenoids, exhibit antimicrobial activity without strong oxidative or abrasive effects on polymer surfaces.<sup>14</sup> Experimental evidence indicates that siwak extract at a concentration of 6.25% is effective in inhibiting *Candida albicans*, supporting its use as a natural denture cleanser with minimal impact on acrylic resin surface integrity.<sup>11</sup>

The effervescent tablet solution without siwak produced the smallest change in surface roughness.

The cleansing action of this formulation is primarily mechanical, driven by the release of carbon dioxide bubbles that assist in detaching debris and plaque from denture surfaces.<sup>12</sup> However, the absence of bioactive antimicrobial compounds may limit its effectiveness in controlling microbial colonization compared with herbal-based formulations containing siwak.<sup>11</sup>

Importantly, although surface roughness increased in all groups, the post-immersion values remained below the clinically accepted threshold for acrylic resin materials, which is considered critical for preventing bacterial plaque retention and denture-related stomatitis.<sup>15</sup> This finding indicates that none of the tested solutions caused surface changes likely to compromise denture hygiene or clinical performance.

This study has several limitations. Only one physical property, surface roughness, was evaluated, and the immersion protocol simulated cumulative short-term use rather than long-term clinical conditions. In addition, microstructural changes were not assessed using advanced imaging techniques such as scanning electron microscopy, which may provide further insight into surface degradation mechanisms.<sup>8</sup> Future studies should investigate additional physical and mechanical properties, evaluate different concentrations of siwak extract, and incorporate longer immersion periods to better represent clinical denture use.

Overall, the findings of this study support the potential use of siwak-based effervescent tablets as a natural denture cleaning agent that does not significantly alter the surface roughness of heat-cured acrylic resin.

## Conclusion

Immersion of heat-cured acrylic resin plates in a 6.25% siwak (*Salvadora persica*) effervescent tablet solution resulted in a slight increase in surface roughness; however, the change was not statistically significant when compared with alkaline peroxide solution and effervescent tablets without siwak. All post-immersion surface roughness values remained within clinically acceptable limits. These findings indicate that siwak-based effervescent tablets can be considered a safe alternative denture cleaning agent for heat-cured acrylic resin with respect to surface roughness.

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ORIGINAL ARTICLE

**Correlation between length of usage and temporomandibular disorder presence in complete denture patient**

Noorfatika Titi Seroja,<sup>1\*</sup> Ricca Chairunnisa<sup>2</sup>

**ABSTRACT**

**Keywords:** Complete denture, Etiology, Length of use, Risk, Temporomandibular disorder

The aim of this study was to see if there was a correlation between the length of usage and the presence of TMD in patients wearing CD at Dental Hospital of North Sumatra University. This study is analytic observational with a cross-sectional design and a sample size of 50 subjects. The samples were separated based on the length of use, which was 12, 18 and 24 months. The FAI was used in interviews, while the DI was used in clinical tests. Subjects were interviewed using the TMD Etiology Index questionnaire to determine the level risk. The findings revealed that the prevalence of TMD risk based on duration of use showed at 12 month group with low risk, followed by 18 months and 24 months who experienced high risk. The results also revealed that the prevalence of TMD status based on duration of use at 12 months without TMD, followed by 18 months and 24 months. The Chi-Square test yielded a value of  $p = 0.0001$  ( $p < 0.05$ ) based on the results of statistical tests evaluating the correlation between duration of usage and TMD status, indicating that there is a correlation between duration of use and TMD status and the highest results were found at 24 months of use of 85.7%. (IJP 2025;7(1):94-97)

