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CASE REPORT

Semirigid fixed bridge management with nonvital abutment and narrowed space

Delivia[1], Ira Tanti[2*]

Keywords: Fixed partial denture, Non-rigid connector, Non-vital abutment, Pier abutment

ABSTRACT

The prevalence of partial edentulism in adults underscores the increasing demand for tooth replacement options. Fixed partial dentures (FPDs) are widely accepted for this purpose. FPD success hinges on factors such as abutment condition, retainer, connector type, pontic design, and edentulous span. A five-unit fixed bridge with a pier abutment requires a non-rigid connector to enhance prosthetic longevity. Moreover, narrowed spaces require more attention. Analysis and diagnostic wax-up are needed for treatment planning. This case presenting the management of a five-unit semirigid fixed bridge with a non-vital pier abutment and narrow space using diagnostic wax-ups. A 62-year-old woman presented with a missing right mandibular first premolar and first molar, with the right mandibular canine and second molar serving as terminal abutments, and a non-vital second premolar serving as a pier abutment. The space between the canine and non-vital second premolar is narrower than normal. Analysis and diagnostic wax-up were done to ensure the space is enough and to avoid excessive reduction, mainly the canine, as it is a vital tooth. The non-vital pier abutment, which has been endodontically treated before, was strengthened with a fiber post. Continued with tooth preparation and fabrication of a five-unit porcelain fused to metal semi-rigid fixed bridge. The design of FPD plays an important role in the success of FPDs. The edentulous span and non-vital pier abutments require more attention; also, non-rigid connectors act as stress breakers to maintain the longevity of all components of FPDs. (IJP 2025;6(2):86-91)

Introduction

The loss of teeth in an individual can disrupt both functional and aesthetic aspects. The long-term loss of teeth without replacement has significant consequences. Adjacent and opposing teeth may migrate, resulting in the edentulous space becoming smaller or larger than before. This can impact prosthesis fabrication, as there may not be enough space to replace the missing teeth adequately.[1]

There are several ways to replace missing teeth. Fixed partial dentures, in the form of bridges, are one way to manage the missing teeth. This type of prosthesis is often chosen by patients for its comfort and simplicity compared to implant-supported prostheses, which require a surgical process. The success of bridge prostheses is influenced by several factors, including the condition of the abutment teeth, connectors, pontics, and the edentulous space.[2]

Most of bridge prostheses are typically constructed using rigid connectors. However there are several cases when non-rigid connectors are often recommended. In some cases of tooth loss, there are situations involving pier abutments. According to The Glossary of Prosthodontic Terms, a pier abutment, also known as an intermediate abutment, is a natural tooth or implant abutment located between terminal abutments, which serves to support fixed or removable prostheses.[3,4] For example, the second premolar becomes a pier abutment when the first premolar and first molar are missing, while the canine and second molar remain. In such cases, the success of the prosthesis and stress distribution depends on both the pier and terminal abutments.[4]

In the case with the presence of pier abutment, the use of rigid connectors may cause the bridge prosthesis to detach from the abutments, and the pier abutment acting as a fulcrum. Additionally, the stress distribution with non-rigid connectors can prolong the lifespan of the bridge prosthesis.[4] Apart from connectors, the condition of the abutment teeth also requires attention and consideration. Abutment teeth that have lost structure or are non-vital require special attention to be included in the fixed prosthesis.

This case report illustrates the management of a five-unit semirigid fixed bridge with a non-vital pier abutment and narrow edentulous space, emphasizing the utilization of diagnostic wax-up and the significance of non-rigid connectors in the presence of pier abutment.

Case Report

A 62-year-old female patient presented at Department of Prosthodontics, dental hospital, Faculty of Dentistry, Universitas Indonesia, with complaints of missing teeth in lower right jaw, causing discomfort and noticeable gaps during chewing. The patient sought

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Figure 1. **Pre-op intraoral photograph**

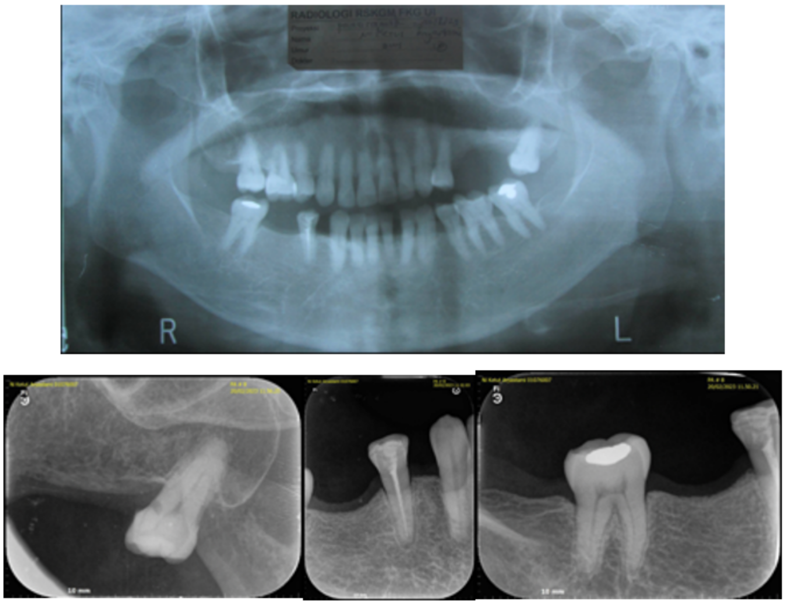

Figure 2. **A. Panoramic x-ray, B. Dental x-ray**

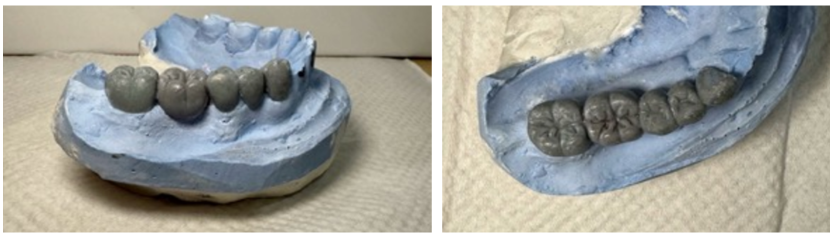

Figure 3. **Diagnostic wax up**

Figure 4. **Temporary restoration**

treatment to improve both function and appearance through denture fabrication. Upon examination, the patient was not undergoing any medical treatment, had never worn dentures before, also revealed moderate oral hygiene with calculus and stains. There was a stable bite with cuspid-protected articulation on both sides, and the patient reported no bad habits. Several teeth were missing, including 25, 26, 27, 44, and 46, with composite filling on 28, amalgam filling on 37 and 47, and endodontic treatment on 45 with composite restoration. Tori mandibular was present both on the right and left sides. Radiographic assessments were performed to complete the examination. After careful examination, thé treatment plan for the patient included a partial denture to rehabilitate the upper jaw, and semirigid fixed bridge with porcelain fused to metal retainer crown on tooth 43, partially veneered with occlusal metal on tooth 47, and dowel crown with pre-fabricated fiber post on tooth 45. The selection of nonrigid connector over rigid ones was justified, particularly due to the presence of a pier abutment, causing the need to minimize stress concentration.

The step-by-step clinical procedure for rehabilitating the lower jaw includes the following: a) fabrication of diagnostic wax-ups b) Dowel crown on tooth 45: preparation of the crown, removal of gutta-percha, preparation and cementation of fiber post. This is followed by preparation of tooth 43 and 47, impression with rubber base materials, and fabrication of temporary restorations. c) Fabrication of the metal coping with non-rigid connectors in the laboratory, followed by trying them in the patient's mouth, as well as color match for facing porcelain. d) Returning to the laboratory for fabrication of facing porcelain and insertion of the restoration.

The non-vital tooth 45, which had undergone endodontic treatment exhibited no complaints. As planned, a dowel crown with pre-fabricated fiber post and partial compostite core was placed. As a study by Sorensen and Martinoff found that 94% of endodontically treated posterior teeth that received coronal coverage were successful.[5] Pre-fabricated fiber posts were preferred for their similarity to dentin in elastic moduli, aiding in stress distribution. The preparation of root canal could be minimize compared to cast posts, since extensive of root canal preparation can increase the risk of tooth fracture. Non-vital teeth with tapered customs post fail more frequently when used as abutments.[6,7] Dowel crown with pre-fabricated fiber post was done on this tooth,

During abutment teeth preparation, parallelism was carefully checked, especially for teeth 43 and 45, given their involvement in a three-unit fixed bridge. The treatment plan also considered the narrow edentulous area resulting from tooth loss that has been left

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Figure 5. **Working cast**

Figure 6. **Metal coping with nonrigid connector**

Figure 7. **Try in of metal coping**

empty for quiet a long time. This condition can affect the adjacent teeth's migration to mesial or distal, and extrusion. Narrow space may interfere the aesthetic and functional aspects, and fabrication could be more complicated. To address this issue, several alternatives were considered, including diagnostic wax-up procedures, orthodontic treatment, increasing the proximal contour of tooth, and creating a smaller pontic size.[8,9] After discussion with the patient and several considerations, she did not want to undergo on orthodontic treatment. For alternatives, diagnostic wax-up was chosen and during the fabrication of diagnostic wax-ups, the narrow space could not accommodate an ideal size of pontic. The pontic was created smaller in order to fit the space, aesthetic aspect was sacrified but still acceptable. To accommodate the space, the planning was to reduce the mesial side of tooth 45 more than 43, as it is a vital tooth.

Following the diagnostic wax up, silicone index made from putty (rubber base) were created for guidance and temporary restorations. The subsequent clinical procedure involved the preparation of abutment teeth. Amalgam restoration on tooth 47 were replaced with composite restoration. After evaluating the preparations, working casts were made using rubber base material and the double impression technique. Provisional restorations were fabricated using tooth-colored bis-acryl materials and cemented with non eugenol temporary cement. The working casts were mounted on the articulator using interocclusal record and sent to the laboratory. In this step, the laboratory work consisted of fabricating metal copings with nonrigid connectors.

The replacement of amalgam with composite on tooth 47 aimed to prevent galvanic reactions that occur when dissimilar alloys or metals are placed in direct contact within the oral cavity.[10] To achieve adequate preparation of supporting teeth, Goodacare et al suggest a reduction of 0.5 – 1 mm for metal and 2 mm reduction for porcelain fused to metal. Due to the minimal occlusal space of tooth 47 caused by the extruded antagonist tooth, intentional endodontic treatment was avoided. After careful consideration, partial veneering with occlusal metal was performed for this tooth.[11,12]

At the next appointment, the metal coping with nonrigid connector was tried on the patient. The anterior segment with the key was inserted first, followed by the posterior segment with the keyway on the mesial side of the pontic. Individual unit try-ins were also performed to verify proper seating, retentiveness, and margin fitness. During this step, evaluation of space

Figure 8. Insertion and cementation

Figure 9. Try in of denture frame

Figure 10. Post-op intraoral photgraph

for porcelain was also conducted, except for the occlusal space for tooth 47, as it is planned to be occlusal metal. Tooth color was determined using shade guide to achieve a natural color. Provisional restorations were re-cemented and the metal coping was sent back to the laboratory for porcelain facing fabrication. Facing porcelain fabrication was completed in the laboratory.

The next visit aimed to cement the restorations using temporary non-eugenol cement. However, before cementation, the final restorations were checked for the retentivess, margin fitness, color match, as well as occlusion and articulation to ensure proper distribution. Once it was confirmed that the restorations were in good condition, cementation proceeded with anterior segment being cemented first, followed by the posterior segment. Any excess cement was removed, and the patient received instruction to maintaining proper oral hygiene.

After approximately 7 days, an evaluation of the restoration was conducted. The patient reported no complaints, felt comfortable, and could chew on the right side comfortably. The restorations were check objectively for any trapped food, and the gingival margin was inspected. After removing the restorations, the edentulous area was examined for any signs of redness. Once everything was ensured, permanent cementation was carried out using luting lass ionomer cement, following the same procedure as before.

At this stage, an impression of the upper jaw was also made taken to fabricate the metal frame denture. The major connector for the denture was a palatal strap, with akers clasps on tooth 24 and 28, and double akers clasps on tooth 16 and 15. At the next appointment, the denture frame was tried on the patient to evaluate the retentiveness and adaptiveness, and a bite registration was performed using a bite rim. The cast then mounted on the articulator according to the bite registration. Similarly to the lower jaw, the edentulous space was narrowed to accommodate only tooth 26 and 27. Evaluation of the denture wax was conducted, followed by gum cuff formation, packing and polishing of the denture. During insertion, occlusion and articulation was checked, and patient received instructions on maintaining proper oral hygiene and cleaning the denture thoroughly.

While fabrication of fixed partial denture using rigid connectors is generally preferred due to the rigidity of the connection between pontic and retainers, providing desirable strength and stability to the prosthesis while minimizing the stresses associated with the restoration, there are cases where nonrigid connectors are indicated. Nonrigid connectors are particularly indicated in cases of pier abutments, promoting a fulcrum-like condition, or in the presence of malaligned abutments where achieving parallelism requires extensive preparation. They are also recommended for long-span fixed partial dentures in the mandibular arch consisting of both anterior and posterior segments.[2] The advantages of using nonrigid connectors include their ability to act as stress breakers and transmit masticatory stress along the axis of abutment tooth, transferring it to the supporting bone rather than concentrating it in the connectors. However, the use of nonrigid connectors also increases laboratory work time and expense.[13,14]

Since there's a pier abutment in this case, a nonrigid connector could break the stress posterior to the pier abutment, allowing so the posterior and anterior units to move independently. Conversly, flexion in the mesiodistal direction caused by splinting of rigid connector can result in the failure of fixed prosthesis due to excessive loading on the surface of the abutment tooth.[15]

There are several types of nonrigid connectors, such as dove-tail or key-keyway or Tenon Mortise, loop connectors, split pontic, and cross-pin and wing. Key-keyway connectors are identified as the most common type. There is some conflicting opinion regarding the placement of nonrigid connectors. Markley suggested placing the connector on one of the terminal abutments rather than on the pier abutment, while Adams and Gill suggested the opposite, which is to place it on the pier abutment. According to Shihlingburg, the ideal placement for this connector is on the middle abutments or the distal aspect of the pier abutment to reduce stress concentration. Additionally, placing the connector on either of the terminal abutments could result in the pontic acting as a lever and the middle abutment functioning as a fulcrum. This statement is supported by a finite element study by Oruc et al.[5,16,17] A study showed that nearly 98% of the posterior teeth, when subjected to occlusal forces, tilted mesially. Placing the keyway on the distal side of the pier abutment securely seats the key into the keyway with any mesial movement.[18,19] In this case, the nonrigid connector was placed within the pontic of first molar and distal side of pier abutment, avoided overcontouring, which is a common problem associated with the use of extracoronal attachment.

In accordance with the diagnostic wax up,the pontic on tooth 44 is smaller, it sacrificing some esthetic aspects but still deemed acceptable. In this case, both pontics both 44 and 46 are designed as modified ridge lap pontics. The modified ridge lap pontic combines aesthetic features with ease of cleaning. The facial side of this pontic overlaps the ridge on the facial side to achieve the appearance of the tooth emerging from the gingiva, while the lingual side remains clear of the ridge for hygiene purposes.[20]

Conclusion

The design of fixed-partial-denture is crucial for their long-term success. While fabrication of fixed partial denture is generally preferred, certain factors such as the presence of pier abutments may necessitate alternatives approaches. The incorporation of nonrigid connectors as stress breakers is particularly significant for the longevity of dentures. Additionally, attention must be paid to factors such as the edentulous span and the condition of non-vital abutments to ensure the durability of the prosthesis. In cases where a narrow edentulous span is present, treatment complexity may increase, potentially leading to compromises in aesthetic aspects, as observed in this study. Thorough examination is essential for determining the viability of nonvital abutments, and the use of pre-fabricated fiber posts can be beneficial in enhancing the condition of such abutment.

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CASE REPORT

Management of bare root complete overdenture in patients with a history of methamphetamine abuse: A case report

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Keywords: Bare root overdenture, Methamphetamine abuse, Alveolar bone preservation

ABSTRACT

Methamphetamine abuse has severe consequences on oral health, commonly leading to rampant caries, advanced periodontal disease, and early tooth loss. These patients frequently become edentulous at a relatively young age. In such cases, a bare root overdenture can be an effective treatment option. This report aims to present the advantages of a bare root complete overdenture for a patient with a history of methamphetamine abuse. A 44-year-old male presented with multiple missing teeth in both arches and a history of non-prescription methamphetamine use for approximately 17 years, with abstinence over the past 7 years. This resulted in dry mouth and extensive tooth decay. Additionally, he had been a heavy smoker for the past 28 years. Clinical examination revealed the absence of teeth 18–16, 14–22, 26–28, 31–38, and 45–48. Radiographic analysis showed that the retained roots of teeth 23–25 and 42-44 were relatively long (9–12 mm) with no mobility. After recording tentative vertical dimension and evaluating the occlusal plane, teeth 15, 23–25, and 41–44 were found to be extruded by 4–6 mm. Tooth 15 and 41 were extracted due to poor prognosis. A bare root complete overdenture supported by abutment teeth 23–25 and 42–44 was selected due to severe tooth extrusion and limited interocclusal space. In this case, the bare root complete overdenture improved the retention, support, and stability of the prosthesis, enhancing the patient's quality of life. Oral hygiene improved after drug cessation, enhancing long-term prosthesis outcome. (IJP 2025;6(2):92-96)

Introduction

Chronic methamphetamine use has detrimental effects on oral health, including xerostomia, decreased salivary pH and buffering capacity, widespread brown carious lesions that may extend to the free gingival margin, tooth erosion, dysgeusia, periodontal disease, increased plaque accumulation and calculus deposits, poor oral hygiene, and ultimately tooth loss.[1,2] Tooth loss itself is a major oral health issue in Indonesia. According to the Basic Health Research (RISKESDAS) survey in 2018, 51.4% of individuals experienced loss of fewer than 28 natural teeth (dentulous), while 1.3% had lost more than 28 teeth (edentulous). The proportion of dentulous individuals was 4.1% at age 15 years, 55.6% at 35–44 years, and 78.2% at more than 65 years, whereas the proportion of edentulous cases reached 9.0% (Kementerian Kesehatan RI, 2018). This issue becomes more critical in individuals with a history of methamphetamine use, where destructive oral changes accelerate tooth loss and may cause edentulism at a relatively young age compared to the general population. In such cases, a bare root overdenture can be an effective treatment option.

According to GPT-9, overdenture is any removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants. Among the various types of overdentures, the bare root overdenture is one option that utilizes retained natural roots without copings or attachments. Tooth roots play an important role in preserving the residual ridge volume as well as enhancing the support and stability of overdentures.[3,4] Bare root overdentures can be applied in cases where the crown structure is extensively damaged yet the roots remain sound, free from caries, and stably anchored in the alveolar bone.[4] In situations where the abutment teeth present a questionable prognosis, fabrication of a bare root overdenture is advantageous, as it allows for further evaluation of the abutment condition.[5] If the abutment teeth eventually require extraction, the bare root overdenture can be modified into a conventional complete denture through relining. Nevertheless, bare root overdentures have certain limitations, such as not directly improving retention and the potential risk of caries development on exposed dentin.[3] This report aims to present the advantages of a bare root complete overdenture for a patient with a history of methamphetamine abuse

Case Report

Case Presentation

A 44-year-old male patient presented to the Dental Hospital of University of Indonesia, with the chief complaint of difficulty in chewing due to multiple missing teeth in both the maxillary and mandibular arches. The patient had a history of illegal methamphetamine use for approximately 17 years but reported cessation of drug

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Table 1. Oral manifestations of methamphetamine use

Oral manifestations	Methamphetamine use
Signs	Rampant caries
	Buccal/interproximal cervical caries
	Darkly stained, crumbling teeth
	Missing teeth
	Decreased salivary pH
	Erosion
	Candidiasis infection
	Cheilitis
	Glossitis
	Periodontal disease
Symptoms	Severe xerostomia
	Bruxism
	Attrition
	Temporomandibular joint pain
	Jaw clenching
	Myofacial pain

Figure 1. Intraoral condition, A. Upper occlusal view, B. Lower occlusal view, C. Anterior view

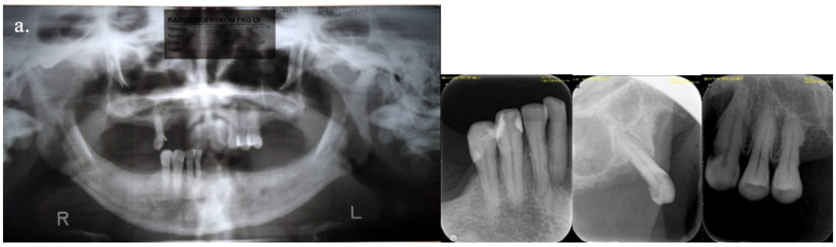

Figure 2. Radiographic examination, A. Panoramic radiograph, B. Periapical radiograph showing teeth 41-44, C. Periapical radiograph showing tooth 23, D. Periapical radiograph showing teeth 23-25

Figure 3. Study models mounted on articulator at tentative vertical dimension. Teeth 15, 23-25, and 41-44 were extruded by approximately 4–6 mm

Figure 4. Root canal treatment of teeth 23-25 and 42-44

use during the past seven years. He also had a smoking habit for the last 28 years and currently smoked around 10 cigarettes per day. At the time of presentation, the patient reported no history of systemic disease and was not under any regular medication. The patient reported having a history of bruxism during methamphetamine use, but the habit no longer persists.

Clinical examination revealed the absence of teeth 18–16, 14–22, 26–28, 31–38, and 45–48. Tooth 15 and 41 exhibited grade 2 mobility, while tooth 42 showed grade 1 mobility. Attrition was observed on teeth 23 and 41–44. The patient's oral hygiene was fair, with reduced salivary flow. The residual ridge demonstrated adequate form and height, with normal tissue support. All frenula and vestibules were within normal limits. The retromylohyoid space was deep. The maxillary tuberosities were small, and the palate was oval-shaped and deep, with a small maxillary torus present. No undercuts were detected in either the maxilla or mandible.

At the first visit, a complete examination was performed, including panoramic and periapical radiographs, as well as study model impressions using a stock tray with alginate. Panoramic and periapical radiographic examinations revealed a crown-to-root ratio of teeth 24, 25, and 42–44 were 2:3. Tooth 23 showed a crown-to-root ratio of 1:1, while teeth 15 and 41 had a ratio of 3:2. The roots of teeth 23–25 and 42–44 were embedded in the alveolar bone with a length of approximately 9–12 mm.

To determine the prosthodontic treatment plan, tentative vertical dimension (VD) was recorded. Once the tentative vertical dimension was established, the study models were mounted on a mean value articulator.