**Introduction**

Temporomandibular disorder (TMD), is a disorder that not only involves the temporomandibular joint but also involves the masticatory muscles and related structures.<sup>1</sup> The etiology of temporomandibular disorder is multifactorial and is still difficult to determine precisely. The Etiology Index Questionnaire for TMD is an index that is easy, simple, and accurate in determining the etiology of temporomandibular disorder.<sup>2</sup> A complete denture (CD) is not good enough if there is poor stability and retention or a loss of vertical dimension. Loss of vertical dimension can occur due to poor fabrication or use of the denture. This can compromise the stomatognathic system as loss of vertical dimension can be exacerbated by long-term use of an inadequate denture. Prolonged wear of a complete denture can cause wear on the denture.<sup>3</sup> Excessive pressure over a long period of time on the temporomandibular joint can result in adaptive and degenerative changes in the joint.<sup>4</sup> Several studies state that excessive masticatory loads will cause occlusal imbalances thereby increasing the possibility of temporomandibular disorder. Dentists must combine various examinations to be able to determine the diagnosis and provide appropriate treatment for the temporomandibular disorder. Based on these problems, this study aims to determine the risk and status of temporomandibular disorder in patients wearing complete dentures in terms of the duration of use.

**Material and Methods**

This observational analytical study conducted at the Dental and Oral Hospital of North Sumatera University employed a cross-sectional design with a sample population of 50 individuals selected through purposive sampling. Participants were divided based on the duration of complete denture use (12, 18, and 24 months). The study, approved by the Research Ethics Committee of Universitas Sumatera Utara, utilized the Fonseca Anamnestic Index and Etiology Index Questionnaire for TMD for data collection through interviews and clinical examinations.

The Fonseca Anamnestic Index comprised 10 questions with three response options, categorizing individuals into absence of TMD, mild TMD, moderate TMD, and severe TMD. The Etiology Index Questionnaire assessed gender, bad habits, emotional stress, and freeway space. Each component had specific codes and scores, determining the overall index score. A high index score ( $\geq 7$ ) indicated a high risk of developing temporomandibular disorders (TMD), while a low score ( $< 7$ ) suggested a low risk. Data analysis employed the Chi-Square test with a significance level of  $p < 0.05$  to examine the correlation between the duration of complete denture use and TMD status in patients.

<sup>1</sup>Specialist Program in Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia  
<sup>2</sup>Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia

\*Corresponding author: noorfatikats@gmail.com

**Table 1. Subjects' risks with Etiology Index Questionnaire for TMD based on duration of use.**

Duration of Use	TMD Risk				Total	
	Low		High		n	%
	n	%	n	%		
12 month	15	100	0	0	15	100,0
18 month	10	47,6	11	52,4	21	100,0
24 month	0	0	14	100	14	100,0

**Table 2. Distribution of subjects' answers regarding bad habits and emotional stress of the Etiology Index Questionnaire for TMD.**

	No		Sometimes		Yes	
	n	%	n	%	n	%
<b>Bad habits</b>						
Do you chew on one side of your jaw?	1	2	27	57	22	75
Do you have a habit of biting your nails?	41	82	10	20	0	0
Do you have a habit of biting hard objects, for example: sewing needles, pencils, etc	50	100	0	0	0	0
Do you like chewing gum?	30	60	20	40	0	0
Do you like propping your chin up?	31	62	19	38	0	0
Do you like sucking the cheeks?	46	92	4	8	0	0
Do you have a habit of sleeping on one side only?	0	0	25	50	50	100
Do you like to move your lower jaw without making contact with your teeth (jaw play)?	44	88	6	12	0	0
Do you like to bite your upper lip?	33	66	17	34	0	0
Do you like to bite your lower lip?	27	54	21	42	0	0
Do you like sucking the tongue?	49	98	1	2	2	4
Do you like to suck tongue and cheek simultaneously?	50	100	0	0	0	0
Do you have a habit of playing with dental appliances or dentures in your mouth?	39	78	11	22	0	0
When you breathe is your mouth open?	10	20	14	28	26	56
Do you like to snore when you are sleeping?	26	52	14	28	10	20
Are you sleepy during the day?	2	4	14	28	34	68
Do you like to grind your upper and lower teeth loudly during the day?	45	90	4	8	1	2
Do you like to grind your upper and lower teeth loudly at night?	39	78	10	20	1	2
Do you like to move your lower jaw when your teeth contact during the day?	46	92	3	6	1	2
Do you like to move your lower jaw when your teeth contact at night?	40	80	9	18	1	2
Does your bed partner often complain you move your lower jaw causing loud noise while sleeping?	46	92	3	6	1	2
<b>Emotional stress</b>						
Do you feel sad if something unexpected happened?	6	12	37	74	7	14
Do you feel weak or off balance?	6	12	44	88	0	0
Are you feeling excessively worried?	9	18	27	54	14	28
Do you feel a lack of energy or a setback?	32	64	18	36	0	0
Do you blame yourself?	22	44	28	56	0	0
Do you cry easily?	7	14	28	56	15	30
Do you feel lonely?	5	10	10	20	35	70
Do you feel that you are not interested in anything?	27	54	22	44	1	2
Are you feeling hopeless for the future?	46	92	4	8	0	0
Do you feel like you can't control the important things in your life?	36	72	13	26	1	2
Do you feel nervous, confused and stressed?	10	20	39	78	1	2
Do you feel that there is something missing from you?	42	84	8	16	0	0
Do you find that you can't cope with the things that need to be done?	31	62	19	38	0	0
Are you angry if something happened beyond your control?	5	10	8	16	37	74
Do you find it very difficult to deal with something that you can not overcome?	13	26	25	50	12	24
Do you find everything difficult?	21	42	25	50	4	8
Do you feel worthless?	42	84	6	12	2	4
Do you feel guilty?	28	56	7	14	15	30