Teeth 23, 24, 25, 42, 43, and 44 were preserved because they had a favorable crown-to-root ratio, no mobility, and sufficiently long roots embedded in the alveolar bone. Tooth 15 was extracted due to grade 2 mobility. Bare root preservation was expected to maintain alveolar bone height and volume, thereby providing additional support and stability. A bare root overdenture without copings was selected because of limited interocclusal space. Then, the patient was referred to the Department of Conservative Dentistry for root canal treatment of teeth 23–25 and 42–44.

After confirming satisfactory endodontic outcomes and absence of patient complaints, decoronation of teeth 23–25 and 42–44 was performed.

On the same day, border molding and the final impression were performed using a custom tray with polyvinyl siloxane (PVS) light-body material, and the impression was poured with type IV dental stone to obtain the working cast. At the subsequent visit, the definitive vertical dimension was established using the occlusal rims, and the master casts were mounted on a semi-adjustable articulator (Stratos 100) for occlusal refinement. A try-in of the anterior and posterior tooth arrangement was then carried out. The acrylic denture

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Figure 5. Decoronation of teeth 23–25 and 42–44

Figure 6. A. Insertion of complete dentures (Intraoral), B. Insertion of complete dentures (Extraoral)

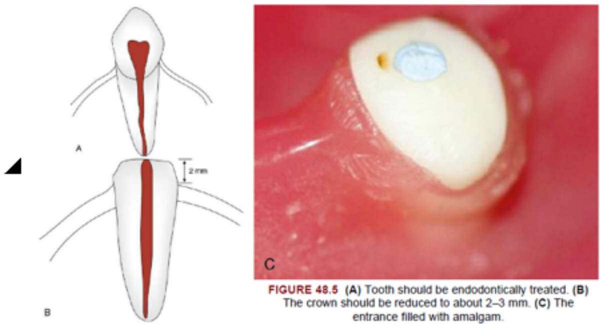

Figure 7. Bare root overdenture

was processed and inserted, followed by evaluation of tissue adaptation using pressure-indicating paste and occlusal adjustment. At the 24-hour follow-up, minor phonetic difficulties were identified and corrected. One month later, the patient's phonetics had improved, and the decoronized abutment teeth remained stable. Regular follow-up every six months was advised to maintain optimal prosthesis function and oral health.

Discussion

Methamphetamine strongly activate the central nervous system, leading to marked euphoria, increased energy, and a sense of self-confidence. Initially, it was used in the treatment of fatigue and depression. However, methamphetamine is classified as an illegal drug due to its high potential for addiction. The association between methamphetamine use and oral health has been widely reported. The characteristic oral manifestations, commonly referred to as "meth mouth," including xerostomia, gingivitis, periodontitis, extensive caries, and tooth fractures.[6]

Rommel et al. (2016) reported that among one hundred methamphetamine users, 72% experienced dry mouth. Decreased blood perfusion of salivary glands caused by METH results in reduced salivation, which causes xerostomia.[7] In addition to dry mouth, 68% of patients reported clenching habits, and 47% complained of temporomandibular joint pain. A salivary buffering capacity below pH 5.5 was observed in 83% of participants, which was attributed to a reduction in sodium bicarbonate concentration.[7] When the protective function of saliva diminishes, rampant caries can develop progressively. Deep carious lesions are commonly found in the cervical regions and tend to extend apically and occlusally. Patients with a history of drug abuse often present challenges in prosthodontic management, including loss of posterior support, secondary occlusal trauma, erosion or attrition, and reduced vertical occlusal dimension.[6]

Boyer et al. (2015) found a correlation between methamphetamine use and an increased incidence of dental caries, particularly among individuals who brushed their teeth less than once a day. The combination of methamphetamine use and poor oral hygiene was shown to significantly elevate the risk of caries.[8] Consistent with these findings, Skrypnyk et al. (2025) concluded that the deterioration of oral conditions in methamphetamine users is influenced by three main factors: limited access to dental care, negative health behaviors, and the direct pharmacological effects of the drug itself. In the present case, the patient reported using methamphetamine for approximately seventeen years, predominantly through inhalation. The clinical findings were typical, characterized by extensive cervical caries extending proximally.

According to GPT-9, overdenture is any removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants. This concept is particularly advantageous in the mandible, where bone resorption occurs up to four times more rapidly than in the maxilla. Overdentures offer several benefits, including the presence of implants or retained natural tooth roots that provide physiological stimulation to the alveolar bone, promoting its maintenance and remodeling. Consequently, the alveolar bone volume can be better preserved. In addition, younger patients are strong candidates for overdenture treatment to prevent future progressive bone loss. The presence of vertical stops also helps minimize the development of hypertrophic soft tissue.[5]

Another advantage of overdenture fabrication is the improvement in denture stability and support, which helps minimize horizontal and torque forces. By retaining natural teeth, proprioceptive feedback can be preserved. Additionally, overdentures offer psychologi-

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cal benefits for patients who are highly motivated to retain their natural teeth.[9] Overdenture fabrication can be performed while evaluating the condition of the abutment teeth. If extraction of the abutment teeth becomes necessary in the future, the existing denture can be relined and converted into a conventional complete denture, as overdentures are reversible in nature.[5]

The abutment teeth are more susceptible to caries and periodontal tissue damage if plaque control is inadequate. Overdentures also require greater interocclusal space compared to conventional complete dentures and may appear bulkier. In addition, the presence of bony undercuts on the labial aspect of the abutment teeth can create difficulties due to the limited path of insertion, potentially resulting in an overcontoured or undercontoured denture base.[5] In this case, topical fluoride application, regular follow-up visits, and patient education on proper oral hygiene practices were implemented to prevent caries development on the abutment teeth.

Overdentures are indicated to enhance denture support and stability, particularly in patients with few remaining abutment teeth of unfavorable distribution, maxillofacial defects, severely worn dentition, congenital anomalies such as microdontia, amelogenesis imperfecta, or partial anodontia, and in cases with abnormal jaw relationships where orthognathic surgery is contraindicated.[10] Contraindications for overdenture treatment include poor oral hygiene, the presence of recurrent caries or periodontal disease, absence of attached gingiva around the abutment teeth, excessive tooth mobility, and financial limitations.[9]

Several factors must be considered when selecting abutment teeth for an overdenture. In general, the gingiva surrounding the abutment tooth should be firmly attached to the cervical region and underlying bone, with no angular bone defects. The tooth should be free of caries, have a well-sealed root canal filling, and exhibit minimal mobility after decoronation, leaving approximately 2–3 mm above the gingival margin. From a positional standpoint, abutment teeth should ideally be distributed bilaterally, with at least one tooth on each side. When connected by an imaginary line forming a fulcrum, a line that is perpendicular to the sagittal plane provides better support than a diagonal one. The canine is considered the most favorable abutment tooth, followed by the premolars. Maxillary incisors may also serve as abutments, particularly when the opposing teeth are natural.[5]

Interocclusal space must be carefully considered in overdenture fabrication. The use of attachments and copings requires additional vertical space. The available space between abutment teeth should also be evaluated to ensure adequate clearance for oral hygiene procedures. When multiple adjacent abutment teeth are present, it is preferable to restore them individually rather than splinting them. From a periodontal standpoint, at least 5 mm of periodontal ligament or one-third of the apical root length should remain, along with a minimum of 3 mm of attached gingiva. The decoronation procedure significantly reduces the potential for leverage or dislodging forces.[5]

In general, overdentures are classified into two main types: tooth-supported overdentures and implant-supported overdentures. Heartwell further categorized tooth-supported overdentures into several types based on the method of abutment tooth preparation and the length of the coping. In addition, various types of attachments can be used in both tooth-supported and implant-supported overdentures. In this case report, the type of overdenture discussed is the bare root or non-coping overdenture. The overdenture is placed directly over teeth that have undergone root canal treatment, either as an interim or definitive prosthesis. Following endodontic treatment and coverage with amalgam, glass ionomer cement (GIC), or composite resin, the clinical crowns are decoronated approximately 2 mm above the gingival margin. The occlusal surface of the remaining root is shaped into a dome or convex form and polished smoothly. This design helps minimize lateral forces transmitted to the abutment teeth.[5]

The bare root overdenture is a simple and cost-effective treatment option that requires minimal interocclusal space. However, its main drawback is the risk of caries on the exposed dentin surface.[3,5] The indications for bare root overdenture fabrication include:[3] The tooth roots are preserved primarily for residual ridge conservation and denture support, with retention and stability being secondary considerations. Elderly patients with compromised general health conditions. Cases requiring additional time to evaluate questionable abutment teeth. Patients with a history of poor oral hygiene, resulting in questionable abutment prognosis. Situations where additional time is needed to improve home care and assess progress before undertaking more extensive dental treatment. Financial limitations that significantly influence treatment planning. Tooth roots that are free of caries. Low caries index.

In this case, due to the limited interocclusal space, a non-coping or bare root overdenture was selected. The roots of teeth 23–25 and 42–44 were retained because they exhibited a favorable crown-to-root ratio, were embedded 9–12 mm within the alveolar bone, showed no mobility, and were free of caries. The retained roots served to preserve the residual ridge volume and provide support for the overdenture. Following decoronation, adequate spacing between the abutment roots was achieved, allowing for proper oral hygiene maintenance. To prevent root caries, topical fluoride application and oral hygiene instructions were provided. At the final follow-up, approximately two

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months after denture insertion, the bare root abutments remained intact, with no evidence of plaque accumulation or caries formation.

Conclusion

Overdentures offer several advantages, including the preservation of alveolar bone volume through physiological stimulation, improved denture stability and support, maintenance of proprioceptive sensation, and psychological benefits for patients who wish to retain their natural teeth. Moreover, overdentures allow continuous evaluation of the condition of the preserved abutment teeth. One of the simplest and most cost-effective types of overdenture is the bare root overdenture, which requires minimal interocclusal space. In this case, with proper indication and maintenance, a functional and esthetic prosthetic outcome was achieved.

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CASE REPORT

Custom ocular prosthetic rehabilitation in patient with Post-enucleation deep eye socket using iris button technique

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Keywords: Custom ocular prosthesis, Iris button, Physiologic impression

ABSTRACT

The eyes are a vital component of facial esthetics and expression. Ocular defects can have a significant psychological impact on patients. An ocular prosthesis is an artificial maxillofacial prosthesis used to restore the appearance of a missing eye. It can be customized to replicate the patient's natural eye in terms of color, shape, size, and movement, resulting in a realistic and natural-looking outcome. The objective of this case report is to explain the procedural steps involved in the fabrication of a custom ocular prosthesis, employing an impression technique using a custom tray and incorporationg the iris button technique. A 36 years old female patient came to RSGM Padjadjaran University to fabricate a new eye prosthesis. The patient had a prior medical history of a severe ocular infection, which necessitated enucleation surgery. The ocular prosthesis was fabricated using an impression technique with a custom tray, employing a physiological impression method to capture the deep regions of the superior palpebral socket. The sclera, iris, and pupil were fabricated using the iris button technique. Custom ocular prostheses incorporating physiological impression technique and iris button technique offer ocular prosthesis with good stability and more natural appearance. (IJP 2025;6(2):97-102)

Introduction

The eyes are a vital component of facial esthetics and expression. The loss of an eye may exert both physical and psychological impacts on the patient, ultimately compromising overall quality of life. This condition may arise from various causes, including malignancy, congenital anomalies, severe trauma, a painful non-functional eye, or infection.[1]

Surgical management of severe ocular conditions may involve evisceration, enucleation, or exenteration. Evisceration involves the removal of the eye's internal structures while the sclera and, in some cases, the cornea are left intact. Enucleation, by contrast, refers to the complete removal of the globe along with a portion of the optic nerve from the orbital cavity. In more severe cases, exenteration involves the total removal of all structures inside the orbit, with extraocular muscles, in a single surgical procedure.[1]

Ocular prostheses serve not only to restore facial esthetics but also to improve psychological health and reinforce patient self-esteem. They represent an essential component of maxillofacial rehabilitation, mitigating both the functional and psychosocial sequelae of eye loss. Defined as a maxillofacial prosthetic device, an ocular prosthesis is specifically fabricated to reestablish the natural appearance of a missing eye.[2] Prefabricated stock ocular prostheses are selected to approximate the patient's ocular characteristics, while custom ocular prostheses are manufactured specifically to match the patient's eye socket shape.[3] The use of custom-made ocular prosthesis is particularly beneficial due to the individualized nature of each socket, requiring precise sizing and shaping of the prosthesis It can be customized to replicate the patient's natural eye in terms of color, shape, size, and movement, resulting in a realistic and natural-looking outcome.[2]

Until now, practitioners have endeavored to construct custom ocular prostheses that exhibit precise adaptation to the surgically treated socket. Such outcomes can be attained by performing an accurate impression of the ocular socket. Herein, a functional ocular impression technique is presented to achieve a better fit of the prosthesis to the defect area. This technique aims to combine cosmetic excellence with comfort for greater benefit to the patient.[4]

One of the essential components in the fabrication of an ocular prosthesis is the replication of the iris. One technique to fabricate custom ocular prosthesis is using iris button technique. Various techniques have been described for obtaining iris buttons, including the use of prefabricated stock eye irises, photographic printing on paper, hand-painting with oil-based pigments, and the incorporation of electronic components for dynamic iris simulation. Among these, hand-painting with oil paints remains the most widely practiced approach due to its adaptability and precise color control through pigment blending during the painting process. This method is also capable of producing aesthetically superior, three-dimensional iris reproductions.[5] Several techniques have been proposed for determining iris orientation in custom-made ocular prostheses. Conventional visual assessment is inherently subjective and often yields inaccurate positioning. To overcome this limitation, a more precise method utilizes the pupillary distance (PD) ruler, an instrument originally employed in optometry for spectacle fitting. The PD ruler

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Figure 1. Clinical view of the patient's ocular socket

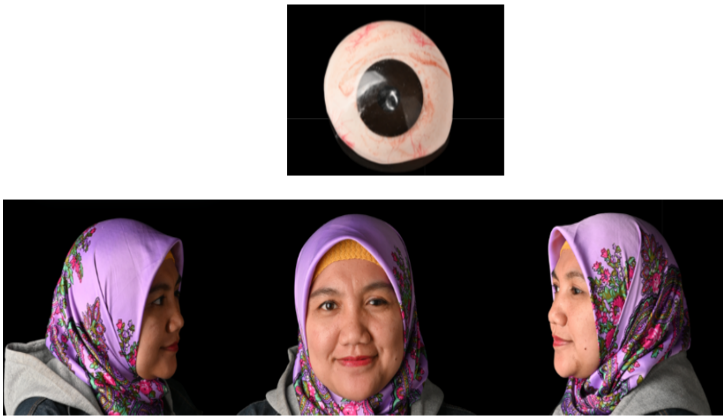

Figure 2. A. Patient's Prefabricated Ocular Prosthesis, B. Extraoral views of the patient with prefabricated ocular prosthesis; right lateral view, C. Frontal view, D. Left lateral view

Figure 3. A. Custom Impression Tray, B. Impression Procedure in the Patient

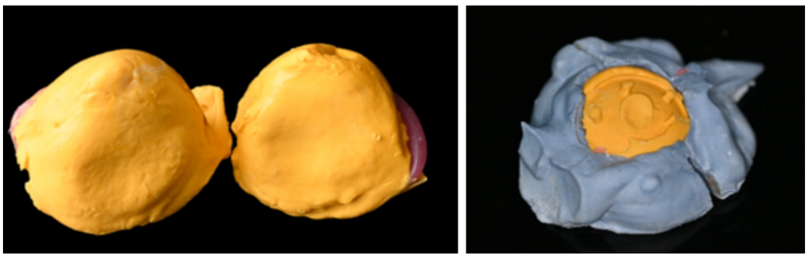

Figure 4. A. Impression of the Patient's Ocular Socket using PVS light body, B. Working Model

enables accurate measurement of both binocular interpupillary distance and monocular pupillary distances, thereby minimizing operator bias associated with traditional techniques.[2]

The objective of this case report is to explain the procedural steps involved in the fabrication of a custom ocular prosthesis, employing an impression technique using a custom tray and incorporationg the iris button technique.

Case Report

Case Presentation

A 36-year-old female patient presented to the Dental Hospital of Universitas Padjadjaran with a complaint of loss of the left eyeball since seven years ago. The patient had undergone enucleation of the left eyeball due to an abscess in the ocular socket. She works as a kindergarten teacher, which requires her to interact with mány people on a daily basis. The patient had been wearing a prefabricated ocular prosthesis and had replaced it several times due to discomfort. The prefabricated prosthesis was loose, causing frequent rotation of the iris and pupil. In addition, the prosthesis often irritated the ocular socket, occasionally resulting in bleeding. The patient requested a new ocular prosthesis that would provide comfort, proper adaptation to the socket, and satisfactory esthetics.

The examination of the eye socket revealed a healthy conjunctiva without signs of infection or inflammation covering the posterior wall of the anophthalmic socket. In addition, the patient's ocular muscles appeared collapsed, resulting in a sunken eye appearance. Examination of the ocular socket showed a very deep superior region with a slight bulge in the superolateral area, while the inferior region appeared very shallow figure 1.

The operator also examined the patient's prefabricated ocular prosthesis. The shape and size of the prosthesis did not correspond to the patient's socket. The iris diameter was disproportionate compared to the contralateral pupil. Furthermore, the scleral portion exhibited extensive reddish discoloration, which did not match the contralateral sclera figure 2.

After a comprehensive examination, the diagnosis was established as anophthalmic left eye post-enucleation due to socket abscess. Differential diagnoses included phthisis bulbi, microphthalmia, congenital anophthalmia, and post-traumatic ocular atrophy. A treatment plan was then formulated according to the patient's condition. The main challenge in this case was the excessively deep superior socket and the very shallow inferior socket, which made it difficult to achieve adequate retention and stabilization. The ocular prosthesis fabrication technique selected for this case was the iris button method.

At the first visit, the patient completed an informed consent form. The procedure was then initiated by fabricating a custom impression tray using a light-cured acrylic material, which was connected to a straw to provide access for the insertion of impression material figure 3A. Prior to trying the tray in the patient's eye, the ocular socket was cleaned with sterile sodium chloride solution to remove any debris or dirt. Subse-

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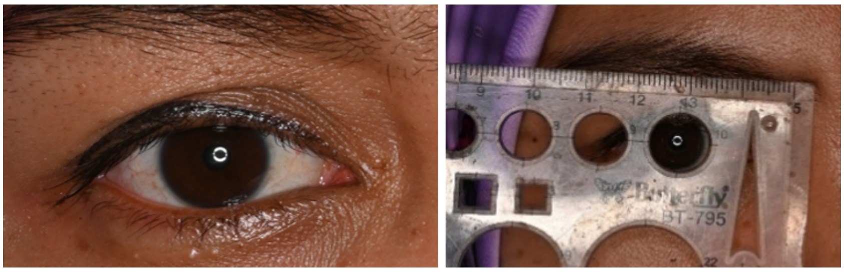

Figure 5. A. Photograph of the Patient's Normal Right Eye, B. Measurement of Iris Diameter Using a Ruler

Figure 6. Fabricated Iris Button

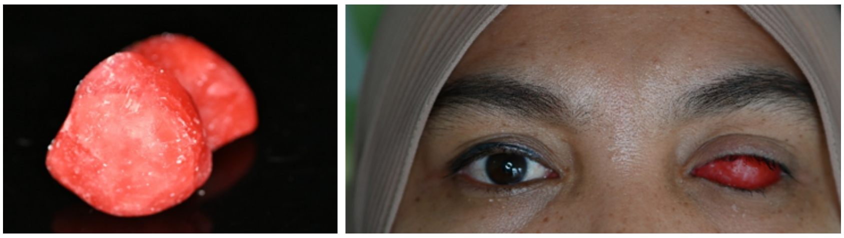

Figure 7. A. Sclerae Wax Template, B. Try-in of the Scleral Wax Template in the Patient's Eye

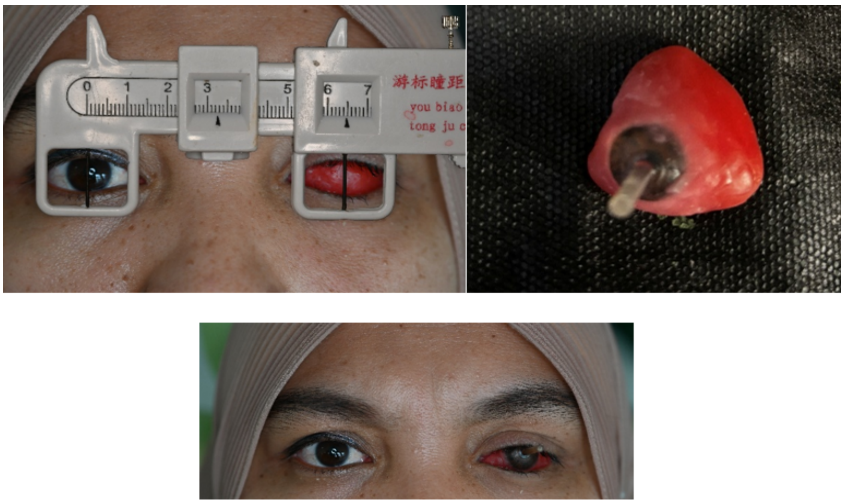

Figure 8. A. Determination of pupil position using a PD ruler, B. Wax Pattern with Attached Iris Button, C. Try-in of the Wax Pattern and Iris Button in the Patient

quently, the custom impression tray was tried in the patient's socket, and necessary adjustments were made to ensure proper fit and adaptation within the socket.

Before making the impression, an escape hole was created in the custom impression tray. The impression of the ocular socket was made using polyvinyl siloxane (light body) impression material. Prior to inserting the material into the socket, the patient's eyelashes were coated with Vaseline. The impression material was then slowly and evenly injected into the socket until it flowed into the orbital and palpebral areas. During the impression procedure, the patient was instructed to keep the eyes open and to move them to the right, left, upward, downward, and to blink slowly. The impression tray was removed after the PVS material had set figure 4A. The ocular socket was examined again to ensure that no impression material remained inside. The impression was disinfected with alcohol spray and poured with dental stone figure 4B.

During the first visit, a photograph of the patient's normal right eye was also taken figure 5A. This served as a reference for the fabrication of the iris button of the left ocular prosthesis. In addition, the diameter of the patient's iris was measured using a ruler to guide the adjustment of the iris button to be fabricated figure 5B. Thereafter, the reference is transferred to the laboratory to serve as a basis for the fabrication of the iris button figure 6.

At the second visit, a scleral wax template was fabricated from the working model figure 7A. The scleral wax template was tried in the patient's ocular socket figure 7B. All wax surfaces The wax surfaces were carefully contoured and smoothed to prevent irritation to the socket. The contour and convexity of the wax were then evaluated and adjusted to match the patient's normal right eye. The patient was instructed to open and close the eyes, as well as to move them in all directions. The scleral wax should demonstrate good retention and stability. The patient was able to close the eyes completely, and during eye movements, the wax remained in position without rotation or dislodgement from the socket.

Subsequently, the position of the pupil was determined using a PD ruler figure 8A The PD ruler was placed as close as possible to the patient's eye, and markings were made on the wax template. The wax was then slightly heated, and the previously fabricated iris button was inserted into the wax figure 8B. The template was reinserted into the patient's eye, and the position of the iris button was evaluated to ensure alignment with the contralateral normal eye figure 8C.

The wax pattern with the attached iris button was then sent to the laboratory for processing. The scleral portion was packed with white acrylic resin, and red fibers were incorporated to simulate blood vessels. The external surface was subsequently laminated with clear acrylic resin to provide a glossy appearance and resemble the natural eye figure 9.

The third visit consisted of the insertion of the

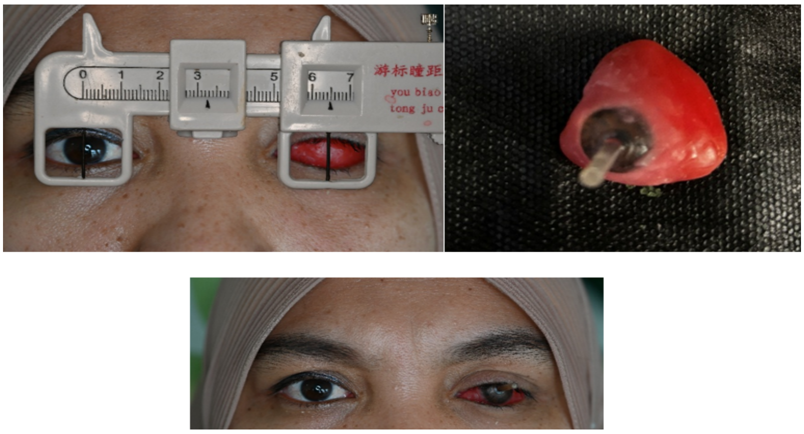

Figure 8. A. Determination of pupil position using a PD ruler, B. Wax Pattern with Attached Iris Button, C. Try-in of the Wax Pattern and Iris Button in the Patient

Figure 9. Final Ocular Prosthesis after Packing

Figure 10. Ocular Prosthesis Inserstion; A. Frontal View, B. Lateral View, C. Frontal View When Patient Close Eyes

ocular prosthesis figure 10. The patient was instructed to sit upright and remain relaxed. The ocular prosthesis was inserted into the patient's eye socket, after which the patient was asked to open and close the eyes slowly. The eyelids had to be able to close completely. The patient was also instructed to move the eyes in all directions and to bend the head forward. The ocular prosthesis was required to demonstrate adequate retention and stability. It had to fit properly, without rotation or dislodgement during functional movements, and should not fall out when the patient bent forward. The patient was instructed to return for a follow-up visit one week later.

At the fourth follow-up visit, the patient was asked about any complaints of pain or discomfort. Areas causing excessive pressure were adjusted on the ocular prosthesis and subsequently polished. Following these adjustments, the patient reported comfort, and the prosthesis demonstrated stable function without dislodgement.

Discussion

The eye is a vital organ because of its complex structure and key role in vision. Loss of vision from different causes can lead to both physical difficulties and emotional distress.[6] Anophthalmia can arise from various etiological factors, predominantly injuries and neoplasms, often following enucleation, evisceration, or exenteration of the eye globe and surrounding orbital tissues. In the present case, the patient developed recurrent socket abscesses, which eventually required surgical management through enucleation. Enucleation specifically involves the removal of a diseased globe from the orbit.[7] The recommended time for initiating ocular prosthesis fabrication is within 6–8 weeks after surgery. Patients should be encouraged to report for prosthetic rehabilitation during this period, as the prosthesis can be constructed concurrently with the healing process.[4]

Patients undergoing enucleation require an ocular prosthesis to compensate for the loss of the natural eye.[8] From a clinical perspective, the desired outcome includes correct eyelid positioning, adequate blink function, normally aligned eyelashes, symmetry with the unaffected eye, good motility, and fabrication of a customized prosthesis.[9] Ocular prostheses serve as comprehensive corrective solutions for post-enucleation defects, fulfilling both functional and aesthetic roles. They contribute to the restoration of facial symmetry, prevention of eyelid malposition, protection of the anophthalmic socket, regulation of tear flow, and reduction of intra-cavity fluid accumulation. Furthermore, they support eyelid function, enable natural eye-opening, and partially reestablish motility while providing a lifelike cosmetic appearance. Importantly, such rehabilitation has profound psychosocial benefits, enhancing patient confidence, improving interpersonal relationships, and ultimately contributing to better quality of life.[10]

Several methods have been proposed throughout the years for constructing ocular prostheses.11 Ocular prostheses are classified into custom-made and prefabricated types. The rehabilitation of anophthalmic sockets represents a significant challenge for dental clinicians, primarily because of cicatricial contraction, progressive atrophy, and tissue changes. As in the present case, the patient had undergone enucleation seven years earlier and had repeatedly worn prefabricated ocular prostheses that did not properly conform to the socket. This led to muscular atrophy and alterations in the surrounding tissue

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architecture, factors that require careful consideration in the design and fabrication of a custom ocular prosthesis. This complex condition necessitates careful consideration of the prosthesis dimensions and contour to achieve optimal outcomes in terms of realistic appearance and symmetry.[12] Custom-made ocular prostheses improve cosmetic results and cause less discomfort for patients. They mimic the lost eye in color, contour, and size, helping to restore facial symmetry. Because they fit closely to the socket tissues, they prevent fluid buildup, keep the tissues healthier, and lower the risk of irritation or infection. They also spread pressure more evenly, reducing the chance of conjunctival abrasion.[8,10]

In this case, impression of the ocular socket was made using a custom tray. Many authors have recommended making a custom tray for ocular impressions. In this instance, creating the personalized tray was an easy and quick workaround. To obtain a good fit, it has also been recommended to modify an existing stock or custom ocular prosthesis using relining material.6 Accurate impression of the defect is a key factor for the successful prosthetic rehabilitation.[8] There are several impression techniques available for obtaining an ocular anophthalmic cavity impression.[11] The technique used in this case report is physiologic impression technique. After the material is injected to the eye socket, the patient was directed to move his eyes up and down, left and right. This will facilitate the flow of the impression material to all aspects of the socket. The polyvinyl siloxane light body elastomeric impression material to achieve the minute details of the defect at resting as well as functional movement.[8]

The reproduction of the iris, especially with respect to its position, size, and color, is critical for the aesthetic success of an ocular prosthesis. Given the technique sensitivity of iris positioning, reliance on visual judgment alone is often inadequate. To ensure precision, a PD ruler is utilized to locate and align the iris accurately on the custom-made prosthesis. The midline is delineated using the ruler while the patient fixes their gaze on a distant point in primary position.[8] The diameter of iris is also important. In this case, It was achieved by measuring the diameter of iris using iris diameter template as the picture above. Roberts et al. recommended the use of a pupillometer for precise pupil alignment in ocular prostheses. In their method, a transparent graph template was employed to accurately determine iris position, thereby minimizing the interobserver variability associated with visual assessment alone, which is prone to binocular vision and parallax errors. This technique is simple and can be readily implemented in routine clinical practice.[13]

The color of iris is also important. Many have suggested various techniques for obtaining colored match iris as with the natural companion eye; such as the use of a digital photography, prefabricated iris from stock eye shells and iris painting using dry earth pigments or oil colors mixed into a painting medium called monopoly.[8] For this case, the iris of the ocular prosthesis was colored using the hand oil painting technique. Zoltie et al. emphasized that hand painting remains the gold standard in artificial eye fabrication, as no scalable alternative has proven equally effective. Oil paints are particularly advantageous due to their versatility and wide color range. This technique allows precise color control, enabling the creation of highly individualized, realistic, three-dimensional irises that surpass results achieved with photoprinting or prefabricated stock options. When performed by a skilled operator, hand painting ensures optimal color blending and produces a natural iris closely resembling the patient's contralateral eye.[14]

In this case, the iris of the ocular prosthesis was fabricated using the iris button method. The iris button technique has been proven to be a reliable method in ocular prosthesis fabrication. According to Dasgupta, et al., this approach allows for highly precise iris reproduction, resulting in superior aesthetic outcomes that closely resemble the patient's natural eye.[15] Putra et al., suggested that this method produce a highly natural, three-dimensional, and textured iris that enhances the aesthetic appearance of the ocular prosthesis.[16] Besides, These techniques have demonstrated advantages, such as simplifying the fabrication process and reducing chairside time.[17]

Conclusion

The rehabilitation of an anophthalmic socket with a custom-made ocular prosthesis provides not only esthetic improvement but also psychological and functional benefits for the patient. The use of a physiologic impression technique allowed for accurate reproduction of the socket anatomy, ensuring proper adaptation, comfort, and stability of the prosthesis. Incorporating the iris button technique enabled precise replication of the contralateral eye in terms of size, color, and position, thereby enhancing the natural appearance of the prosthesis. This case highlights that custom ocular prostheses fabricated with these techniques are a reliable treatment option to offer good stability and a more natural appearance, thereby restoring facial esthetics, promoting patient confidence, and improving overall quality of life.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Prosthetic rehabilitation in a patient with an anophthalmic socket following enucleation for absolute glaucoma

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Keywords: Absolute glaucoma, Anophthalmic socket, Enucleation, Ocular prosthesis, Prosthetic rehabilitation

ABSTRACT

Absolute glaucoma is a progressive condition that causes irreversible optic nerve damage from elevated intraocular pressure. When it no longer responds to treatment, patients may develop severe pain and complete vision loss, making enucleation the final option for relief. After enucleation, prosthetic rehabilitation is essential to restore facial appearance, improve function, and support psychological well-being. This case report outlines the clinical course and prosthetic management of an anophthalmic socket after enucleation for absolute glaucoma, highlighting key fabrication steps and the importance of structured follow-up care. A 23-year-old male with worsening, treatment-resistant glaucoma experienced persistent pain, scleral redness, and complete vision loss, leading to enucleation in 2018. His first prosthesis loosened after two years, and recurrent socket bleeding in 2023 necessitated an additional surgery. A new custom prosthesis was fabricated using a polyvinyl siloxane impression, followed by wax try-ins and precise iris–pupil positioning with callipers and a PD ruler. Acrylic painting was applied to create a natural ocular appearance. After insertion, the prosthesis was evaluated for comfort, stability, and esthetics, with follow-ups at one day, one week, and six months. This case highlights the value of personalized prosthetic design and consistent aftercare in achieving optimal outcomes for patients with anophthalmic sockets. (IJP 2025;6(2):103-106)

Introduction

The eyes are among the most vital organs of the human body. In addition to their primary role in vision, intact eyes significantly contribute to facial esthetics and expressions. Loss of an eye not only affects a patient physiologically but also has a profound impact on psychological well-being and social life.[1] Loss of an eye may result from various conditions such as carcinoma, trauma, sympathetic ophthalmia, a painful blind eye, or congenital anomalies. Surgical management of these conditions depends on the severity of the case and may involve one of several approaches, including evisceration, enucleation, or exenteration.[2]

Absolute glaucoma is a chronic and progressive ocular disease characterized by irreversible optic nerve damage resulting from persistently elevated intraocular pressure. If left untreated or unresponsive to therapy, the condition may progress to complete vision loss accompanied by painful complications.[3] In severe cases, enucleation is considered the definitive treatment to relieve symptoms. Enucleation is a surgical procedure in which the entire eyeball is removed following the severance of the extraocular muscles and the optic nerve.[1,4]

Following enucleation, prosthetic rehabilitation plays a crucial role in restoring facial symmetry, functional balance, and the patient's psychological well-being. In cases of ocular defects, rehabilitation is achieved through the use of ocular prostheses. These prostheses are generally classified into two types: stock ocular prostheses and custom-made ocular prostheses.[5] Stock ocular prostheses, once widely used and still available today, offer advantages such as minimal fabrication time and a variety of iris sizes and colors. However, they often cause discomfort and increase the risk of infection due to poor adaptation to the socket, in addition to esthetic limitations from mismatched iris colors. Stock eyes are thin, acrylic-based, and generally indicated for post-evisceration cases. In contrast, custom ocular prostheses are suitable for rehabilitation after both evisceration and enucleation. They provide superior esthetics, as the iris and sclera can be matched to the contralateral eye, and better functional adaptation to the patient's socket. However, their main drawback is the longer laboratory processing time.[6]

Currently, ocular prostheses are commonly fabricated from polymethyl methacrylate (PMMA), or acrylic.[7] In Indonesia, PMMA is widely used because of its durability, biocompatibility, and natural esthetic appearance. Local studies have also highlighted its effectiveness in producing customized ocular prostheses that provide both improved esthetics and patient comfort.[1,8,9]

This case report aims to present the clinical progression and prosthetic rehabilitation of a patient with an anophthalmic socket following enucleation due to absolute glaucoma. It highlights the step-by-step prosthesis fabrication process and emphasizes the importance of post-insertion care in achieving successful outcomes.

Case Report

Case Presentation

A 23-year-old male patient presented with a history of worsening glaucoma unresponsive to three laser surgeries. Symp-

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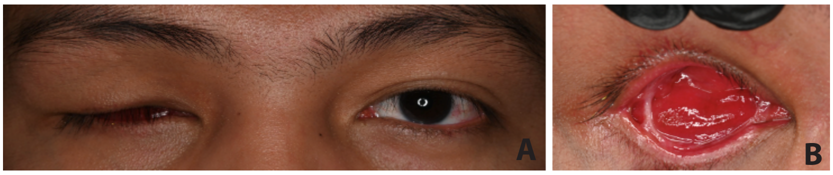

Figure 1. **Patient's profile, A. Frontal view, B. The socket of the right eye**

Figure 2. **An impression of the socket of the right eye**

Figure 3. **Try in scleral shell template with wax**

Figure 4. **Try in sclera**

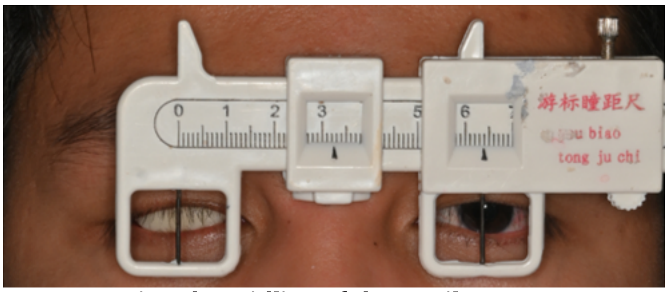

Figure 5. **Measuring the midline of the pupil**

Figure 6. **Marking of pupil and iris**

toms included severe eye pain, scleral redness, and vision loss. In 2018, the patient was first diagnosed with glaucoma with markedly elevated intraocular pressure. A laser surgery was performed to reduce the pressure. However, the intraocular pressure rose again, accompanied by progressive visual darkening, necessitating a second laser procedure. Despite these interventions, the ocular condition deteriorated further. The patient developed severe symptoms, including conjunctival hemorrhage, mild proptosis, and a greenish discoloration of the cornea. As a result, the ophthalmologist decided that enucleation was the only definitive solution. Following the surgery, the patient was provided with an ocular prosthesis.

In 2020, after more than two years of use, the prosthesis became loose and was subsequently replaced with a new one. In 2023, the patient experienced complications associated with the prosthesis, presenting with bleeding and wound dehiscence at the surgical site. A fourth surgery was performed to re-suture the affected area. After this procedure, a new prosthesis was fitted, but it could no longer be properly retained. Therefore, the patient required a new ocular prosthesis to be made.

Examination of the left eye revealed a healthy conjunctiva with no signs of infection figure 1A. In contrast, the right eye had suffered from an infection six years earlier and subsequently underwent enucleation. Clinical examination of the right eye socket showed complete removal of the eyeball figure 1B. The diagnosis in this case was confirmed as an anophthalmic socket post-enucleation due to absolute glaucoma. The prognosis is favorable, provided that a stable and well-functioning ocular prosthesis can be fabricated. A custom ocular prosthesis with individualized iris and scleral characterization is planned for the patient.

Prior to initiating treatment, the procedure was thoroughly explained to the patient, and informed consent was obtained. After comprehensive history-taking and clinical evaluation, the impression stage was carried out, beginning with the construction of a customized impression tray designed to fit the patient's ocular socket. This tray was fabricated from self-cured acrylic resin and equipped with a straw to allow the injection of impression material. The socket was first rinsed with sterile sodium chloride solution to remove debris, and the tray was then tried in to confirm adequate adaptation.

For the impression, a light-body polyvinyl siloxane material was used. The patient was seated in an upright position and instructed to remain relaxed. Prior to placement, the eyebrow region was coated with petroleum jelly, and the socket was cleaned once again with saline and gently dried with a cotton pellet. The impression material was carefully injected into the socket in a slow and uniform manner until it completely filled the orbital and eyelid areas.

During tray placement, the patient was asked to keep the eyelids open while gentle pressure was applied, followed by functional eye movements to capture dynamic contours. After the material had set

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Figure 7. Coloring of pupil and iris

Figure 8. Insertion of ocular prosthesis

Figure 9. Control and Evaluation

figure 2, the tray was removed carefully, and the socket was inspected to ensure no residual material remained. The impression was disinfected with alcohol spray and poured with dental plaster to obtain the working cast. Finally, the impression was forwarded to the laboratory for prosthesis fabrication.

The second visit, the patient was instructed to sit upright in a relaxed position. The upper eyelid was gently lifted to insert the superior edge of the scleral shell template, followed by pulling down the lower eyelid to facilitate placement of the inferior edge. The wax-modified scleral shell template was adjusted to ensure a comfortable fit and to minimize irritation figure 3. Eyelid mobility during opening and closing, as well as the overall contour of the eyeball, was carefully evaluated from multiple angles to achieve close resemblance to the contralateral eye. Key considerations at this stage include the alignment of the eyeball shape, convexity, eyelid movement, aesthetics, stability, and retention. The size, color, and iris configuration are selected based on the natural eye on the contralateral side as a guide.

During the third visit, the acrylic sclera was tried in on the patient figure 4. The pupil position was determined by aligning the edge of a PD ruler on the sclera and marking the reference point with a pencil or permanent marker. The iris diameter of the natural eye was then measured using a sliding caliper figure 5. Afterward, the scleral shell made of polymethyl methacrylate (PMMA) was removed from the socket, and a circular outline representing the iris was drawn using a compass, centered on the previously marked pupil point, and adjusted to match the natural iris diameter. At this stage, it was crucial to ensure that the scleral shell was symmetrical with the contralateral eye, had a comparable convexity, and was comfortable without any sharp edges figure 6.

Subsequently, the anterior surface of the sclera was reduced by 1–2 mm using a round bur to provide space for clear acrylic layering and iris–pupil customization. The site for the iris and pupil was prepared in the form of a concavity. Coloring was carried out within this prepared area using brown acrylic paint for the iris and black acrylic paint for the pupil. During the following visit, the patient was instructed to sit upright and remain relaxed. The eye socket was irrigated with saline solution and gently dried with cotton pellets. The ocular prosthesis with customized iris and pupil characterization was then tried in figure 7. Esthetics, retention, and stability were carefully reassessed.

During the fifth visit, the patient was instructed to sit upright and remain relaxed. The eye socket was cleaned with saline solution and gently dried with cotton pellets. Both the right and left ocular prostheses were inserted, after which the patient was asked to perform functional movements by looking left, right, upward, and downward figure 8. At this stage, the comfort and mobility of the prostheses within the sockets, globe convexity, and eyelid dynamics were evaluated. Esthetics, retention, and stability were also reassessed.

Post-insertion, detailed instructions were provided regarding the use, limitations, and care of the prostheses. The patient was trained in insertion and removal techniques, including removal by pulling the lower eyelid downward, directing the gaze upward, and gently disengaging the lower margin of the prosthesis with a finger. Continuous wear of the prosthesis for 24 hours was recommended, with instructions not to remove it at night to avoid eyelid malposition. Prior to removal, the prosthesis should be moistened, then cleaned under running water using hypoallergenic soap, and stored in saline solution. The use of lubricating eye drops was advised to prevent dryness. A follow-up appointment was scheduled one week after insertion.

During the sixth visit, the patient reported experiencing comfort throughout the week of prosthesis use figure 9. Clinical examination of both the left and right eye sockets revealed no signs of inflammation. The socket was irrigated with saline solution and gently dried with cotton pellets. The ocular prosthesis was then reinserted, showing satisfactory retention, stability, and esthetics.

Discussion

The loss of an eye often leads to both physical and psychological challenges. Beyond reduced vision, patients commonly experience emotional distress due to social reactions to their facial disfigurement. Early replacement of the missing eye, following adequate healing after enucleation or evisceration, is essential to support physical recovery, psychological adjustment, and social acceptance.[8]

The primary purpose of an ocular prosthesis is to restore normal facial appearance, thereby enhancing self-confidence and social interaction.[1] Prostheses are generally recommended 6–8 weeks after surgery, once the socket has healed.[10] Although fabrication of a custom ocular prosthesis is a technique-sensitive procedure, it provides superior outcomes compared to prefabricated stock prostheses. Custom ocular prostheses allow replication of iris and scleral color, pupil and iris size, and contour, resulting in natural movement, correct orientation, and a more realistic, symmetrical facial appearance.[11]

One of the major challenges is achieving a natural appearance and movement. While stock prostheses are more economical, they may not conform precisely to the socket, often resulting in discomfort, irritation, and poor esthetics. Conversely, custom prostheses offer better socket adaptation, coordinated movement with the contralateral eye, and more natural color and orientation of the iris.[1,9]

In the present case, the patient initially wore a stock eye that caused socket discomfort and ulceration. After rehabilitation with a custom ocular prosthesis, the patient reported improved comfort, absence of socket injury, and enhanced esthetics due to individualized anatomical adaptation. The ability to match iris color and position to the contralateral eye is a unique advantage of custom prostheses.[12] The use of polymethylmethacrylate (PMMA) further ensures biocompatibility, esthetic integration, and comfort. For optimal function, an ocular prosthesis must provide proper eyelid support, maintain orientation in primary gaze, allow coordinated movement, and ensure retention within the socket while maintaining natural appearance.[13,14] Although custom fabrication requires more time and precision, it yields better long-term esthetic and functional outcomes than stock alternatives. Importantly, while visual function cannot be restored, custom prostheses significantly reduce psychological trauma and support social reintegration.[1,6,9]

Long-term maintenance is also critical. Over time, the surface of the prosthesis may become rough, leading to debris accumulation. Regular cleaning is recommended, and when scratches or deposits occur, repolishing should be performed. Follow-up every six months is advised to evaluate and adjust the prosthesis, ensuring sustained comfort, esthetics, and function.[1,6]

Conclusion

This case demonstrates that effective rehabilitation of anophthalmic sockets extends beyond the technical process of prosthesis construction and requires a holistic, interdisciplinary approach tailored to each patient. Careful consideration of anatomical variations, functional demands, and patient expectations is essential to achieving predictable outcomes. The integration of accurate fabrication techniques with structured aftercare supports both the stability and esthetics of the prosthesis, while also ensuring long-term comfort and adaptation. Beyond physical restoration, this comprehensive management plays a vital role in improving psychological well-being, self-confidence, and social reintegration following ocular enucleation.