**Table 3. Distribution of total scores of etiology index questionnaire for TMD.**

Etiology		n	%
Sex	Male	12	48
	Female	38	52
Stress	Yes	32	64
	No	18	36
Bad habits	Yes	12	24
	No	38	76
Free way space	2-4mm	28	56
	<2mm or >4mm	22	44

**Results**

The results showed that a total of 25 subjects (50%) had a low risk of TMD, while 25 other subjects (50%) had a high risk of TMD with the highest prevalence on 24

month (100%), followed by 18 month (52,4%) and 12 month none were at high risk of temporomandibular joint disorder, as shown in table 1. On the bad habits component, 22 subjects (44%) often chew on one side of the jaw and 25 subjects (50%) have a habit of sleeping on one side only. On the emotional stress component, 35 subjects (70%) often feeling lonely and 37 subjects (74%) often feel angry if something happens beyond their control table 2. In this study, for gender distribution, there were 38 (76%) women and 12 men (24%). On the freeway space component, 28 subjects (56%) have 2-4mm freeway space and 22 (44%) have <2mm or >4mm freeway space table 3. The results of the study also showed that 33 subjects (66%) had TMD, while 17 other subjects (34%) did not have TMD where-in the highest prevalence were 18 month (42%), followed by 24 month (24%) and 12 month none have TMD table 4. The common signs and symptoms found in the subjects are difficult to open mouth widely (46%), tiredness when they are chewing (8%) and frequent headaches (8%) table 5. Based on the results of statistical tests that were analyzed using the Chi-Square test, a value of p=0.0001 (p<0.05) was obtained, which means that there was correlation between the duration of use and status of TMD table 4.

**Discussion**

The results showed that 44% subjects have bad habits of chewing on one side of the jaw. Panjaitan Y (2016) recorded 75% of complete denture wearers like to chew on one side only. Ved (2017) recorded that 56 patients (57.7%) out of 97 subjects that like to chew on one side, had temporomandibular disorder. 14% subjects also often feel sad if something unexpected happened and 74% subjects often feel angry if something happens beyond their control. Patil S (2016) recorded 60% patients with temporomandibular disorder experience stress and depression. Habib et al. (2015) also recorded that almost a third of research subjects had a history of emotional stress, and 57.8% of them were classified as experiencing mild to severe degrees of TMD. This research showed that 56% subjects have 2-4mm freeway space and 22% subjects have <2mm or >4mm freeway space. This is consistent with research conducted by Oliveira F et al. (2021) who recorded 35 complete denture patients (70%) had normal vertical dimensions, and another 15 patients (30%) had abnormal vertical dimensions and also supported by research conducted by Galvão (2020), out of 60 subjects with normal vertical dimensions, 32 people (53.3%) did not have temporomandibular disorder. A total of 25 subjects (50%) had a low risk of TMD, while 25 other subjects (50%) had a high risk of TMD with the highest prevalence on 24 month (100%), followed by 18 month (52,4%) and 12 month none were at high risk.