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CASE REPORT

Digitally-Assisted conventional immediate denture in aggressive periodontitis with limited abutments

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Keywords: Aggressive periodontitis, Compromised abutments, Hybrid workflow, Immediate denture, Intraoral scanning

ABSTRACT

Aggressive Periodontitis (AgP) frequently precipitates premature, multi-unit tooth loss in young adults, imposing substantial esthetic and psychological burdens. While the immediate provision of a prosthesis is critical to preclude the damaging edentulous phase and sustain patient confidence, conventional impression techniques inherently pose a significant risk of iatrogenic trauma to the remaining, often highly mobile, fragile abutments. This report details a hybrid digital-conventional protocol designed to maximize clinical safety and esthetic predictability during immediate removable partial denture (IRPD) delivery amidst fragile abutments. A 35-year-old female diagnosed with generalized AgP necessitated the extraction of eleven teeth, with only periodontally sound canines and premolars retained. Intraoral scanning technology was strategically utilized for anatomical data acquisition, successfully mitigating the risk of inadvertent dislodgment of the mobile abutments. The resulting digital data facilitated a precise pre-extraction simulation of the final ridge contour and esthetic try-in, guiding the subsequent conventional laboratory fabrication. An acrylic IRPD was delivered immediately post-extraction, successfully resolving the pre-existing diastema and restoring patient function. The strategic integration of intraoral scanning into a conventional IRPD workflow offers a cost-effective, clinically safe, and highly predictable solution for managing complex immediate prosthetic cases involving limited and compromised supporting structures, thereby enhancing treatment outcomes. (IJP 2025;6(2):107-109)

Introduction

Aggressive periodontitis is a destructive and swiftly progressing periodontal condition typically affecting younger individuals, resulting in premature tooth loss, severe alveolar bone resorption, and functional deficiency. This pathological process often significantly impairs both esthetics and psychosocial well-being, demanding immediate, comprehensive management.[1,2] The disproportionate bone loss observed relative to localized factors differentiates it from chronic periodontitis.[3]

The loss of anterior teeth presents a particularly acute distress, impacting speech and self-confidence.[4] Immediate dentures are a vital therapeutic modality, as they circumvent the psychologically damaging edentulous period, stabilize esthetics, and promote psychological comfort.[5,6] Furthermore, these prostheses serve a beneficial function as a surgical splint, offering protection to the extraction sites during the initial healing phase.

Contemporary dentistry increasingly leverages digital tools, such as intraoral scanners, to visualize post-extraction anatomy and greatly enhance esthetic predictability, by using digital simulations that allow clinicians to visualize post-extraction outcomes.[7-9] However, the expense associated with a fully digital workflow (e.g., 3D printing of the final prosthesis) remains a significant barrier in many clinical settings. Therefore, a hybrid protocol that utilizes highly accurate intraoral scanning for precise diagnosis and planning, combined with cost-effective conventional laboratory fabrication, represents a balanced and adaptable clinical strategy.

This case report details the successful rehabilitation of a young female patient afflicted by generalized aggressive periodontitis, employing intraoral scanning for critical digital simulation to guide the subsequent conventional fabrication of an immediate removable partial denture.

Case Report

Case Presentation

A 35-year-old systemically healthy female sought treatment primarily due to highly mobile anterior teeth and dissatisfaction regarding her smile esthetics. She reported masticatory difficulties and expressed profound anxiety regarding potential edentulism.

Intraoral examination revealed generalized gingival recession, deep probing depths, and Grade III mobility affecting multiple maxillary and mandibular anterior teeth figure 1. Panoramic radiography confirmed generalized vertical bone loss, extending extensively into the middle and apical third of the roots figure 2. The diagnosis of generalized aggressive periodontitis was confirmed.

Eleven teeth were considered hopeless and indicated for extraction. Premolars and canines, which retained adequate periodontal support, were preserved to serve as abutments.

Case Management

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Table 1. Treatment Timeline of the case

Time Point	Clinical Procedures	Findings / Patient Feedback
Day 1 (Initial visit)	Clinical and radiographic examination (panoramic), intraoral and extraoral photographs, intraoral scanning with Runyes V3. STL files sent to laboratory for fabrication of pre-extraction model and digital extraction simulation.	Patient presented with generalized aggressive periodontitis and severe tooth mobility. Expressed concern about esthetics and fear of being toothless.
Week 1 (Treatment day)	Extraction of hopeless teeth, wound suturing, and immediate insertion of removable partial denture.	Prosthesis delivered successfully, restoring esthetics and phonetics immediately after extraction.
Post-op Day 1 (Missed visit)	Patient unable to attend follow-up due to family matters.	—
Week 2 (1st follow-up)	Clinical check-up, adjustment of prosthesis, suture removal.	No significant complaints; swelling reduced; patient reported anxiety about possible suture loosening. Healing uneventful.
Week 3 (2nd follow-up)	Further evaluation of soft tissue healing.	Patient reported increased comfort, able to chew and speak normally. Extraction sites healing well.
Week 4 (3rd follow-up)	Final short-term review.	Patient could chew slightly harder foods, felt normal function restored, expressed satisfaction with esthetic and functional outcomes.

Figure 1. Patient's extra and intra oral photo (initial condition)

Figure 2. Panoramic Radiograph

Figure 3. 3D model comparison before and after surgery

Due to the high mobility and frailty of the remaining abutments (canines and premolars), an intraoral scan (Runyes V3) was performed to safely capture the full-arch data and interocclusal relationship, mitigating the risk of inadvertent tooth extraction often associated with conventional impression trays.

The digital files were processed to simulate post-extraction arches, virtually removing hopeless teeth and generating predictive ridge contours. This simulation allowed evaluation of anterior esthetics, midline correction, and smile design, aiding both clinical planning and patient communication.

Despite digital planning, fabrication was performed conventionally for affordability and flexibility. Acrylic denture teeth were arranged in wax according to the digital simulation. A conventional acrylic immediate removable partial denture was fabricated with Gillet clasp retention on premolars.

At the surgical appointment, the hopeless teeth were extracted, and the prosthesis was inserted immediately, restoring esthetics, phonetics, and function while acting as a protective dressing.

Follow-ups were carried out at one week, two weeks, and three weeks. Adjustments were made to relieve sore spots, maintain occlusion, and monitor healing. The patient reported satisfaction with esthetics and regained self-confidence.

Discussion

The immediate restoration of the anterior zone is mandatory in such cases to prevent the esthetic and psychological trauma associated with an edentulous phase.[2,4,6] This case utilized a hybrid approach, strategically combining the high precision of digital scanning with the proven accessibility of conventional laboratory fabrication. Critically, the use of the intraoral scanner proved essential in achieving clinical safety, as it eliminated the need for force application during impression making, thereby protecting the few remaining, highly compromised abutments from potential iatrogenic dislodgment.

A known limitation of the purely conventional immediate denture technique is the inability to conduct an anterior tooth try-in to verify esthetics and occlusal plane. In this hybrid protocol, the digital simulation of the post-extraction ridge provided a virtual mock-up for evaluating anterior esthetics, midline correction, and smile design prior to fabrication figure 3. This step significantly enhanced the patient's acceptance and improved the predictability of the final esthetic outcome. The intraoral scanner played a critical role in preventing mechanical dislodgment of fragile teeth during impression making, while also capturing accurate occlusion. Digital simulation enhanced esthetic predictability and strengthened patient acceptance, addressing a known limitation of conventional immediate dentures, which lack anterior try-ins.[7-9]

The decision to preserve the canines and

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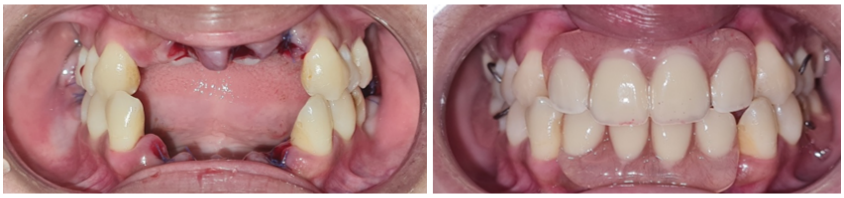

Figure 4. Post-surgical and insertion of removable immediate denture

Figure 5. Final Condition 3 weeks after insertion

premolars, utilizing them as abutments with Gillet clasps, was pivotal. This approach ensures superior stability and better load distribution, aligning with literature advocating for removable partial immediate dentures over complete immediate dentures when sufficient abutment teeth are available. Retention of premolars provided stability and improved load distribution, consistent with previous literature advocating partial rather than complete immediate dentures when possible.[5] Psychologically, the immediate esthetic restoration was paramount for this young patient, successfully maintaining her social integration and self-confidence, a major concern in aggressive periodontitis cases.[2,3,6]

A limitation of the immediate denture, regardless of the workflow, is the inevitable alveolar bone resorption following extraction, which necessitates periodic relining or eventual rebasing to maintain fit and stability. The patient was thoroughly educated regarding the necessity of continuous maintenance and the long-term plan for a definitive prosthetic solution, such as fixed partial dentures or dental implants, once healing process is complete.

Conclusion

This case successfully demonstrates that implementing a hybrid digital-conventional workflow is a viable and cost-effective solution for challenging immediate denture cases, particularly those complicated by aggressive periodontitis and limited, compromised abutments. The integration of intraoral scanning ensured clinical safety during data acquisition and significantly enhanced esthetic predictability through digital simulation. This approach resulted in the immediate restoration of esthetics, phonetics, and the patient's psychosocial well-being.

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CASE REPORT

Management of single complete dentures in parkinson's patients

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Keywords: Motor Impairment, Parkinson's disease, Single complete denture

ABSTRACT

Background: Parkinson's disease is a progressive neurodegenerative disorder that disrupts control of body movement, which directly affects oral function, including adaptation to dentures. Motor symptoms such as tremors, bradykinesia, and rigidity, as well as non-motor manifestations such as cognitive impairment and depression, pose challenges in prosthodontic rehabilitation. Purpose: Prosthodontic management of single complete denture for an elderly patient with advanced stage Parkinson's disease, highlighting clinical challenges, care strategies, and the role of caregivers. Case: A 75-year-old female with diagnosis of Braak stage 6 Parkinson's disease have difficulty chewing due to complete tooth loss in the upper jaw and nearly total tooth loss in the lower jaw. The patient experienced motor limitations, medication-induced xerostomia, and difficulty understanding instructions. Management: Prosthodontic treatment consisted of fabricating conventional single complete dentures made of acrylic on the upper and lower jaws. Management of these limitations involved an individualized approach, simple denture design, modification of the tooth arrangement, and comprehensive education involving caregivers, this includes training in denture wearing and salivary gland massage to address lacks of saliva. Conclusion: Prosthodontic management in Parkinson's patients requires simple denture design, empathetic, as well as effective communication and education with both the patient and caregiver to achieve optimal oral rehabilitation. This can improve chewing function, comfort, and quality of life for patients. (IJP 2025;6(2):110-115)

Introduction

Parkinson's disease is a progressive neurological condition that affects the nervous system, particularly the areas of the brain that produce dopamine. Dopamine is a chemical that is important for controlling movement. When these dopamine-producing nerve cells are damaged, dopamine levels decrease, leading to characteristic motor symptoms such as tremor (shaking), bradykinesia (slowed movement), rigidity (stiffness), and balance problems. The cause of nerve cell loss is still unknown, but it is likely a combination of genetic and environmental factors. Dr. James Parkinson described this disease as shaking palsy.[1-3]

As the second most common neurodegenerative disease in the world after Alzheimer's, Parkinson's is generally diagnosed in older adults, i.e., those over 60 years of age, with prevalence increasing with age. The average age of Parkinson's patients is 65 years, with prevalence increasing by 0.6% in the 65–69 age group and 2.6–3.5% in the 85–89 age group. Medications for the symptoms caused by this disease vary and there is no single primary choice, but commonly used drugs include levodopa, dopamine agonists, cholinesterase inhibitors, antimuscarinic drugs, monoamine oxidase-B inhibitors, and amantadine. In addition to medication, surgery or a combination of both can also be performed to reduce the symptoms of Parkinson's disease.[4]

The manifestations of Parkinson's disease can extend to the oral cavity. Motor disorders can make it difficult to maintain oral hygiene, and the side effects of medications taken by patients can trigger other problems, such as dry mouth (xerostomia), reduced masticatory function, caries, periodontal disease, hypersalivation and drooling, orofacial pain, burning mouth syndrome, bruxism, and taste disorders.[5] These symptoms can also cause various orofacial manifestations, such as reduced facial expression with a mask-like appearance, reduced blinking frequency, tremors in the forehead, eyelids, lips, and tongue muscles, and involuntary mandibular movements.1 Previous studies have shown that this disease does not only affect one type of jaw movement, but impacts several involuntary and automatic movements. Therefore, difficulty swallowing (dysphagia) is common in Parkinson's patients due to weakness of the pharyngeal motor muscles.[6]

Non-motor symptoms also pose a negative impact on Parkinson's patients, such as sleep disorders, cognitive issues, and depression.3Depression is the most common mental illness associated with Parkinson's disease, with a prevalence ranging from 4% to 70%.[7] The presence of oral manifestations, motor disorders, and psychological disturbances in Parkinson's patients complicates the fabrication of dentures.

This case report discusses the management of complete single denture fabrication, including denture design, difficulties in impression taking and recording jaw movements, education and

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Figure 1. **Extraoral photograph**

Figure 2. **Intraoral photo of the patient in the occlusal position. Teeth 43 and 38 remain**

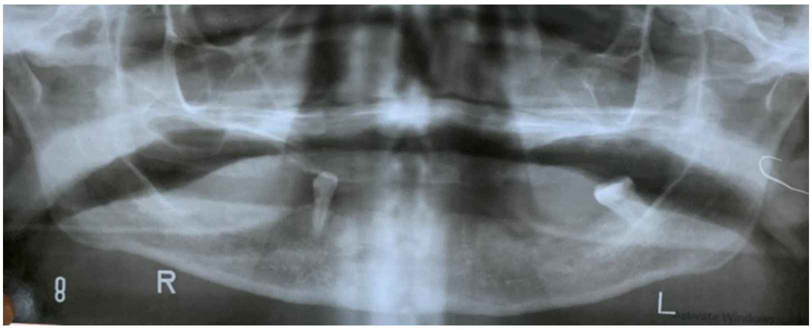

Figure 3. **Panoramic radiographic photo. There is no thinning or discontinuity of the mandibular cortex, and no lesions are visible on the patient's jawbone**

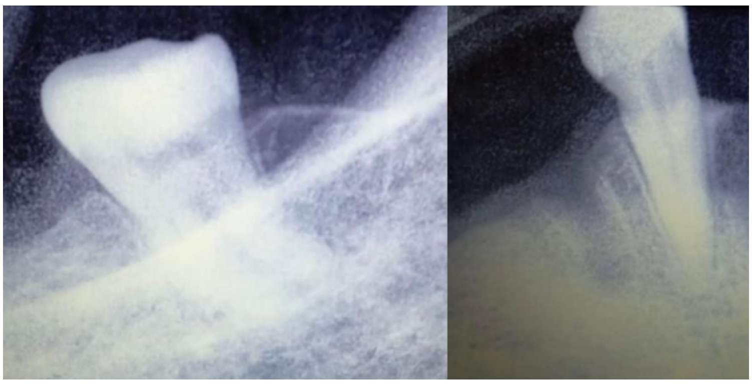

Figure 4. **Periapical radiograph of teeth 38 and 43. The crown-to-root ratio is still good at 2:1, with no widening of the periodontal ligament or periapical lesions**

instructions on denture use, and the role of caregivers in this care. Care strategies for Parkinson's patients must consider the physical and psychological challenges associated with the disease, in addition to empathy and concern from the operator, as well as effective time management.

Case Report

A 75-year-old female patient came to the Specialized Dental and Oral Hospital of the Faculty of Dentistry, University of Indonesia, with the main complaint of wanting dentures made so that she could chew food comfortably because she was currently experiencing difficulties due to tooth loss. The patient has a history of using a partial removable denture on the upper jaw, which is no longer secure due to the extraction of the teeth that supported the denture. Currently, the denture is no longer in use.

The patient suffers from Parkinson's disease and is under the supervision of an internal medicine specialist. Extraoral examination: square face with asymmetry, straight profile, unequal height of the pupils and tragus indicating poor vertical balance. Symmetrical nose with normal respiratory function. Symmetrical lips, closing perfectly, and physiological oral aperture. Lymph nodes are not palpable and are not painful.

No clicking, crepitus, or pain was found in the left and right temporomandibular joints when opening or closing the mouth. Palpation of the masticatory muscles, including the masseter, temporalis, and pterygoid muscles, also did not cause pain. The patient's orofacial muscles were rigid, making it difficult to move laterally and impossible to move according to the operator's instructions.

Intraoral examination: the left posterior upper vestibule is shallow, the right posterior upper and anterior vestibules are moderate, the left and right posterior lower vestibules are shallow, and the anterior lower vestibules are moderate. The residual ridge shape of the patient's upper jaw is oval in the left posterior, right posterior, and anterior regions; with low height in the left posterior, moderate height in the right posterior and anterior regions; low tissue resistance in the left posterior, right posterior, and anterior regions; the surface shape of the left posterior and anterior regions is uneven, while the right posterior region is smooth. The shape of the residual ridge of the patient's lower jaw is triangular on the left posterior, oval on the right posterior and anterior; with low height on the left posterior, right posterior, and anterior; low tissue resistance on the left posterior and right posterior, moderate on the anterior; the surface shape of the left posterior, right posterior, and anterior is uneven.

The condition of the patient's oral cavity shows moderate oral hygiene with visible plaque and calculus accumulation on the remaining teeth, namely teeth 38 and 43. The patient's salivary glands produce secretions in less than normal volume with normal consistency. The size of the patient's tongue appears normal with normal mobility, but it is in Wright Class 3 position where the tongue is retracted and falls to the

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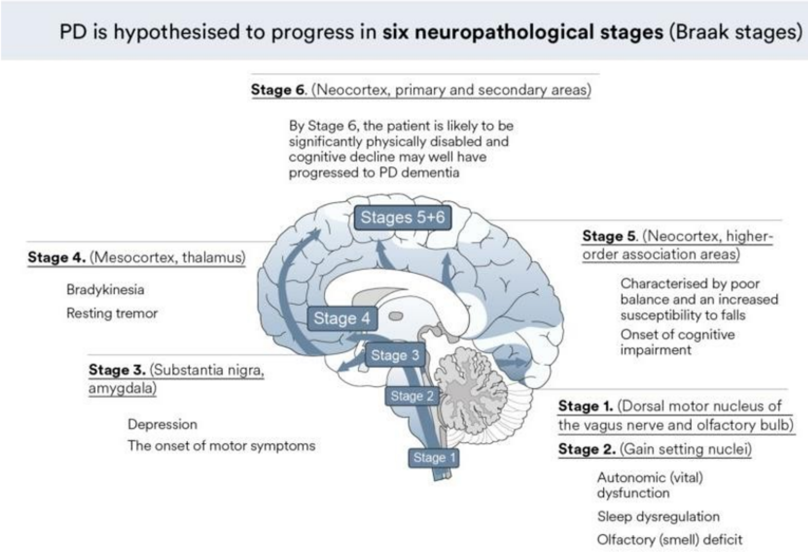

Figure 5. Stages of parkinson's disease according to braak stages

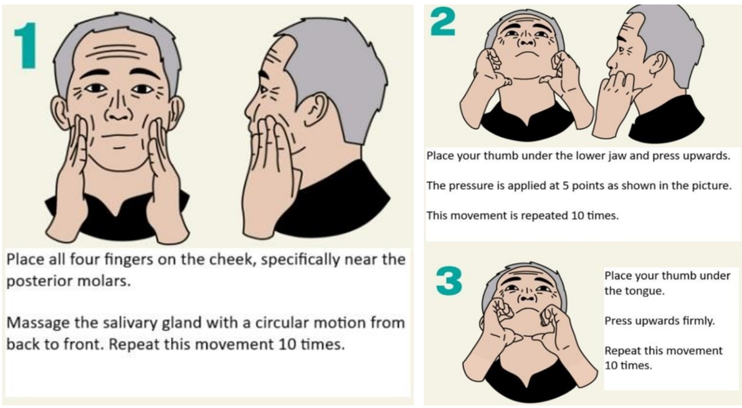

Figure 6. Illustration of salivary gland massage

Figure 7. Definitive vertical dimension

bottom of the mouth, with the tip of the tongue curling upward. The patient's gag reflex is low, and the oral mucosa appears healthy without any lesions or pathological abnormalities. The jaw relationship shows a prognathic pattern. The patient's chewing ability is still good.

In this case, the patient refused to undergo dental implant placement and extraction of the remaining teeth. The patient was provided with an explanation and the potential risks. Clinical and radiological examinations of teeth 38 and 43 resulted in a diagnosis that these teeth are vital with a good crown-to-root ratio and no mobility, making them suitable as abutment teeth. There is no lack of prosthetic space. The diagnosis for this patient was complete tooth loss in the upper jaw and teeth 37, 36, 35, 34, 33, 32, 31, 41, 42, 44, 45, 46, 47, and 48, requiring rehabilitation with the fabrication and placement of a complete single denture; a complete upper denture and a conventional acrylic partial removable lower denture.

This patient has Parkinson's disease in Braak Stage 6, with clinical characteristics of difficulty walking and mobility using a wheelchair. Braak et al define stages 1-3 as the presymptomatic phase and stages 4-6 as the symptomatic phase. In the presymptomatic phase, Lewy bodies are already visible in the brain. In stage 2, patients experience difficulty sleeping and loss of smell. In stage 3, patients begin to experience depression and motor limitations, while in stage 4, the characteristic signs of Parkinson's disease occur, such as slow movement and tremors when the patient is at rest. In stages 5 and 6, patients have difficulty standing due to impaired balance and decreased cognitive function.8 The muscles of the extremities and oral cavity are stiff, there is difficulty moving the mandible, and there is difficulty with in understanding and remembering instructions. Oral manifestations include xerostomia due to the antidepressant and antipsychotic medications routinely consumed by the patient. Because the treatment plan for this patient involved complete upper dentures, cohesive adhesion was required for retention, and the operator asked the caregiver to consult with an internist about administering artificial saliva. However, this was not medically approved. Therefore, the operator could only provide education and instructions for performing salivary gland massage (Figure 2.6) and consuming plenty of water to increase saliva production in the patient.

In this case, conventional denture fabrication was chosen due to functional movement limitations caused by neurological impairment. Acrylic material was the primary choice due to its ease of repair. For Parkinson's patients, the use of denture adhesive can enhance confidence in wearing dentures.9 Treatment began with anatomical impressions to create a tentative vertical dimension bite block and individual impression trays for the upper and lower jaws. The upper jaw impression tray was made without spacers for zinc oxide eugenol impression material, and the lower jaw was made using two wax spacers and stoppers for alginate impression material. On the next visit, the

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Figure 8. **Denture base elevation modification. Teeth 27 and 47 were replaced with base elevation to reduce the patient's chewing load**

Figure 9. **Occlusion and Articulation. In the upper jaw, red indicates occlusal contact and blue indicates articulation contact. In the lower jaw, black indicates occlusal contact and red indicates articulation contact**

Figure 10. **Intraoral view of the patient's complete denture**

operator measures the tentative vertical dimension using a bite splint because the patient's old dentures are no longer secure and have an incorrect vertical dimension of occlusion. On the same day, functional impressions are taken using green stick compound and physiological impressions are taken.

The next visit involved definitive vertical dimension measurements. The definitive vertical dimension was recorded in the centric relation position. The centric relation was obtained using the swallowing method, bilateral manual guidance, and the creation of a Walkhoff nucleus on the upper jaw bite block. The vertical dimension, bite block alignment, profile, and phonetic closest speaking space were well confirmed. After that, a facebow transfer was performed for mounting on a semi-adjustable articulator.

Teeth arrangement was performed using the concept of bilaterally balanced occlusion with modification of the antagonistic contact of teeth 38 and 17, which were replaced with an elevated denture base without tooth elements. This was done to reduce masticatory load. On the incisal of tooth 43, model reduction was performed because the tooth passed the curve of Wilson and interfered with the occlusion concept arrangement. During the next visit, a night trial and occlusal adjustment of tooth 43 were performed. This was followed by a laboratory process of making clasps, where a 2-finger clasp was used on tooth 38 as a combination support and a gilet clasp was used on tooth 43. After that, a post dam, gum cuffing, and packing were made.

During the next visit, a single complete denture was inserted. The expansion of the wings and base of the denture was confirmed to be correct before observing the intaglio surface pressure on the mucosa using pressure indication paste (a mixture of fletcher powder and olive oil). After that, occlusion and articulation were examined to confirm the concept of a bilaterally balanced occlusion.

The first challenge during insertion was the lack of retention of the complete upper jaw denture due to xerostomia, prompting the operator to remind the patient to massage the salivary glands and instruct them to massage before wearing the denture. The patient was instructed to use denture adhesive if the xerostomia condition was not resolved by massage. The second obstacle was the patient's difficulty in inserting and removing the dentures due to severely limited motor skills. For this, the operator educated and trained the caregiver to assist the patient. The final obstacle was the patient's difficulty in understanding the instructions, so the operator prepared notes to be given to the patient and caregiver.

At the last control visit, the patient still routinely massaged the salivary glands and subjectively had no complaints regarding comfort. The dentures were retentive and the patient rarely used denture adhesive until the end of the control treatment. Objectively, the mucosa was healthy with good occlusion and articulation. Therefore, it can be concluded that restorations in Parkinson's patients require an effective and concise treatment plan with the simplest possible treatment

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design, good communication between the operator and the patient, as well as between the operator and the caregiver.

Discussion

Oral rehabilitation in patients with Parkinson's disease presents unique challenges that require a comprehensive approach. This case discusses prosthodontic management in a Parkinson's patient with maxillary edentulism and partial mandibular edentulism, with restoration using a single acrylic complete denture. Parkinson's disease is a degenerative brain condition associated with various motor and non-motor symptoms, such as slow movement, tremors, stiffness, imbalance, and cognitive decline and mental disorders. This condition significantly affects the patient's ability to maintain oral health and adapt to dentures.[3,5]

Xerostomia, or dry mouth, is a common complaint among Parkinson's patients and is the root cause of caries and periodontal disease. This occurs due to a reduction in both stimulated and unstimulated saliva secretion, which is caused by the consumption of medications that treat Parkinson's symptoms, such as tricyclic antidepressants, antipsychotics (e.g., clozapine), anticholinergics, beta-blockers, and antihistamines. These medications are categorized as xerogenic drugs.10 Efforts to overcome xerostomia include: increasing hydration by drinking enough water, massaging the salivary glands to increase saliva quantity, using special dry mouth lozenges to increase saliva quantity and consuming xylitol, avoiding mouthwashes containing alcohol and cigarettes as they can worsen dry mouth, Patients can also be taught facial muscle exercises and tongue exercises aimed at improving the function of the orofacial muscles and facilitating saliva production and distribution.[3,5,9]

Parkinson's patients often need help maintaining their oral hygiene. Therefore, caregiver education is very important. Caregivers need to be taught how to maintain the oral hygiene of patients and their dentures. In terms of denture care, caregivers must ensure that dentures are cleaned daily by soaking and brushing them with a non-abrasive cleaner. Dentures should be rinsed thoroughly after contact with the cleaner before being reinserted. It is also important to remember not to soak dentures in boiling water. Dentures should be stored submerged in water when not in use.[3,6]

The implementation of a coordinated treatment plan, including the fabrication of appropriate dentures and comprehensive education, can significantly improve the oral function of patients with Parkinson's disease . Improved chewing rates and bite force after the use of stable upper jaw complete dentures contribute to improved masticatory ability in patients. This is directly related to improved quality of life in patients related to oral health.[11] A compassionate and attentive approach to PD patients is essential to address anxiety and improve patient compliance with treatment. Cognitive impairment, dementia, and difficulties in verbal communication must be handled sympathetically. Therefore, it is recommended that dentists introduce themselves at each appointment. Stress is known to exacerbate tremors and uncontrolled movements during treatment. Smiling, direct eye contact, and gentle touch are known to reduce anxiety.

The presence of a caregiver beside the patient also helps to increase the patient's confidence and to interpret the patient's speech. Short appointments in the morning are ideal for patients. Tremors are less frequent in the morning. Communication with patients can be improved by using closed questions and allowing sufficient time for patients to respond. Effective communication is essential to motivate patients to undergo treatment and to use dentures successfully in the future. The dental chair backrest should be raised and lowered slowly. The dental chair should be in an upright position to prevent orthostatic hypotension.[12]

During the impression procedure, a 45-degree reclining position during impression taking is beneficial to avoid excessive saliva accumulation and reduce the risk of aspiration. Since patients cannot perform functional movements well, the Gothic arch tracing method cannot usually be used in Parkinson's patients to record the centric relation. Instead, bilateral manipulation techniques are used to guide the mandible into centric relation. Tooth arrangement in the neutral zone also improves the stability and retention of dentures. In the study by Viktor et al, tooth arrangement in the neutral zone did not interfere with involuntary muscle movements in Parkinson's patients.12Monoplane tooth elements are recommended for patients with poor muscle control to assist with irregular mandibular movements. A lingual occlusion scheme can also be used in Parkinson's patients due to better masticatory efficiency and more limited lateral movement of dentures. Flat or monoplane lower denture elements are expected to enhance feedback from the masseter muscle and mucosa, thereby helping patients improve proprioception and mandibular movement. Water- -based denture adhesive and denture cleaners will also help boost confidence in denture use and maintain denture hygiene.[3,9]

Given the progressive nature of Parkinson's disease and possible changes in the hard and soft tissues of the oral cavity (such as ridge resorption), regular check-ups are essential. Patients should continue to visit the dentist every 6 months to ensure optimal denture adaptation, evaluate the condition of the supporting tissues, and manage any complications that may arise.

Conclusion

Parkinson's disease is a neurodegenerative disorder that causes motor and non-motor symptoms, which directly or indirectly affect the condition of the oral cavity and the patient's adaptation to dentures. Oral manifestations commonly found in Parkinson's patients, such as xerostomia, decreased orofacial motor skills, and cognitive impairment, pose challenges in all stages of denture fabrication and placement.

The role of caregivers is crucial as companions throughout the process of care, use, and daily maintenance of dentures, especially for patients with physical and cognitive limitations in the advanced stages of the disease. Management of xerostomia involves education on salivary gland massage and increased water intake, as the use of artificial saliva requires medical clearance that is not always obtainable for certain patients. Effective communication and written instructions are vital to overcome cognitive barriers and ensure the success of ongoing oral rehabilitation.

Post-insertion evaluations show that with an individualized approach, multidisciplinary collaboration, regular monitoring, and modifications to denture fabrication and fitting techniques, patients can still achieve optimal chewing function, comfort, and quality of life. Therefore, prosthodontic care management for Parkinson's patients requires an effective, simple, patient-centered treatment plan supported by proper education for patients and caregivers to achieve successful oral rehabilitation outcomes.

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CASE REPORT

Restoring function and quality of life through early interim obturator therapy after left hemimaxillectomy

Riddo A. Rudhanton, Astila Fitriana, Agus Dahlan*

Keywords: Maxillectomy, Maxillofacial prosthesis, Obturator, Spindle cell sarcoma

ABSTRACT

Background: Maxillectomy, whether total or partial, results in significant anatomical and functional disturbances, including oronasal communication, impaired mastication, speech difficulty, and esthetic disfigurement. These sequelae can severely affect a patient's nutritional status, social interaction, and psychological well-being. Rehabilitation following maxillectomy aims to restore oral function and improve quality of life through obturator prostheses that close the surgical defect Objective: This case report aims to present the clinical management for hemi-maxillectomy Case Report : This report presents the case of a 76-year-old female, a housewife, who was referred to the Prosthodontic Clinic of RSKGMP Universitas Airlangga by an Oncology Surgeon for the fabrication of an obturator. The patient presented two weeks after hemi-maxillectomy surgery performed on. The patient complained of oronasal communication, hyper nasal speech, and difficulties in mastication and swallowing postoperatively; she had no previous experience using any obturator prosthesis. An interim acrylic obturator was planned to restore oral-nasal separation, improve speech intelligibility and swallowing function, and support psychological adaptation during the healing phase. Clinical procedures included impression-taking of the maxillary defect, jaw relation recording, tooth arrangement, and fabrication of an acrylic obturator supported by the remaining teeth. Follow-up evaluations demonstrated marked improvement in speech resonance, masticatory efficiency, deglutition, and patient comfort, with gradual adaptation to the prosthesis. Conclusion: This case report highlights the importance of timely interim obturator rehabilitation in elderly post-hemi maxillectomy patients to restore function, improve quality of life, and reduce psychological distress.. (IJP 2025;6(2):116-119)

Introduction

Maxillary defects resulting from hemimaxillectomy represent one of the most challenging conditions in restorative dentistry and maxillofacial surgery. These defects often result from tumor resection, trauma, or congenital anomalies and lead to significant oronasal communications that compromise oral function and aesthetics. The loss of hard and soft palatal structures creates substantial difficulties in mastication, deglutition, and speech, profoundly affecting the patient's physical health and psychological wellbeing.[1,2]

The immediate post-operative period following hemimaxillectomy demands urgent prosthodontic intervention to restore basic oral functions and facilitate wound healing. During this critical phase, the placement of an interim obturator becomes essential to seal the defect, prevent regurgitation of food and liquids, and reduce hypernasal speech. Interim prostheses serve as a bridge between surgery and definitive rehabilitation, allowing tissues to stabilize while providing the patient with functional restoration and social reintegration.[2-4]

Interim obturators offer several clinical advantages in the early post-surgical management of hemimaxillectomy patients. These prostheses enable early oral feeding, improve patient comfort, facilitate speech clarity, and provide psychological reassurance through partial restoration of normal appearance. The prompt fabrication and insertion of interim obturators have been shown to significantly enhance patient adaptation and quality of life during the healing phase.[4,5]

The literature supports the use of interim obturators as a standard of care in maxillofacial rehabilitation following hemimaxillectomy. This case report presents the clinical management and outcomes of an interim obturator prosthesis for a hemimaxillary defect, demonstrating its role in functional and psychosocial rehabilitation. The case illustrates the importance of early prosthetic intervention and the clinical techniques required for successful interim obturator fabrication and adaptation.[5,7]

The present case report documents the clinical features, diagnostic evaluation, and therapeutic management of a patient presenting with lateral dystonia treated with occlusal splint therapy, demonstrating the significant contribution of dental interventions in the holistic care of movement disorders affecting the stomatognathic system.

Case Report

Case Presentation

A 76-year-old female patient presented to the Prosthodontics Clinic at the Dental Hospital (RSKGMP), Universitas Airlangga, upon referral from an Oncology Surgery Specialist for fabrication of a maxillary obturator, two weeks after undergoing hemimaxillectomy. The surgical procedure was performed on May 4th, 2024, with a

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Figure 1. The extraoral condition of the patient

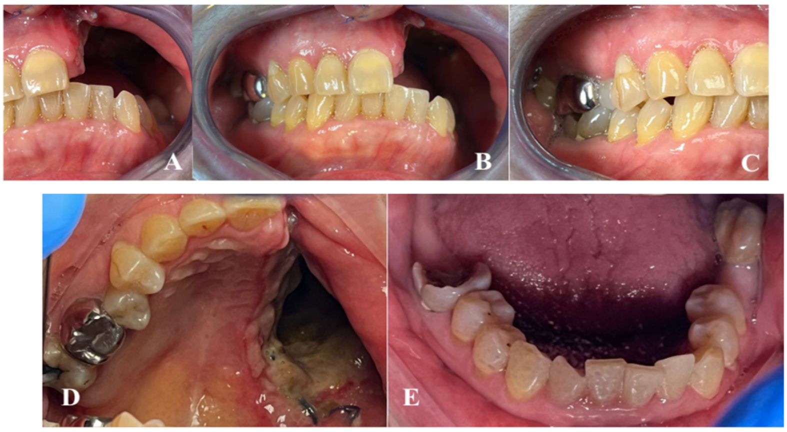

Figure 2. The intraoral condition of patient

Figure 3. Panoramic radiograph

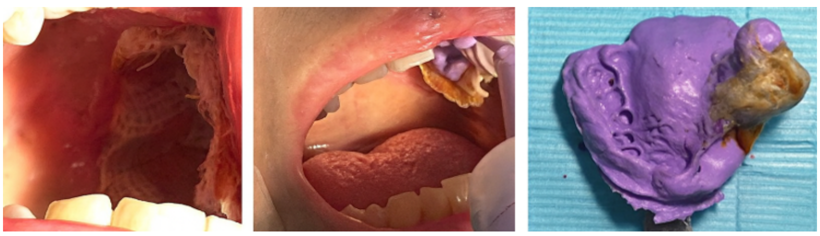
Figure 4. Sterile gauze for stopper (left), Alginate applied in sterile gauze (center), Impression of maxillary (right)

clinical diagnosis of malignant melanoma (differential diagnosis: sarcoma), and the histopathological examination established a final diagnosis of spindle cell sarcoma. The patient reported that her last dental treatment on the lower left posterior teeth had been carried out approximately 10 years prior to presentation. She had no previous experience with obturator prostheses.

The patient was diagnosed with multiple concurrent dental and maxillofacial conditions. There is a post-hemimaxillectomy defect in the left maxillary region consistent with a Class I Aramany maxillary defect, reflecting unilateral loss of maxillary teeth and supporting structures. In addition, the patient presents with edentulous ridges in the mandibular right first molar (tooth 46) and mandibular left second molar (tooth 37/47) regions, a chronic apical periodontitis secondary to pulpal necrosis in tooth 46, and a horizontally angulated, Class III impacted mandibular left third molar (tooth 38).

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The radiographic evaluation revealed loss of maxillary bone and associated teeth in the left upper region, consistent with a post-surgical maxillary defect. Mandibular posterior edentulism was noted in the regions of teeth 36 and 47. Radiopaque findings were evident in teeth 17 and 37, representing existing restorative fillings, and a radiopaque crown restoration was observed on tooth 16. A radiolucent lesion was identified on the distal aspect of tooth 46, suggestive of proximal dental caries, while a radiopaque mass in the mandibular left third molar region confirmed an impacted tooth 38.

The clinical session began with patient identification, completion of clinical records, and obtaining informed consent. Functional impressions of the maxillary and mandibular arches were made using stock trays and an irreversible hydrocolloid impression material (alginate). In the maxillary defect area, the surgical site was first protected using sterile moistened gauze and povidone-iodine for asepsis, after which the impression material was injected into the defect using a syringe to accurately capture its morphology. The impressions were then poured with type III dental stone to obtain the working casts.

Based on the maxillary working cast, a record base and occlusion rim were fabricated, followed by jaw relation registration. Lip support, the occlusal plane, and the buccal corridor were evaluated clinically, and tooth shade was selected to match the adjacent natural teeth (A3, Vita Classical). The maxillary and mandibular working casts were mounted on an articulator according to the established maxillomandibular relationship,

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Figure 5. **The jaw relation registration (left), Maxillary bite rim (center), Tooth arranged with articulator (right)**

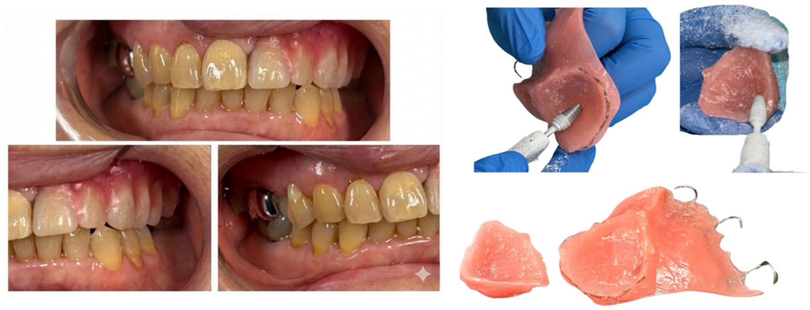

Figure 6. **The try-in in patient (left), Fabrication of hollo part (right)**

and acrylic denture teeth were arranged in the edentulous area corresponding to the obturator prosthesis.

A clinical try-in of the arranged teeth on the obturator framework was performed to assess occlusion, aesthetics, phonetics, and prosthesis stability. After necessary adjustments, the final contouring was completed and the prosthesis was processed in heat-cured acrylic resin. A two-piece closed hollow obturator design was used, with the hollow portion created and then joined using self-cured acrylic resin. The internal acrylic of the hollow section was reduced to decrease the overall weight of the prosthesis to enhance comfort during use. Finishing and polishing were carried out until all surfaces were smooth and free of sharp edges.

At the insertion appointment, the obturator was placed intraorally and adjusted as required. The patient was instructed to wear the obturator continuously for 24 hours, including during speech, drinking, consumption of soft foods, and sleep. Detailed instructions were provided regarding insertion and removal techniques, as well as daily cleaning of the prosthesis. Because the patient resided in Malang and was medically compromised, routine in-person follow-up visits were minimized; instead, the operator maintained regular remote communication to monitor comfort and function. The patient was referred to an oral and maxillofacial surgeon in Malang for extraction of teeth 38 and 46 as indicated.

Within two months of obturator insertion, the patient passed away due to gastrointestinal complications related to her systemic condition. As a result, prosthetic rehabilitation could be completed only to the stage of interim obturator fabrication, and a definitive obturator was not achieved.

Discussion

Clinical Challenges in Hemi-maxillectomy Rehabilitation

Post-hemi-maxillectomy rehabilitation represents one of the most challenging scenarios in maxillofacial prosthodontics due to the extensive nature of the surgical defect and the profound functional consequences for the patient. The resection of maxillary structures results in loss of hard and soft palatal tissues, creating significant oroantral/oro-nasal communications that fundamentally compromise the patient's ability to perform basic oral functions.[6] These defects necessitate rigorous prosthodontic intervention to achieve adequate seal, retention, and stability while minimizing prosthetic weight and complexity.

Significance of Interim Obturator Placement

The placement of an interim obturator approximately one week following surgical resection provides critical early support and protection during the most vulnerable stage of tissue healing.[7] During this phase, tissues remain mobile, non-cicatrized, and actively bleeding, making them susceptible to irritation and further trauma. The interim obturator serves to minimize tissue manipulation, reduce bleeding, protect healing tissues, and support the psychological wellbeing of the patient by enabling early functional restoration. In the present case, the interim obturator was inserted one-week post-hemi-maxillectomy and was intended to serve the patient until optimal tissue healing was achieved, typically occurring over a period of 2-6 months.

Design Considerations: Closed Hollow Bulb Obturator

For patients with extensive maxillary defects following hemi-maxillectomy, achieving adequate prosthetic rigidity while maintaining clinical acceptability requires careful design considerations regarding retention, stability, and prosthetic weight. The closed hollow bulb obturator design was selected for this case due to its multiple advantages over the open hollow bulb design.[6,7] The closed hollow bulb configuration prevents retention of fluids and food debris, facilitates oral hygiene maintenance, and allows for easy prosthesis cleaning—advantages that are critical for patient compliance and long-term success.[8] Additionally, the closed hollow design can extend superiorly into the defect area, minimizing air spaces and mucous accumulation, thereby reducing overall prosthetic weight by approximately 30-35%,[8,9] which significantly decreases stress on supporting tissues and improves patient comfort and tolerance.

Fabrication Technique: Two-Piece Method

In this case, the interim obturator was fabricated using the two-piece technique, where the

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hollow bulb portion and the palatal base portion were constructed separately and subsequently united using self-cured acrylic resin.[10] This technique offers several distinct advantages over the single-piece (one-piece) technique: the obturator can be fabricated with reduced overall weight, the acrylic wall thickness of the hollow portion remains uniform, and the prosthesis is more convenient and comfortable for the patient to wear.[8] The two-piece technique also allows for greater flexibility in fabrication, easier clinical adjustment, and simplified maintenance during the post-insertion phase.

Retention and Stability Mechanisms

Prosthetic retention in hemi-maxillectomy patients is derived from remaining dentition and residual palatal tissues. In this case, retention was achieved through wrought wire clasps placed on the remaining maxillary anterior teeth (teeth 11, 14, and 16), specifically utilizing half-Jackson clasp design on these abutment teeth. The prosthetic base was extended to the maxillary tuberosity region to maximize functional support, retention, and overall prosthetic stability. Maximum palatal coverage of the remaining palate ensures optimal distribution of functional loading and improved prosthesis support, which are essential considerations in extensive maxillary defects.[7,11]

Post-Insertion Clinical Course and Treatment Interruption

Following successful insertion of the interim obturator one week post-operatively, the patient was scheduled for adjunctive radiotherapy two weeks after prosthesis insertion. During the first radiotherapy session, the patient reported satisfactory function and wore the prosthesis comfortably without significant complaints. However, following the second course of radiotherapy several weeks later, the patient developed severe oral mucositis that severely compromised nutritional intake and prevented continued use of the obturator prosthesis. This complication progressively deteriorated the patient's general health status and resulted in digestive complications.[12] Unfortunately, the patient's condition deteriorated further, and he expired approximately two months after interim obturator insertion, preventing continuation of prosthodontic rehabilitation to the definitive obturator phase.