The common signs and symptoms found in the subjects are difficult to open mouth widely (46%),

**Table 4. Chi Square test for correlation between duration of use and the status of TMD.**

Duration of Use	TMD Status				Total		P
	Not Present		Present		n	%	
	n	%	n	%			
12 month	15	100	0	0	15	100,0	0,00001
18 month	0	0	21	100	21	100,0	
24 month	2	14,3	12	85,7	14	100,0	

**Table 5. Distribution of subjects' answers based on Fonseca Anamnestic Index and Dysfunction Index.**

Questions	No		Sometimes		Yes	
	n	%	n	%	n	%
<b>Fonseca Anamnestic Index</b>						
Do you have difficulty opening your mouth wide?	9	18	18	36	23	46
Do you consider yourself a tense (nervous) person?	17	34	32	64	1	2
Do you have difficulty moving your jaw to the sides?	35	70	14	28	1	2
Do you feel fatigue or muscle pain when you chew?	3	6	43	86	4	8
Do you have frequent headaches?	13	26	33	66	4	8
Do you have neck pain or a stiff neck?	48	96	2	4	0	0
Do you have ear aches or pain in that area (TMJ)?	50	100	0	0	0	0
Have you ever noticed any noise in your TMJ while chewing or opening your mouth?	50	100	0	0	0	0
Do you have any habits such as clenching or grinding your teeth?	25	50	24	48	1	2
Do you feel that your teeth do not come together well?	43	86	6	12	1	2
<b>Dysfunction Index</b>						
Symptom Impaired range of movement					n	%
Criteria						
- Normal range of movement					0	28
- Slightly impaired mobility					1	19
- Severe impaired mobility					5	3
Symptom Impaired TMJ function						
Criteria						
- Smooth movement without joint sounds and deviation					0	38
- Joint sounds in one or both joints and deviation					1	12
- Locking or luxation of joint					5	0
Symptom Muscle pain						
Criteria						
- No tenderness to palpation					0	44
- Tenderness to palpation in 1-3 sites					1	6
- Tenderness to palpation in 4 or more sites					5	0
Symptom TMJ pain						
Criteria						
- No tenderness to palpation					0	17
- Tenderness to palpation					1	33
- Tenderness to the back side of palpation					5	0
Symptom Pain on movement of the mandible						
Criteria						
- No pain on movements					0	45
- Pain on 1 movement					1	5
- Pain on 2 or more movements					5	0

tiredness when they are chewing (8%), frequent headaches (8%), and muscle pain (12%). This finding is consistent with Jandial S et al's (2017) that stated the most common signs and symptoms of temporomandibular disorder in patients wearing complete dentures were joint pain and limitations (34.5%), muscle fatigue during mastication (17%), and muscle pain (14.5%). Based on the duration of use there was 33 subjects (66%) had TMD, while other 17 subjects (34%) did not have TMD wherein the highest prevalence were 18 month (42%), followed by 24 month (24%) and 12 month none have TMD. This is in line with study conducted by Khalid et al. (2016), the longer a complete denture is used, the denture will experience wear. As a result of wear on the denture, the patient can experience an imbalance in occlusal force distribution due to abrasion of the posterior teeth and attrition of the anterior teeth. Abrasion of the posterior teeth can occur

due to food while attrition of the anterior teeth can occur due to friction or tooth-to-tooth contact. Patients who use a complete denture also often experience discomfort in its use such as pain in the joints and irritation of the mucosa. Joint pain is usually felt when opening and closing the mouth, which is the highest prevalence of TMD in patients wearing a complete denture.<sup>10</sup>