Clinical Implications and Limitations

This case illustrates several critical clinical considerations in managing hemi-maxillectomy patients with concurrent malignancy. The development of severe oral mucositis following radiotherapy, despite successful initial prosthodontic rehabilitation, represents a common and often unpredictable complication that can interrupt prosthodontic treatment even when clinical protocols are meticulously followed.[13] While the interim obturator provided significant functional and psychological benefits during the early post-operative period, advanced cancer with adjunctive radiotherapy presents substantial limitations to long-term prosthodontic rehabilitation success.[14]

The case underscores the importance of early maxillofacial prosthodontic intervention while also highlighting the multifactorial nature of long-term rehabilitation outcomes in cancer patients. Although definitive obturator therapy could not be achieved in this case due to medical complications, the interim prosthesis provided the patient with critical functional restoration and improved quality of life during a challenging post-operative period.

Conclusion

This case demonstrates that even in medically compromised post hemi-maxillectomy patients, an interim two-piece closed hollow obturator can provide meaningful functional and psychosocial benefits within a limited timeframe. The prosthesis effectively re-established separation between the oral and nasal cavities, improved speech and swallowing, and offered acceptable aesthetics and comfort.

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CASE REPORT

Prosthodontic management of angle class III malocclusion with a maxillary single complete denture and mandibular partial denture: A case report

Meliana,[1]* Ahmad Masruri

Keywords: Angle class III malocclusion, Esthetic rehabilitation, Occlusal scheme, Prosthodontic management, Removable partial denture, Single complete denture

ABSTRACT

Angle Class III malocclusion presents a challenge in prosthodontic rehabilitation, especially when a maxillary single complete denture must oppose a partially dentate mandibular arch. Achieving acceptable esthetics and function requires careful planning of the occlusal scheme, tooth position, and vertical dimension, particularly in patients who refuse or are unsuitable for orthodontic or orthognathic treatment. This case report describes the prosthodontic management of a 63-year-old male patient with Angle Class III malocclusion, presenting with a completely edentulous maxilla and a partially edentulous mandible. The patient's chief complaint was poor esthetics due to reverse overjet, sunken lip support, and disharmonious smile appearance, compounded by functional difficulties in mastication. A maxillary single complete denture and a mandibular removable partial denture were planned to correct anterior esthetics while maintaining a stable and functional occlusion. In patients with Angle Class III malocclusion who decline or are not candidates for orthodontic or surgical correction, careful prosthodontic planning with a maxillary single complete denture opposing a mandibular partial denture can provide satisfactory esthetic and functional outcomes. A case-based, individualized approach is essential to respect the underlying skeletal pattern while optimizing dental and facial esthetics. (IJP 2025;6(2):120-124)

Introduction

A single complete denture (SCD) is defined as a complete denture placed on only one jaw, which can occlude with natural teeth, fixed bridge prostheses, removable partial dentures, or a complete denture on the opposing jaw.[1] An SCD occluding with natural teeth or a mandibular partial denture is a clinically challenging situation, as the position and morphology of the opposing teeth are relatively unchangeable and will greatly determine the occlusal form of the denture.[1-3]

Inaccurate planning of an SCD, especially in cases where an edentulous maxilla occludes with a mandible having bilateral free-end posterior teeth (Kennedy Class I), can lead to denture instability, base fracture, and resorptive changes of the maxillary ridge known as combination syndrome.[3,4] Therefore, occlusal design, load distribution, and selection of denture base material require special consideration in such cases.[2]

Angle Class III malocclusion, characterized by a more mesial anteroposterior relation of the mandible to the maxilla, is often associated with reverse overjet, anterior and/or posterior crossbite, and a concave facial profile.[5] In adult patients with partial or total tooth loss, rehabilitation often requires a multidisciplinary approach involving orthognathic surgery, orthodontic therapy, and prosthetic rehabilitation.[5] However, factors such as age, systemic condition, financial limitations, or patient refusal of surgical procedures and long-term treatment may necessitate a solely compensatory prosthodontic approach.[6-8]

Various case reports have demonstrated that Class III malocclusion in adult patients can be managed with a non-surgical prosthodontic approach through a combination of increasing the vertical dimension of occlusion, occlusal adjustment, and the use of removable dentures or overlay dentures, favorable functional outcomes when carefully planned.[6-8] This case report describes the prosthodontic management of a patient with a completely edentulous maxilla and a partially edentulous mandible with Angle Class III malocclusion, rehabilitated using a maxillary single complete denture and a mandibular removable partial denture. Emphasis is placed on anterior aesthetic correction and establishing a stable occlusal scheme within the limitations of the existing skeletal pattern.

Case Report

This case report describes a 63-year-old male with Angle Class III malocclusion, a completely edentulous maxilla, and a partially edentulous mandible with missing teeth #36, 37, 38, 44, 45, 46, 47, and 48. The patient complained of an unesthetic dental appearance, a sunken facial profile, and difficulty chewing. The patient declined orthodontic or orthognathic surgical treatment, so a prosthodontic approach was chosen, consisting of a maxillary single complete denture and a mandibular removable partial denture. The focus of treatment was anterior aesthetic correction and achieving a stable occlusion within the limitations of the skeletal pattern.

History

A 63-year-old male presented to the Prosthodontic Clinic of the Dental and Oral Hospital (RSGM), Hasanuddin University, with

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Figure 1. **Pre-treatment frontal extraoral photograph with retractor: the lower third facial profile appears reduced, upper lip support is diminished, and the ridge is not adequately visible when the mouth is opened**

Figure 2. **Right and left lateral extraoral pre-treatment photographs: A concave facial profile is observed, with a more prominent mandibular projection and insufficient upper lip support, reflecting a reduction in the vertical dimension of occlusion**

Figure 3. **Pre-treatment frontal intraoral photograph: shows complete edentulism of the maxilla with moderately resorbed alveolar ridges and healthy-appearing mucosa. The mandible presents remaining anterior teeth with attrition and discoloration, bilateral posterior tooth loss, and physiological pigmentation on the anterior labial gingiva. The jaw relationship indicates a tendency toward an Angle Class III skeletal pattern**

Figure 4. **Panoramic view**

the chief complaints of missing upper teeth, difficulty chewing, and unattractive dental appearance." The patient felt his upper lip appeared "sunken" and the lower jaw appeared more prominent, which affected his appearance when smiling and speaking.

Medical history revealed no significant systemic diseases (e.g., no history of uncontrolled diabetes, severe cardiovascular disease, or head-neck radiation therapy). The patient refused orthognathic surgery or orthodontic treatment due to cost, long treatment duration, and concerns about surgical procedures.

Clinical Examination

Extraoral examination showed a concave facial profile with a more prominent mandibular projection, decreased lower facial height, and inadequate maxillary lip support. At rest position, the incisor teeth were not visible, and the smile line tended to be flat to a reverse smile line, consistent with a Class III malocclusion presentation.[6]

Intraoral examination revealed: Maxilla: Completely edentulous with a relatively flat alveolar ridge and healthy mucosa, without ulceration or signs of severe inflammation. Mandible: Partially edentulous with missing teeth 36, 37, 38, 44, 45, 46, 47, and 48. Remaining teeth were 31, 32, 33, 34, 35, 41, 42, and 43. The pattern of tooth loss indicated bilateral free-end areas, thus classified as Kennedy Class I. Mild to moderate attrition was observed on the mandibular anterior teeth, likely due to long-term compensatory masticatory function. The vertical dimension of occlusion appeared to be decreased, indicated by a widened interocclusal rest space and increased wrinkling at the corners of the mouth.

Radiographic Examination; Panoramic radiograph showed sufficient maxillary alveolar bone height for complete denture retention, without clear pathological radiographic abnormalities. The alveolar bone around the remaining mandibular teeth (31-35 and 41-43) appeared adequate, with periodontal ligaments within normal limits. No pathological radiolucent or radiopaque lesions were observed. The temporomandibular joints showed no significant radiographic abnormalities.

Diagnosis; Based on history and clinical-radiographic examination, the following diagnoses were established: Completely Edentulous Maxilla; Partially Edentulous Mandible with Kennedy Class I classification; Skeletal Angle Class III Malocclusion; Decreased Vertical Dimension of Occlusion; Chief Complaints: Aesthetic disturbance (concave profile, reduced lip support) and masticatory function disturbance.

Treatment Plan; The treatment plan was formulated considering the patient's desire to avoid surgical or orthodontic procedures: Maxillary rehabilitation with a single complete denture (maxillary single complete denture); Mandibular rehabilitation with a metal framework removable partial denture utilizing teeth 31, 32, 33, 34, 35, 41, 42, and 43 as supports and retainers. Determination of the vertical dimension of occlusion using bite rims. Arrangement of anterior teeth to improve facial and smile aesthetics, while creating a stable occlusal relationship within the limitations of the

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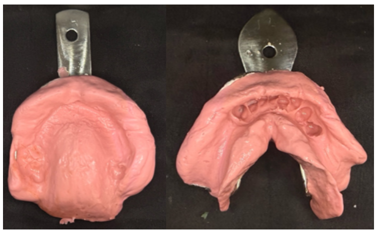
Figure 5. Anatomical impression made using an irreversible hydrocolloid material

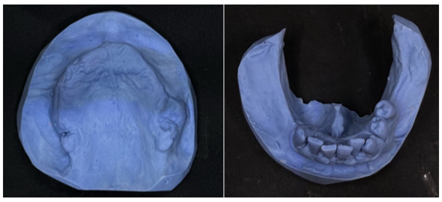
Figure 6. Anatomical model


Figure 7. Diagnostic Wax-up

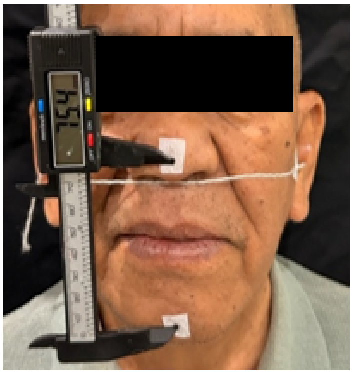
Figure 8. Determination of the vertical dimension

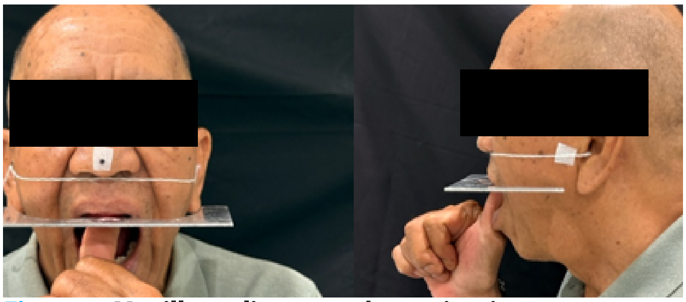
Figure 9. Maxillary alignment determination

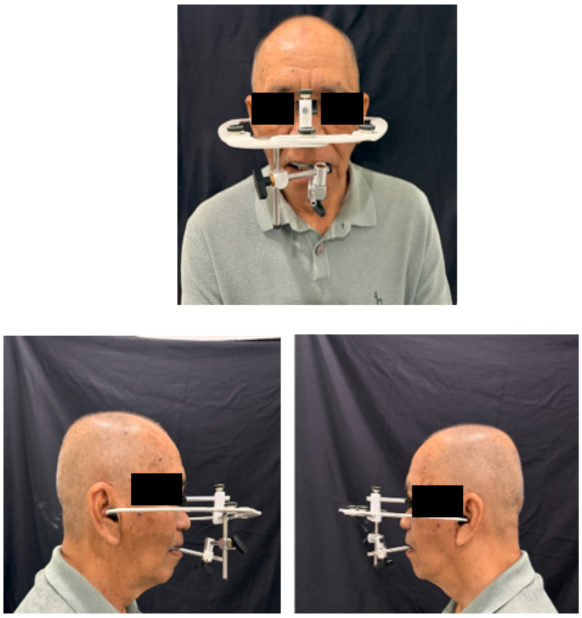
Figure 10. Transfer face Bow

Class III skeletal pattern. Patient education and scheduled periodic follow-up appointments.

Clinical Stages; Preliminary Impressions and Diagnostic Models: Preliminary impressions were made with irreversible hydrocolloid. Facebow transfer and mounting on a semi-adjustable articulator were performed. Evaluation and Diagnostic Wax-up: Occlusal analysis and diagnostic wax-up were performed to simulate tooth placement and assess aesthetic and occlusal corrections. Determination and Verification of Vertical Dimension: Bite rims were used to determine the new vertical dimension based on aesthetics, phonetics, and facial measurements. Design of Mandibular RPD: A metal framework RPD was designed with a lingual plate major connector, occlusal rests, and RPY/RPI clasp systems. Tooth Arrangement and Try-in: Maxillary anterior teeth were set more labially. Occlusion was adjusted for stable function and aesthetics. Try-in was performed for evaluation. Final Insertion and Occlusal Adjustment: The definitive SCD and RPD were inserted. Occlusal adjustments were made for balance and stability. Instructions and Follow-up Visits: The patient received instructions on denture use and hygiene. Follow-up visits were scheduled. The patient reported satisfaction with the outcome.

Discussion

Rehabilitating patients with Angle Class III malocclusion and partial or total tooth loss is a challenge that requires a comprehensive understanding of skeletal relationships, mandibular function patterns, and prosthodontic limitations.[5-8] In this case, the patient declined orthodontic and orthognathic surgical treatment, so a realistic approach was compensatory correction through removable dentures utilizing planned increases in vertical dimension and tooth arrangement.

The use of a maxillary single complete denture occluding with mandibular teeth, whether natural or a partial denture, has long been known to carry biomechanical risks such as instability, denture base fracture, and ridge resorptive changes.[1-4] The occlusal load from natural teeth, which is much greater and more rigid than from denture teeth, demands careful occlusal design, including adjustment of the occlusal plane and, if necessary, modification of the occlusal surfaces of the opposing teeth.[1-3]

In this case, the diagnostic wax-up proved very helpful in visualizing the potential for aesthetic improvement and occlusal relations before definitive treatment, as also emphasized in various case reports of Class III cases managed prosthodontically.[6-8] The wax-up allows the clinician to evaluate the extent to which overjet/overbite correction can be achieved without compromising the stability of the denture base and without causing uncomfortable interincisal relationships for the patient.

The vertical dimension of occlusion is another

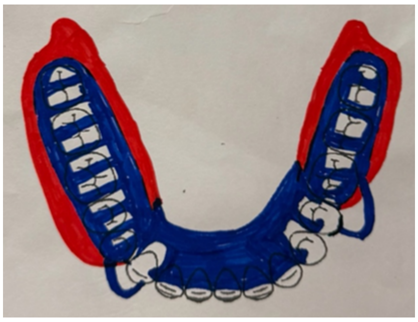

Figure 11. Design of mandibular RPD

Figure 12. Teeth arrangement and try-in

Figure 13. Post-treatment frontal intraoral photograph in centric occlusion: showing the maxillary complete denture and mandibular removable partial denture with a harmonious occlusal scheme. The anterior overjet and overbite appear more favorable, posterior contacts appear stable, and the metal clasp of the RPD is visible on the mandibular canine

Figure 14. Post-treatment mandibular occlusal intraoral photograph: showing the metal framework of the RPD with a lingual bar major connector, occlusal rests on the abutment teeth, and bilateral posterior artificial teeth

key parameter. A decreased vertical dimension, besides reducing masticatory efficiency and comfort, also worsens facial appearance and can clinically deepen the Class III pattern.[5-7] A controlled increase in vertical dimension, as performed in this case, can help correct anterior relationships and provide sufficient prosthetic space for denture tooth arrangement. Previous reports indicate that restoring the vertical dimension height monitored through an interim or temporary phase can provide important information regarding patient tolerance and long-term occlusal stability.[5-8]

The design of the mandibular RPD must follow the basic principles of partial denture design, but with special attention to load distribution when occluding with a maxillary complete denture. Classic studies on maxillary complete dentures occluding with bilateral free-end mandibular RPDs emphasize the importance of adequate support, retention, and stability to reduce the risk of denture fracture and ridge resorptive changes.[3,4]

In the context of Class III malocclusion, it is not always possible to achieve an "ideal" occlusal relationship like Class I, especially if orthognathic surgery is not performed. A realistic goal is to achieve a stable occlusion, functionally acceptable, and improved aesthetics within the limitations of the skeletal pattern.[6-8] In this case, a more favorable anterior relationship was successfully obtained without sacrificing posterior stability, by relying on increased vertical dimension, careful tooth arrangement, and meticulous occlusal adjustment.

Overall, this case supports previous findings that well-planned prosthodontic management can be a safe and effective alternative for adult patients with Class III who cannot or do not wish to undergo surgical or orthodontic therapy.[5-8]

Conclusion

Rehabilitating patients with Angle Class III malocclusion using a maxillary single complete denture occluding with a mandibular partial denture is a significant clinical challenge, but can still yield good aesthetic and functional results if preceded by thorough diagnosis, meticulous occlusal planning, and systematic clinical procedures.

A case-based approach tailored to patient needs, including the use of a diagnostic wax-up, evaluation of the vertical dimension of occlusion, and appropriate RPD design, allows for achieving a favorable compromise between skeletal limitations and the aesthetic-functional demands of adult patients with Class III malocclusion.

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Figure 15. **Post-treatment frontal extraoral photograph: showing improved upper lip support, a more harmonious smile line, and enhanced anterior tooth display after placement of the maxillary complete denture and mandibular RPD**

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CASE REPORT

Aesthetic rehabilitation with crowns and laminate veneers on maxillary anterior teeth and altered cast impression technique for mandibular metal framework partial denture

Andriani T,* Mia Syafitri, Meliana, Akmal S. Ikhwan

Keywords: Altered cast technique, Crown, Partially edentulous, Removable partial denture, Veneer

ABSTRACT

APartial tooth loss in the mandible can impair masticatory function, phonetics, and occlusal stability, and reduce quality of life. Discoloration and disharmony in the shape of the maxillary anterior teeth also affect smile esthetics and self-confidence. A combination of veneers and crowns on the maxillary anterior teeth with a metal-framework removable partial denture in the mandible is a functional and relatively affordable prosthodontic rehabilitation option. A 46-year-old female patient presented to the Dental and Oral Hospital of Hasanuddin University with a chief complaint of feeling insecure about her appearance due to the shape of her teeth and various teeth in the maxilla. The patient also complained of difficulty chewing due to the loss of several teeth in the mandible. She had never used any dentures before. The patient requested a denture that could improve her appearance and be comfortable so that she could chew food properly. Rehabilitation using a combination of crowns and laminate veneers on the maxillary anterior teeth and a metal-framework removable partial denture (RPD) with the Altered Cast technique in the mandible successfully improved aesthetics, occlusal function, and patient comfort. This approach provides more stable prosthesis adaptation, natural restorative results, and good clinical success. Comprehensive care and periodic control are required to maintain long-term results. (IJP 2025;6(2):125-129)

Introduction

According to data from the Indonesian Ministry of Health, the prevalence of dental caries/cavities in Indonesia based on the 2018 Basic Health Research (Riskesdas) is approximately 45.3% of all dental problems.[1] Teeth have a very important function in a person's life. In addition to aesthetics and phonetics, teeth also play a major role in fulfilling a person's nutritional needs through their masticatory function. A person with neat and healthy teeth presents a more attractive appearance and increases self-confidence in daily activities. If healthy teeth are not properly maintained, they can become damaged and lead to tooth loss.[1]

Research indicates that the pattern of tooth loss in the upper jaw, lower jaw, and both jaws occurs most frequently in the 40-65 year age group, with the highest tooth loss, especially molars.[2] Tooth loss can occur due to the interaction of complex factors such as caries, periodontal disease, and trauma, with the most common cases being caused by caries. Teeth play a very important role in the human digestive process. Tooth loss will certainly greatly affect a person in terms of functional, aesthetic, and social aspects.[2]

On the other hand, increasing aesthetic demands have driven the development of techniques and restorative materials for anterior teeth, including veneers and crowns, which allow for the correction of shape, color, and tooth proportion while preserving as much healthy tooth structure as possible. Porcelain laminate veneers have become one of the popular treatments over the last decade. Porcelain laminate veneers are generally used to restore teeth with defects on the enamel surface, teeth discolored

Figure 1. Patient's facial profile

Figure 2. Intraoral view of maxilla and mandible

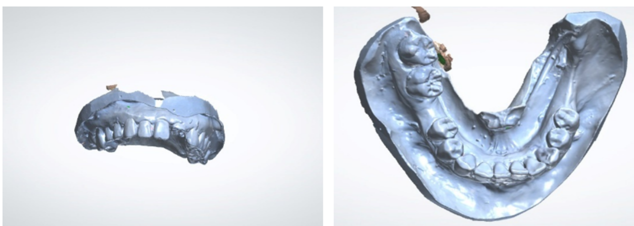

Figure 3. Study models

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due to fluorosis, tetracycline, or devitalization, and malformations.[3]

A crown is a type of fixed restoration that is cemented onto an abutment tooth using cement, making it unlikely for the fixed restoration to detach from its abutment tooth. A full crown is a restoration that completely covers the clinical crown surface of a tooth. This crown can be a stand-alone restoration or act as a retainer for a bridge. Full crowns can be made for anterior or posterior teeth and are made entirely from all-ceramic or acrylic.[3]

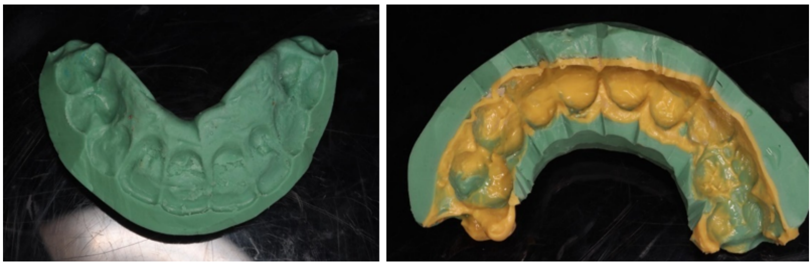

Figure 4. A. Preparation guide, B. Putty index

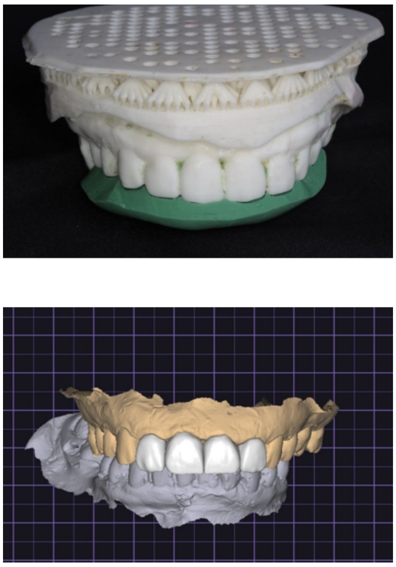

Figure 5. 3D Model of virtual wax-up

Figure 6. Tooth preparations

Figure 7. Temporary veneers and crown

Metal-framework partial dentures (cast partial dentures) remain the primary choice for rehabilitating partial edentulism in patients who have several suitable abutment teeth. Proper design can provide retention, stability, physiological load distribution, and long-term comfort. In cases of partial tooth loss, a removable partial denture is one of the affordable and effective treatment options. The type of removable partial denture that can be used is a metal-framework removable partial denture. A metal-framework partial denture is a prosthesis used to replace several teeth in an arch, whose base is made from a very strong chrome cobalt alloy material.[4]

Partial tooth loss in the mandible can impair masticatory function, phonetics, and occlusal stability, and reduce quality of life. Discoloration and disharmony in the shape of the maxillary anterior teeth also affect smile aesthetics and self-confidence. A combination of veneers and crowns on the maxillary anterior teeth with a metal-framework removable partial denture in the mandible is a functional and relatively affordable prosthodontic rehabilitation option.

This case report describes the management of aesthetic rehabilitation in a patient with various and misshapen maxillary anterior teeth and partial edentulism in the mandible, using a combination of laminate veneers and crowns in the maxilla and a Metal Framework Removable Partial Denture with the Altered Cast Technique in the mandible.

Case Report

A 46-year-old female patient presented to the Dental and Oral Hospital of Hasanuddin University (RSGMP Unhas) with complaints of lacking confidence in her appearance due to the shape of her teeth and cavities in the upper jaw. The patient also complained of difficulty chewing due to the loss of several teeth in the lower jaw. The patient had never used dentures before. The patient wanted dentures that could improve her appearance and comfortable dentures so she could chew food properly.a).


Figure 8. Try-in of laminate veneers and crown

Figure 9. A. Etching process, B. Etching Process


Figure 10. Etching restorations


Figure 11. Cementation

Treatment of Maxillary Anterior Teeth: Laminate Veneers (11, 12, 22) and Crown (21). Initial Visit & Diagnostics: Anamnesis, extraoral and intraoral examination, and panoramic radiography were performed. Scaling and light root planing were performed. Oral hygiene instructions were given. Anatomical impressions were taken using stock trays and irreversible hydrocolloid. Study models were poured in Dental Stone Type II. Preparation Guide & Putty Index: A Putty Index and Preparation Guide were created for teeth #11-22. Digital Planning: A virtual wax-up was performed on teeth #11-22 using CAD software. Tooth Preparation: Veneer preparation on teeth #11, #12, #22 and crown preparation on tooth #21 were performed. Temporary Restorations: Temporary veneers and crown were fabricated using the Putty Index. Try-in: Try-in and adjustment of the definitive Laminate Veneers and Crown. Insertion: Tooth surfaces were cleaned. Mylar Matrix Strips were placed. Teeth were etched with 37% phosphoric acid gel. Restorations were etched. Laminate Veneers and Crown were cemented using light-cure adhesive resin cement. Mandibular Rehabilitation: Metal Framework RPD with Altered Cast Technique. Diagnostic Impressions & Design: Diagnostic impressions were made. Study models were surveyed and a metal framework was designed. Abutment Preparation: Rest seats were prepared on teeth #33, #35, #45, and #47. Custom Tray & Border Molding: A Custom Impression Tray (SCI) was used. Border Molding was performed using Green Stick Compound. Framework Fabrication: The metal framework was fabricated. Master Cast Sectioning: The master cast was sectioned distal to the abutments. Altered Cast Impression: Border molding and secondary impression with polyvinyl siloxane were performed with the framework in place. Bite Registration & Articulation: Bite rims were fabricated and models were mounted on an articulator. Vertical Dimension: Bite rim try-in, measurement of rest vertical dimension (RVD) and occlusal vertical dimension (OVD). Framework Try-in & Insertion: The metal framework was tried-in and inserted.

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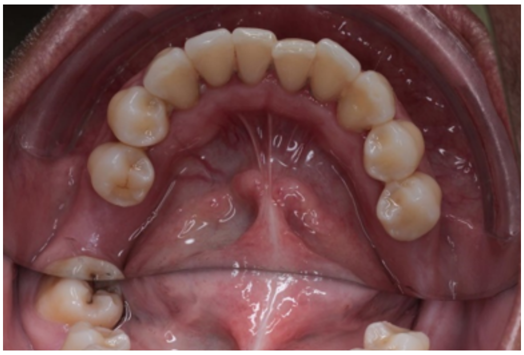

Figure 12. Abutment preparation

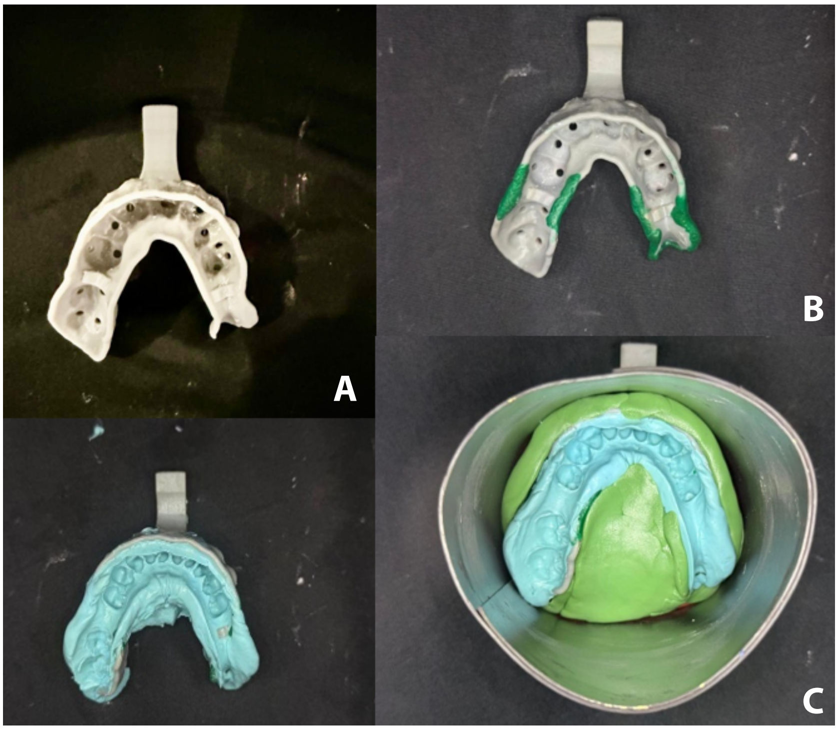

Figure 13. A. Custom tray, B. Border molding, C. Beading boxing

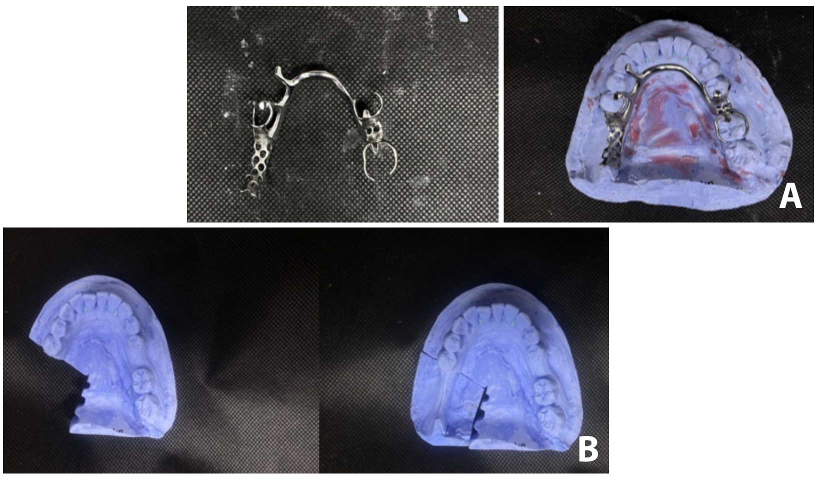

Figure 14. A. Metal framework, B. Master cast sectioning

Discussion

In this case, the rehabilitation approach combined fixed restorations in the maxilla with a removable prosthesis in the mandible. Aesthetic rehabilitation in the maxillary anterior region is a clinical challenge because this area significantly affects the patient's appearance, phonetics, and self-confidence.[5]

Laminate veneers are minimally invasive restorations that preserve more tooth structure, primarily used in cases of mild to moderate discoloration, shape changes, or limited enamel defects.[6,7] They provide good aesthetic results and have stable color durability. However, in cases with extensive tooth damage, significant shape changes, or weakened tooth structure, the use of a full crown is more appropriate to provide adequate retention and resistance.[3] In this case, tooth 21 had undergone root canal treatment and required a fiber post for core build-up, making a zirconia crown the restoration of choice due to its strength, aesthetics, and biocompatibility.[8]

For the mandibular rehabilitation, a metal framework removable partial denture (RPD) was chosen. Metal framework RPDs are more ideal than acrylic dentures as they are stronger, thinner, and allow for better design respecting periodontal health.[4,9] The altered cast technique was employed to achieve better adaptation to the movable mucosal ridge, improve stability and retention, and reduce excessive pressure on the mucosal tissue.[10,11] This technique is crucial for free-end saddle cases (Kennedy Class I) to record the supporting tissue in a functional state and ensure optimal support and stability.[9]

Combining fixed anterior restorations with a mandibular RPD requires careful occlusal planning to prevent overload, especially on the veneers. The selection of restorative materials and precise laboratory techniques are vital for long-term success.[12] The use of modern ceramics and the altered cast technique, accompanied by accurate clinical execution, yielded a stable, biocompatible, and durable rehabilitation outcome.

Conclusion

The combination of crowns and laminate veneers on the maxillary anterior teeth and a metal framework RPD with the altered cast technique in the mandible provided a comprehensive rehabilitation solution that successfully restored aesthetics, occlusal function, and patient comfort. This case highlights that a multidisciplinary, planned approach with appropriate material selection and techniques can achieve excellent clinical results in complex cases involving both aesthetic and functional demands. Patient education and periodic recall are essential for maintaining long-term success.

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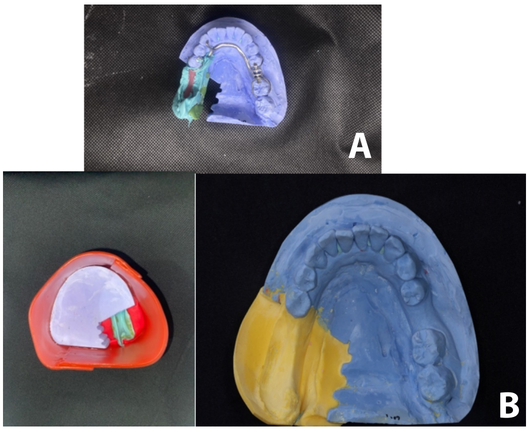

Figure 15. **A. Altered cast impression process, B. Final impression**

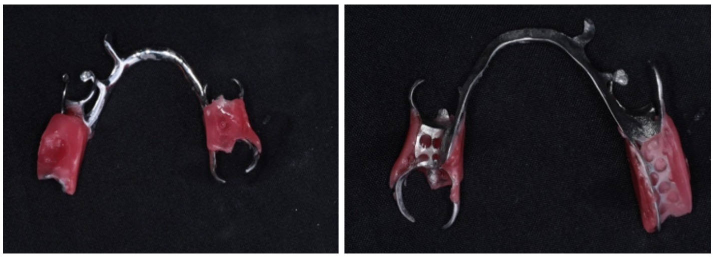

Figure 16. **Bite rim**

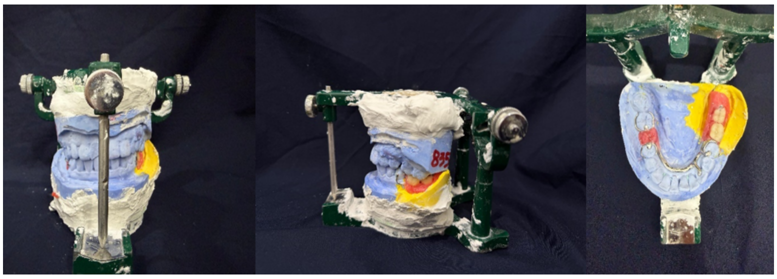

Figure 17. **Mounted models**

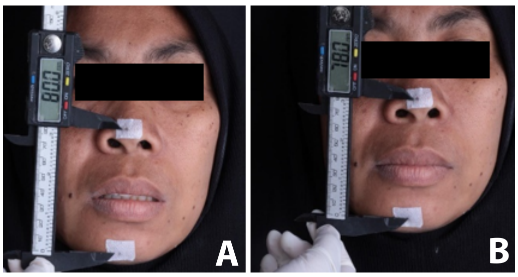

Figure 18. **A. RVD Measurement, B. OVD Measurement**

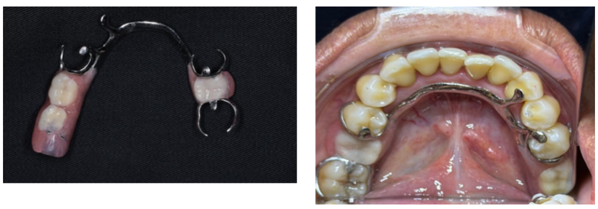

Figure 19. **Framework try-in and insertion**

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CASE REPORT

Integration of leaf gauge technique in the digital fabrication of stabilization splint for temporomandibular disorder: A case report

Alexander Justin,[1] Syafrinani,[2]* Ricca Chairunnisa[2]

Keywords: Arthralgia, Disc displacement with reduction, Leaf gauge, Local myalgia, 3D printing

ABSTRACT

Temporomandibular disorder (TMD) is a multifactorial musculoskeletal condition characterized by jaw pain, limited mandibular movement, and joint sounds. A common subtype is disc displacement with reduction (DDWR), often accompanied by local myalgia and arthralgia. Stabilization splints are a standard treatment modality, with 3D printing offering benefits such as precision, efficiency, and reduced clinical time. However, the effectiveness of splint therapy depends on accurate recording of the mandibular-maxillary relationship, which can be reliably achieved using a leaf gauge. To report the management of a TMD case involving DDWR, myalgia, and arthralgia in an adolescent patient using a leaf gauge to establish centric relation during the fabrication of a 3D-printed stabilization splint. An 18-year-old male presented with right-sided jaw pain and clicking upon mouth closure. History revealed parafunctional habits, including unilateral mastication and academic stress. Diagnosis was confirmed via DC/TMD Axis I and II, along with clinical and radiographic assessment, indicating DDWR with myalgia and arthralgia. Treatment includes behavioral treatment, infrared light therapy, and fabrication of a stabilization splint. Centric relation was determined using a leaf gauge to ensure accurate mandibular positioning. The use of a leaf gauge in this case facilitated precise centric relation, enhancing the efficacy of the 3D-printed stabilization splint. This approach contributed to significant symptom improvement and underscores the value of integrating analog tools within digital workflows in TMD management. (IJP 2025;6(2):130-135)

Introduction

The temporomandibular joint (TMJ) is one of the most complex joints in our body. The temporomandibular joint (TMJ) is an articulation between the mandibular condyle and the mandibular fossa of the temporal bone. These two bony structures are separated by the articular disc, which functions as an intra-articular cushion to prevent direct contact between the bone surfaces. The TMJ is classified as a compound joint. Anatomically, a compound joint involves at least three bony elements, but in the TMJ, only two bones directly contribute to the formation of the joint.[1]

Temporomandibular joint dysfunction (TMD) is a complex musculoskeletal condition that can cause jaw pain, limited movement of the joint, and/or other related structures.[2] According to the Glossary of Prosthodontic Terms (GPT), the definition of TMD is a condition that causes abnormal, incomplete, or impaired function of the temporomandibular joint and/or the masticatory muscles. Irritation of the auriculotemporal nerve and/or the chorda tympani nerve, which arises from the tympanic plate, may be caused by changes in anatomical relationships and temporomandibular joint dysfunction associated with loss of occlusal vertical dimension, loss of posterior tooth support, and other malocclusions.

These disorders can cause a series of clinical manifestations, including headache, tinnitus, otalgia (pain around the ear), hearing disturbances, and glossalgia (pain in the tongue). This condition reflects the complex involvement between the stomatognathic system and the cranio-mandibular neuroanatomical structures.[3] Among the intraarticular disorders of the temporomandibular joint (TMJ), disc displacement with reduction (DDWR) is the most common condition, with a prevalence of up to 41% of TMD diagnoses.

Disc displacement with reduction (DDWR) is characterized by the displacement of the articular disc from its normal position when the jaw is at rest, which returns to its original position during mandibular movement, typically accompanied by a clicking sound upon mouth opening.[4] The correlation between temporomandibular joint pain, termed arthralgia, and the position of the articular disc remains a controversial topic in the scientific literature. Although most cases of disc displacement with reduction (DDWR) are asymptomatic, the occurrence of intra-articular inflammatory processes may trigger pain sensations. This indicates that disc displacement does not directly cause pain in all cases; rather, the involvement of local inflammatory mechanisms may contribute to the pathogenesis of pain symptoms in some patients.[5,6]

Treatment for cases of disc displacement with reduction (DDWR) generally consists of patient education such as advising the patient to minimize excessive mouth opening—along with physical self-regulation (PSR) techniques and/or the use of an occlusal splint.[4] A study conducted by Conti, et al.[7] (2006) treated 57 patients with disc displacement with reduction (DDWR) using occlusal splints, and

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Table 1. **Examination of Pain Intensity and Palpation of Masticatory Muscles and TMJ (0 = no pain, 1 = discomfort, 2 = pain)**

Examination	Region	
	Right	Left
Temporalis	Ant : 1 Med : 1 Post : 1	Ant : 0 Med : 0 Post : 0
Tendon temporalis	1	0
Lateral pterygoid	2	0
Masseter	Superior : 1 Middle : 1 Inferior : 1	Superior : 0 Middle : 0 Inferior : 0
Regio submandibula	0	0
Sternocleidomastoideus	Posterior : 0 Anterior : 0 Klavikula : 0	Posterior : 0 Anterior : 0 Klavikula : 0
Splenius Capitis	-	-
Trapezius	0	0
Maximum pain-free mouth opening (mm)	30 mm	
Maximum mouth opening with pain (mm)	35 mm	
Maximum assisted mouth opening (mm)	37 mm	
Lateral movement	5 mm	10 mm
TMJ pain	2	0
TMJ noises	Open : - Close : Kliking	Open : - Close: - -
Headache	-	-
Tinitus	-	
Static Occlusion	Right : Klas I Angle (molar relationship)	
Dynamic Occlusion	Left : Klas I Angle (molar relationship) Overbite : 2 mm Overjet : 2 mm Group function	
Midline deviation maximum mouth opening during	Deviation to the right during mouth closure	

Table 2. **Post-treatment assessment of pain intensity and palpation of masticatory muscles and TMJ (0 = no pain, 1 = discomfort, 2 = pain)**

Examination	Region	
	Right	Left
Temporalis	Ant : 0 Med : 0 Post : 0	Ant : 0 Med : 0 Post : 0
Tendon temporalis	0	0
Lateral pterygoid	0	0
Masseter	Superior : 0 Middle : 0 Inferior : 0	Superior : 0 Middle : 0 Inferior : 0

Figure 1. **Frontal and lateral profile**

Figure 2. **Intra-oral examinations**

reported a significant improvement in both pain intensity and clicking sounds of the temporomandibular joint (TMJ).

Muscle-related disorders constitute the largest subgroup among the various diagnoses of temporomandibular disorders (TMDs). Scientifically, this condition encompasses a range of manifestations, including myalgia and myofascial pain, which serve as the primary etiologies of non-odontogenic orofacial pain. The predominant prevalence of muscle disorders highlights the critical role of neuromuscular factors in the pathophysiology of TMD.[8] According to a recent meta-analysis, the most effective therapeutic approaches include counseling, occlusal splint therapy, and jaw exercises, as well as heat/light therapy or physiotherapy. This multimodal approach has demonstrated superior efficacy in alleviating pain symptoms, improving mandibular function, and modulating psychosocial factors that contribute to masticatory muscle disorders.[9,10]

Since its initial introduction in the early 1980s through the CEREC system, Computer-Aided Design and Computer-Aided Manufacturing (CAD-CAM) technology has undergone rapid development and has been widely adopted—particularly through 3D printing fabrication methods—not only in the field of restorative dentistry, but also across all branches of dental medicine. This technological innovation has enabled chairside restorations to be performed entirely under the clinician's supervision, offering numerous advantages such as cost efficiency and significantly reduced production time. The fabrication of occlusal splints using a fully digital workflow offers several advantages over conventional techniques. One of its primary benefits is the significantly reduced fabrication time and minimal risk of contamination, making it a more efficient and practical option in modern clinical practice. However, the success of the splint is highly dependent on the accuracy of the centric relation, which can be effectively achieved through the use of a leaf gauge.[10]

Centric relation (CR) can be recorded using two primary techniques: bimanual manipulation and the anterior device technique. One of the instruments employed in the anterior technique is the leaf gauge. The leaf gauge functions by relaxing the lateral pterygoid muscle, thereby allowing the mandibular condyles to assume a passive and stable centric relation position. This is achieved through the stimulation of mandibular elevator muscles (such as the masseter and temporalis), which help position the mandible physiologically without involving muscles that could induce deviation or abnormal pressure on the temporomandibular joint. Clinically, this technique is advantageous for obtaining a more accurate and reproducible CR position.[11]

Case Report

Case Presentation

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Figure 3. Panoramic radiography imaging Panoramic

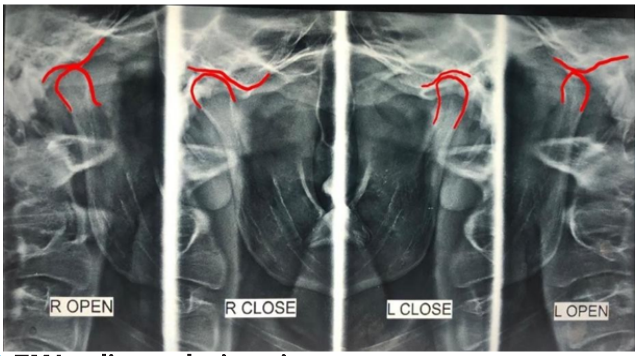

Figure 4. TMJ radiography imaging

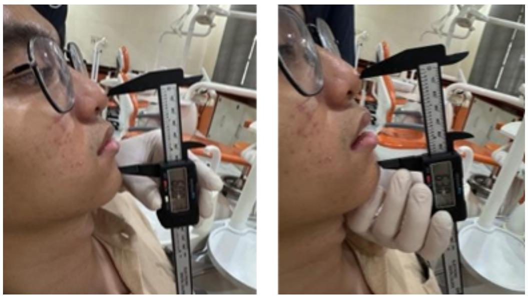

Figure 5. Freeway space (3mm)

Figure 6. Custom leaf gauge

Figure 7. Centric relation determination with leaf gauge technique

An 18-year-old male patient figure 1 presented to the Dental and Oral Hospital, University of North Sumatra (RSGM USU) with a chief complaint of dull pain and occasional discomfort in the right jaw, particularly in the preauricular region. Anamnesis revealed that the pain typically occurred during periods of stress and increased activity over the past six months. The patient also reported several parafunctional habits, such as chewing and sleeping predominantly on one side.