Several factors can also be triggers, contributors, or perpetrators of temporomandibular joint disorders including dysfunctional habits, reduction in vertical dimensions due to tooth loss, old dentures or habits of not wearing a denture during the day, not removing the denture while sleeping, lack of stabilization and retention of the denture and psychological factors. Dysfunctional habits can cause damage to the masticatory structure, teeth, periodontium tissue and temporomandibular joint and are closely related to the occurrence of temporomandibular joint disorders. In this study, the most likely factors that play a role in temporomandibular disorder are bad habits and emotional stress. This study showed that most subjects have bad habits of chewing on one side of the jaw and a habit of sleeping on one side only. Shofi (2014) states that people who have a bad habit of chewing on one side tend to have temporomandibular disorder because the habit of chewing on one side can cause additional pressure on the masticatory muscles and cause muscle spasms, causing pain and joint disorders.<sup>11</sup> Study conducted by Yalçinkaya E. (2019) also states that body and head posture during sleep play an important role in the etiology of temporomandibular disorder because continuous changes in craniocervical posture can cause changes in mandibular position. Emotional stress can also cause temporomandibular disorder. In this study, most of the subjects often felt sad if something unexpected happened and were often angry if something happened out of control.<sup>12</sup> Husada (2019) states that severe stress can cause changes in the body which are basically preparing the body's muscles (including temporomandibular muscles) to face any form of threat or burden that exceeds their normal capabilities. Changes in the muscles are in the form of an increase in muscle activity (hyperactivity).<sup>13</sup>

A state of hyperactivity that lasts for a long time or continuously will trigger muscle fatigue which will be followed by muscle spasms. This muscle spasm will then trigger the occurrence of an imbalance in the distribution of loads or excessive loading on the joints, which will cause disruption and even further damage to the temporomandibular joint or the surrounding area. There are also other factors that can influence the occurrence of temporomandibular disorder. Women tend to experience muscle pain in the neck, arms, shoulders and upper body, while men generally tend to experience more muscle pain in the back and lower body. The role of female sex hormones in pathogenesis of temporomandibular disorder has indicated that excessive exoge-

nous ovarian hormones can put women at risk for temporomandibular disorder. In addition, the vertical dimension also plays an important role in the temporomandibular joint. Loss of vertical dimension will cause the mandible to shift from its actual centric relation and into a continuous centric position. The occurrence of differences in vertical dimensions due to the absence of teeth has an impact on the mechanism of the temporomandibular joint which can result in disruption of the temporomandibular joint. Based on the results, there is correlation between duration of use and status of TMD, this is because the occurrence of temporomandibular joint disorders is multifactorial which includes physical risk factors, occlusal disharmony, psychosocial problems and the presence of systemic diseases. Therefore, the relationship between complete denture wear and temporomandibular joint disorders can occur due to various factors, such as improper denture design or clinical wear can initiate temporomandibular joint disorders after several years of use.

### Conclusion

Based on the results of this study, there is a relationship between the length of use and the status of temporomandibular joint disorders in patients wearing complete dentures at Dental Hospital Universitas Sumatera Utara where the results of the study found the highest temporomandibular joint disorders in the length of use of 24 months (85.7%), this is based on occlusal wear that occurs in complete dentures after long use. There are several factors that contribute to the occurrence of temporomandibular joint disorders, namely bad habits, stress and vertical dimensions that can be measured on the Temporomandibular Joint Disorder Etiology Index questionnaire.

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1. The manuscript, written in English. Non-medical foreign terms are used only when necessary and are provided with its translation. Indonesian Journal of Prostodontics also publishes articles written in academic English.
2. Manuscripts including tables, references and figure legends must be typewritten (double-spaced) using *Microsoft Word* on 210 x 297 mm or size A4 paper with margins of 3 cm. The maximum number of pages is 20.
3. The Editor reserves the right to edit the manuscript at her discretion, without changing the meaning, to articles accepted for publication.
4. The author is responsible for the contents of the article.
5. When the article is accepted for publication, the author must subscribe to Indonesian Journal of Prostodontics for, at least, one year and bear the printing cost of the accepted manuscript.

### Systematic order of the manuscript

1. Based on the type of the article, the submitted manuscript should be arranged in the following order:
  - a. Research article: abstract, introduction, materials and method, results, discussion, conclusion and suggestions, and references.
  - b. Case report: abstract, introduction, case report with pre- and post-study picture, discussion, conclusion and suggestion, and references.
  - c. Literature review: abstract, introduction, literature studies, discussion, conclusion, suggestion, and references.
2. Title of article should be brief, concise, informative, not exceeding 20 words, followed by authors' name (omit title), institution, address, contact number, fax and *email*.
3. Abstract is written in English, one-spaced, not exceeding 200 words and should briefly reflect the contents of the article:
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4. References follow the Vancouver Style (*Uniform requirements for manuscript submitted to biomedical journals*). References should be numbered consecutively with arabic number in the order in which they appear in the manuscript. No more than six authors should be listed. If there are more than six names, they are followed by 'et al'. Abbreviations of journals name follow *index medicus*. All references mentioned refer to only the sources quoted in the article.

### Examples of references:

#### a. Journal article

Rose ME, Huerbin MB, Melick J, Marion DW, Palmer AM, Schiding JK, et al. Regulation of interstitial excitatory amino acid concentrations after cortical injury. *Brain Res.* 2002; 935 (1-2): 40-6.

#### b. Book (chapter author)

McGlumphy EA. Implant-supported fixed prostheses. In: Rosenstiel SF, Land MF, Fujimoto J, editors. *Contemporary fixed prosthodontics*. 3<sup>rd</sup> ed. St. Louis: Mosby, Inc.; 2001. p.313-9.

#### Book (editor as the author)

Gilstrap LC, Cunnigham FG, van Dorsten JP, editors. *Operative obstetrics*. 2<sup>nd</sup>ed. New York: McGraw-Hill; 2002.

#### c. Seminar/conference paper

Isaac DH. Engineering aspects of the structure and properties of polymer-fibre composites. In: Vallittu PK, editor. *Symposium book of the European Prostodontic Association (EPA) 22<sup>nd</sup> annual conference; 1998 August 27-29; Turku, Finlandia*. Turku: Department of Prosthetic Dentistry & Biomaterials Project, Institute of Dentistry, University of Turku; 1998. p. 1-12.

#### d. Conference proceeding

Harnden P, Joffe JK, Jones H, editors. *Germ cell tumours V. Proceedings of the 5<sup>th</sup> Germ Cell Tumour Conference; 2001 Sep 13-15; Leeds, UK*. New York: Springer; 2002.

#### e. Translated article

Zarb GA, Bolender CL, Hickey JC, Carlsson GE. *Buku Ajar prostodonti untuk pasien tak bergigi menurut Boucher*. Ed.10. Alih bahasa: Mardjono D. Jakarta: EGC; 2001. p.288-90, 333-7.

#### f. Dissertation/thesis

Barkowski MM. *Infant sleep and feeding: a telephone survey of Hispanic Americans [dissertation]*. Mount Pleasant (MI): Central Michigan University; 2002.

#### g. Dictionary / reference books

Dorland's illustrated medical dictionary. 29<sup>th</sup> ed. Philadelphia: W.B.Saunders; 2000. Filamin; p. 675.

#### h. Article journal in electronic format

Abood S. Quality improvement initiative in nursing homes: the ANA acts in an advisory rle. *Am J Nurs [serial on the Internet]* 2002 Jun [cited 2002 Aug 12]; 102 (6): about 3 p.]. Available from: URL: <http://www.nursingworld.org/AJN/2002/june/Wawatch.htm>.

#### i. Homepage/Web site

Foley KM, Gelband H, editors. *Improving palliative care for cancer [monograph on the Internet]*. Washington: National Academy Press; 2001 [cited 2002 Jul 9]. Available from: URL: <http://www.nap.edu/books/030974029/html>