Prior to initiating treatment, a comprehensive examination was performed, which included an assessment of the masticatory muscles and temporomandibular joints (TMJ) through palpation, intraoral photography, TMJ and panoramic radiographic imaging, as well as Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I and II evaluations.

Radiographic Analysis figure 3: Impacted teeth identified: 18, 28, 38, and 48; No pathological abnormalities detected; From the TMJ radiographic findings, the following observations were made: Closed Mouth Position: Right side: The condyle appears larger than the left condyle, with the mandibular condyle positioned within the glenoid fossa. Left side: The mandibular condyle is positioned within the glenoid fossa.

Open Mouth Position: Right side: The condyle appears larger than the left condyle, with the mandibular condyle positioned anterior to the articular eminence. Left side: The mandibular condyle is positioned more anterior to the articular eminence compared to the right condyle.

Based on the comprehensive clinical evaluation, the patient was diagnosed with disc displacement with reduction, local myalgia, and arthralgia, conditions that were primarily associated with psychological predisposing factors and parafunctional habits contributing to the development of temporomandibular disorder (TMD). The prognosis was considered favorable, as the patient demonstrated good cooperation, motivation to undergo treatment, and a willingness to modify detrimental habits. Other contributing factors, such as occlusal discrepancies and dental crowding, were identified, and orthodontic treatment was planned to correct tooth alignment.

Treatment began with preliminary therapy, including scaling and root planing, followed by determination of the patient's freeway space using a caliper figure 5. The splint fabrication process commenced with the creation of a custom leaf gauge, made from panoramic radiographic film measuring 4 × 10 cm with a thickness of 0.2 mm per layer. The number of layers for the leaf gauge was adjusted according to the patient's freeway space figure 6.

The patient was instructed to bite on the leaf gauge while performing protrusive and retrusive mandibular movements. When the mandible reached the retruded position, the patient was asked to gently maintain the bite for 30 seconds to 1 minute. This proce-

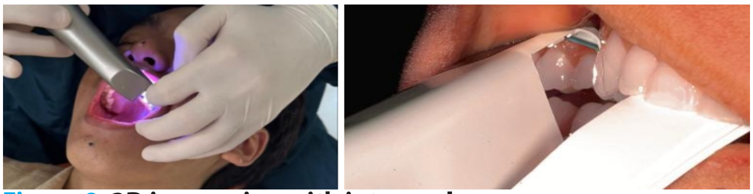
Figure 8. **3D impression with intra oral scanner**

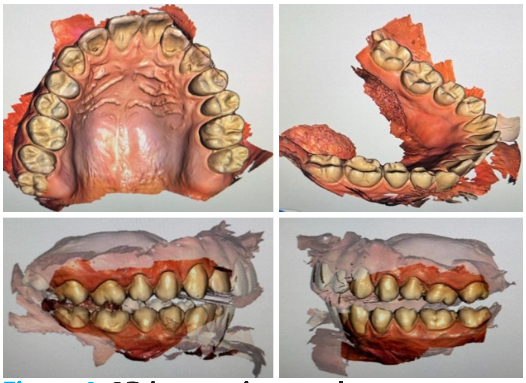
Figure 9. **3D impression results**

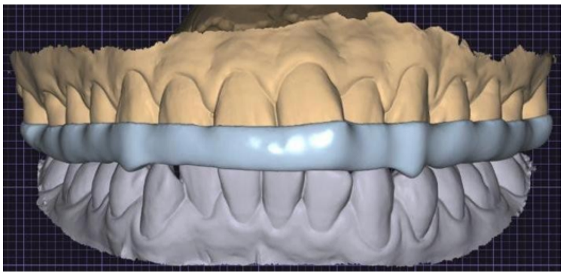
Figure 10. **Occlusal splint 3D design**


Figure 11. **Insertion of the occlusal splint and verification of canine guidance**


Figure 12. **Heat therapy with infrared light**

dure was repeated two to three times figure 7. Subsequently, while the patient maintained the biting position on the leaf gauge, a 3D digital impression was obtained using an intraoral scanner figure 8.

Following the 3D digital impression, the scanned data were sent to the laboratory for 3D printing fabrication of the occlusal splint, designed with a thickness of 3 mm corresponding to the patient's freeway space and incorporating a canine-guided occlusal scheme figure 10. During the second visit, the splint was inserted for intraoral adjustment and verification figure 11. The patient was also provided with adjunctive light/heat therapy using an infrared lamp applied to the right temporomandibular joint region figure 12.

A follow-up evaluation was conducted 1–2 weeks after splint insertion to assess muscle condition, mouth opening, and joint sound. After two weeks, a re-evaluation was performed, including an examination of the masticatory muscles and occlusion, while the patient continued to wear the stabilization splint continuously throughout the day. The patient reported improved comfort and a notable reduction in pain around the TMJ region. After one month of follow-up, the patient no longer experienced pain or clicking sounds in the temporomandibular joint table 2.

Discussion

The temporomandibular joint (TMJ) is anatomically and functionally classified as the most complex synovial articulation within the human musculoskeletal system. The articular surfaces of this joint are in direct contact with the articular disc, an avascular structure that derives its nutritional supply from the synovial fluid.[12] Dislocation of the temporomandibular joint (TMJ) disc is a disorder characterized by an abnormal displacement of the articular disc in relation to the mandibular condyle and the mandibular fossa. One subtype of temporomandibular disc displacement is disc displacement with reduction (DDWR). During mandibular opening, the articular disc undergoes repositioning over the condylar head, thereby restoring a physiologically aligned articular relationship. The asynchrony between disc translation and condylar motion may result in audible acoustic phenomena, typically perceived as clicking, snapping, or popping sounds, which are commonly detected during the mandibular opening phase.[6]

The etiological factors of disc displacement with reduction (DDWR) and arthralgia are predominantly associated with abnormal biomechanical forces exerted on the mandibular condyle, which may progressively alter the morphology and function of the articular tissues. These pathological changes disrupt the physiological relationship between the condyle and the articular disc.[12] Bruxism, psychological stress, clenching, oral parafunctional activities, mandibular trauma, excessive masticatory activity, morphological alterations of the articular eminence and joint surfaces, insufficient

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intraarticular lubrication, structural modifications of the articular disc, degenerative joint disorders, hyperactivity of the lateral pterygoid muscle, ligamentous injury, abnormal dental occlusion, mandibular hypoplasia, posterior tooth loss, deflective occlusion, and joint hypermobility are all potential risk factors that may contribute to the development of disc displacement with reduction (DDWR).[13,14] These factors, either individually or synergistically, can induce biomechanical and neuromuscular imbalances within the stomatognathic system, thereby increasing the susceptibility to articular disc displacement and contributing to functional disturbances of the temporomandibular joint.

Management of the patient's psychological factors can be achieved through the implementation of Physical Self-Regulation (PSR) techniques, which aim to promote systemic relaxation, thereby alleviating pain symptoms and functional disturbances. Patients are instructed to eliminate deleterious habits such as clenching or grinding, practice diaphragmatic breathing, maintain proper head posture (avoiding tilting), allocate dedicated relaxation periods twice daily, and ensure a comfortable sleeping position to support neuromuscular balance and recovery.[15] A study conducted by Aggarwal et al. demonstrated that the combination of Physical Self-Regulation (PSR) therapy and patient education effectively alleviates orofacial pain symptoms, highlighting the synergistic benefits of integrating behavioral and educational interventions in TMD management.[16]

The management of DDWR cases is contingent upon the patient's clinical complaints. In patients presenting with disc displacement with reduction accompanied by clicking but without additional symptoms, occlusal therapy is generally not indicated, and patient education is recommended. However, in cases where DDWR is associated with pain, the use of a stabilization occlusal splint may be warranted. An occlusal splint is a therapeutic device fabricated from acrylic resin, designed to cover the occlusal surfaces of one dental arch while establishing controlled and precise occlusal contacts with the antagonist arch.

The eccentric guidance of this splint is selectively configured on the canines (canine guidance) to prevent posterior interferences during lateral and protrusive mandibular movements, thereby reducing occlusal load on the masticatory muscles and temporomandibular joint structures. The stabilization splint in centric relation (CR) is designed to provide uniform occlusal contacts when the mandibular condyles are positioned anterosuperiorly, supported by the articular disc and articulating with the posterior slope of the articular eminence, representing a musculoskeletally stable and physiologically optimal position.[1,10]

An engram is a pattern of muscle activity stored in memory that can induce mandibular deviation, leading to errors during the recording of centric relation (CR). A muscle deprogrammer is a device used to eliminate these engrams and consistently position and stabilize the condyles in centric relation. Muscle deprogramming is achieved by placing the deprogrammer, such as a leaf gauge, in the anterior region, thereby preventing posterior occlusal contacts.[17] This approach allows the lateral pterygoid muscles to relax, enabling the mandibular condyles to assume an accurate centric relation (CR) position. Muscle relaxation eliminates abnormal traction forces on the condyles, thereby allowing the temporomandibular joints to achieve a stable and physiologically optimal articulatory position.[18]

Conventional impression-taking presents several challenges. Patients with mucosal undercuts or interdental spaces may cause distortion of the impression material during tray removal. Such complications impair the fabrication of a precise splint and hinder the attainment of an accurate impression. These issues can be mitigated through 3D digital impression techniques, which offer advantages such as enhanced precision, greater efficiency, and a reduction in the number of patient visits required.[19] This approach enables the clinician to fabricate splints with high accuracy and reduced production time. It can be implemented in the clinical setting as a novel, standardized method for digitally-based splint fabrication.

Conclusion

The implementation of a digital workflow using an intraoral scanner and 3Dbased splint design facilitates the rapid and precise fabrication of the device while minimizing distortions commonly encountered with conventional techniques. The leaf gauge functions as an effective deprogrammer, promoting relaxation of the lateral pterygoid muscles and allowing the mandibular condyles to achieve a musculoskeletally stable and physiologically accurate centric relation (CR) position. The use of the leaf gauge in centric relation determination has been shown to contribute significantly to the successful fabrication of 3D-printed stabilization splints in TMD cases.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Integrated approach of splint, face and full-body yoga, and smartphonebased cognitive behavioral therapy for temporomandibular disorder: A case report

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Keywords: Clenching, Cognitive behavioral therapy (CBT), Face yoga, Full-body yoga, Myofascial

ABSTRACT

Background: Temporomandibular disorders (TMD) can result from stress, occlusal imbalance, trauma, and poor posture. Stress often triggers parafunctional habits such as clenching, leading to masticatory muscle hyperactivity, fatigue, stiffness, and pain radiating to the head and other body regions. Conservative therapies include splints, yoga, and cognitive behavioral therapy (CBT). Objective: To report the management of a TMD case diagnosed as myofascial pain with spreading and arthralgia using a combination of stabilization splint, face and full-body yoga, and smartphone-based CBT. Case Report: A 28-year-old female presented with muscle pain radiating to the head, neck, and lower back, and limited mouth opening. She had a history of clenching. DC/TMD Axis I confirmed myofascial pain with spreading and arthralgia; Axis II showed mild depression (score = 6). Treatment comprised a stabilization splint, face and full-body yoga, and smartphone-based CBT over six weeks. Post-treatment, mouth opening increased from 25 mm to 33 mm, depression score decreased to 1, and muscle tension was significantly reduced. The patient reported improved quality of life and awareness of parafunctional habits. Conclusion: A multidisciplinary approach integrating splint therapy, yoga, and smartphone-based CBT effectively reduces TMD symptoms. Splints and yoga relax muscles, while CBT enhances stress management and awareness of clenching, contributing to therapeutic success. (IJP 2025;6(2):136-141)

Introduction

Temporomandibular disorders (TMD) is a term used to describe a range of pain and dysfunction conditions affecting the temporomandibular joint (TMJ), the masticatory muscles, and associated surrounding structures. It is one of the leading causes of chronic orofacial pain.[1] TMD can significantly affect an individual's quality of life, particularly during activities such as speaking, chewing, and mouth opening. The prevalence of TMD is reported to be around 10–15% in the general adult population, with the majority of patients being women between the ages of 20 and 40.[2] The prevalence among adolescents is estimated to be approximately 27%.[3] Given its high incidence and functional impact, identifying the specific type and characteristics of TMD is crucial for establishing an accurate diagnosis.

The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) is a widely used diagnostic framework for systematically classifying various types of temporomandibular disorders. According to the DC/TMD, TMD can be categorized into TMD-related headache (including myalgia, arthralgia, and myofascial pain), intraarticular TMJ disorders, and degenerative TMJ disorders. Among these conditions, myofascial pain is the most commonly encountered, affecting approximately 45.3% of the global population.[3] In addition to its high prevalence, individuals with TMD are at greater risk of experiencing depressive symptoms, difficulties in daily activities, and reduced quality of life. The pain associated with this condition is typically dull and persistent, making it the most frequently reported symptom. Beyond musculoskeletal pain, the disorder is also characterized by tenderness on palpation of the TMJ and masticatory muscles, as well as limited joint mobility. When the pain is not confined to the stimulated area but radiates to other muscles or regions of the body, the condition is classified as myofascial pain with spreading.[4]

The causes of TMD are multifactorial, involving a complex interaction between occlusal, psychological, individual behavioral, traumatic, and environmental factors. One factor frequently associated with the development of TMD is psychological stress, which can increase autonomic nervous system activation, leading to involuntary muscle tension such as clenching, especially during waking hours. Prolonged muscle tension contributes to TMJ dysfunction, triggering pain symptoms and limited jaw movement.[4,5]

TMD management should be individualized and comprehensive, taking into account its underlying multifactorial etiology to ensure targeted, effective, and sustainable treatment.[4] Management of myofascial pain with spreading typically involves conservative approaches, including the use of stabilization splints to position the jaw in centric relation, reduce parafunctional activity, improve occlusal load distribution, and alleviate muscle tension.[6] Additionally, physical therapies such as stretching exercises and muscle relaxation through yoga have been shown to effectively reduce muscle tension, enhance

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Table 1. Examination of pain intensity and palpationof masticatory muscle and TMJ (0= no pain, 1= discomfort, 2=pain)

Examination	Region: Right	Region: Left
Temporalis	Ant : 1 Med : 0 Post : 0	Ant : 0 Med : 0 Post : 0
Tendon temporalis	1	0
Lateral pterygoid	1	0
Masseter	Superior : 2 Middle : 1 Inferior : 1	Superior : 0 Middle : 0 Inferior : 0
Regio submandibula	2	0
Sternocleidomastoideus	Posterior : 1 Anterior : 1 Klavikula : 1	Posterior : 0 Anterior : 0 Klavikula : 0
Splenius Capitis	1	-
Trapezius	1	0
Maximum mouth opening without pain (mm)	25 mm	
Maximum mouth opening with pain (mm)	28 mm	
Maximum assisted opening	33 mm	
Lateral Movement	5 mm	13 mm
TMJ Pain	1	0
TMJ noises	Open : - Close : -	Open : - Close : -
Headache	-	-
Tinitus	-	-
Static Occlusion	Right : Klas II 1/2P Angle (molar relationship) Left : Klas I Angle (molar relationship)	
Dinamic Occlusion	Canine guidance Overbite: 4 mm Overjet: 3 mm	
Midline deviation during maximum mouth opening	Deviation to the right during mouth closure	

Table 2. Treatment evaluation

Parameter	Initial Condition	2 Weeks Follow up	6 Weeks Follow up
Maximum mouth opening without pain (mm)	25 mm	28 mm	33 mm
Lateral Movement	Right : 5 mm Left : 13 mm	Right : 8 mm Left : 13 mm	Right : 11 mm Left : 13 mm
Muscle Examination			
Temporalis	Right Ant : 1	Right Ant : 1	Right Ant : 0
Tendon temporalis	Right : 1	Right : 1	Right : 1
Lateral Pterygoid	Right : 1	Right : 1	Right : 1
Masseter	Right Superior : 2 Middle : 1 Inferior : 1	Right Superior : 1 Middle : 0 Inferior : 1	Right Superior : 0 Middle : 0 Inferior : 1
Regio Submandibula	Right : 2	Right : 2	Right : 0
Sternocleidomastoideus	Right Posterior : 1 Anterior : 1 Klavikula : 1	Right Posterior : 1 Anterior : 1 Klavikula : 0	Right Posterior : 0 Anterior : 0 Klavikula : 0
Splenius Capitis	Right : 1	Right : 0	Right : 0
Trapezius	Right : 1	Right : 1	Right : 0

Figure 1. Frontal and lateral profile of the patient's face

blood flow, and improve posture, all of which contribute to alleviating TMD symptoms.[7] Although various physical and conservative therapies are effective in symptom reduction, addressing psychological factors also plays a crucial role in the onset and persistence of TMD symptoms.

Therefore, to achieve a more comprehensive management approach, cognitive behavioral therapy (CBT) has increasingly been used to help patients regulate emotional and behavioral responses that may aggravate TMD.[8] The use of app-based CBT has become a convenient treatment option, allowing patients to monitor and control jaw activity anytime and anywhere. One available application, BRUXISM + Fix Teeth Grinding, has proven effective in controlling and reducing clenching behavior. A multidisciplinary app- roach that addresses occlusal, muscular, and psychological factors is essential for achieving optimal outcomes.

In this case, the management of myofascial pain with spreading was conducted using a stabilization splint, physical 'exercises including face and full-body yoga, and appbased CBT via BRUXISM + Fix Teeth Grinding.

Case Report

Case Presentation

A 28-year-old female patient presented to RSGM USU with a primary complaint of jaw pain and discomfort in the preauricular region, neck, shoulder, and right arm, radiating to the lower back, persisting for the past two weeks. The patient reported no history of TMJ clicking or audible joint sounds. She also disclosed a parafunctional habit of forceful jaw clenching during periods of psychological stress, which was evidenced by bigonial widening and horizontal alveolar bone resorption at the cervical one-third of nearly all mandibular teeth figure 3.

Prior to initiating treatment, a comprehensive examination was conducted to assess the patient's complaints, including extraoral and intraoral evaluation, palpation of the masticatory muscles and TMJ, and panoramic radiography.

Closed Mouth: Right: mandibular condyle positioned in the glenoid fossa; Left: mandibular condyle positioned in the glenoid fossa o Open Mouth: Right: mandibular condyle positioned anterior to the articular tubercle; Left: mandibular condyle positioned at the summit of the articular eminence.

The mouth opening pattern is less than the normal range (40 mm), with a rightward deviation observed during opening.

Myofascial Pain with Spreading and Athralgia. Etiolog y: Parafunctional habits such as clenching due to stress. Clinical features: Myofascial pain with spreading. Pain on palpation of multiple muscles (temporalis, temporalis tendon, masseter, sternocleidomastoid, lateral pterygoid, submandibular region) involving more than two muscles, with pain not triggered at a single point. Athralgia; Pain elicited on palpation of the right intra -auricular region. AXIS I; TMD pain screening score: 6 indicating presence of TMD (a score >3 indicates presence of TMD). AXIS II; Chronic Pain Scale: Grade III (moderately limiting) Pain Intensity (CPI) 60 (point =3) high intensity pain. Pain-related limitation 50 (point =2). Jaw Function Limitation Scale: Mastication

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Figure 2. **Intraoral examination**

Figure 3. **Panoramic radiograph**

Figure 4. **Temporomandibular joint radiograph**

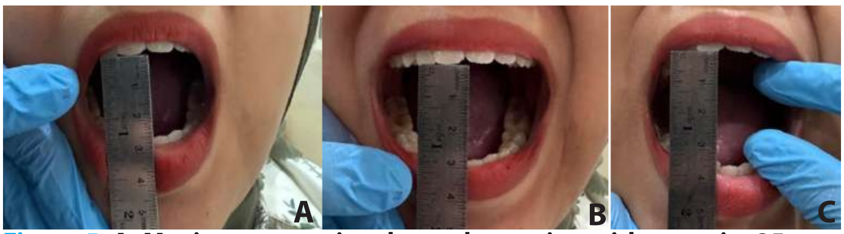

Figure 5. **A. Maximum unassisted mouth opening without pain: 25 mm, B. Maximum unassisted mouth opening with pain: 28 mm, C. Maximum assisted mouth opening: 33 mm (soft end feel)**

Figure 6. **A. Working model , B. Survey on model**

limitation score: 2.6 2.22 ± 0.13 (chronic TMD). Mobility limitation score: 3 2.22 ± 0.13 (chronic TMD). Verbal and non, verbal communication limitation score: 1.75 0.72 ± 0,10 chronic TMD; Patient Health Questionnaire. Depression (score 6) mild depression. GAD – Anxiety (score 4) <6 indicates mild anxiety. Patient Health Questionnaire. Physical symptoms (score 13) A score of 6–9 indicates the presence of severe physical symptoms. Oral Behavior (Score 26) 25-62 indicates that the patient's oral behaviors are contributing factors to TMD.

Based on a comprehensive examination, the patient was diagnosed with myofascial pain with spreading and arthralgia, atributed to psychological predisposition and the parafunctional habit of clenching, which contributed to the development of TMD. The treatment plan included fabrication of an upper jaw stabilization splint, face and fullbody yoga for muscle relaxation and postural improvement, psychological education for stress management and elimination of parafunctional habits contributing to TMD symptoms, and the use of the BRUXISM+Fix Teeth Grinding application to monitor jaw activity. The patient's prognosis is considered good due to her cooperative attitude, willingness to undergo treatment, and awareness of the need to modify harmful habits.

During the first visit, both subjective and objective examinations were conducted, followed by Phase I definitive treatment. This included patient education to explain the psychological mechanism underlying her condition, specifically how stress triggers clenching and its effects on the masticatory muscles, as well as the subsequent spread of discomfort to other body regions. The stages of treatment and the primary goal—relief of muscle and TMJ pain—were also explained.

Subsequently, fabrication of the stabilization splint began with anatomical impressions figure 6A, calculation of the vertical dimension of occlusion (VDO = 70.8 mm) and vertical dimension at rest (VDI = 74.9 mm), allowing the determination of the patient's freeway space, measured at 4 mm. After obtaining the working model, a survey was conducted on the model to establish the optimal tooth contour height for the splint figure 6B.

During the second visit, a facebow transfer was performed, and the centric relation (CR) position was determined using a 4 mm leaf gauge. The patient was instructed to move the mandible forward and then backward, repeating this movement two to three times. When the mandible reached its most posterior position, the patient was asked to bite lightly—just enough to hold the leaf gauge in place—and maintain this position for 15 minutes. This mandibular position was considered the centric relation. If no discomfort or pain was reported in the TMJ, the fabrication of the stabilization splint proceeded.

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Figure 7. A. Transfer facebow, B. Centric relation determination using a leaf gauge

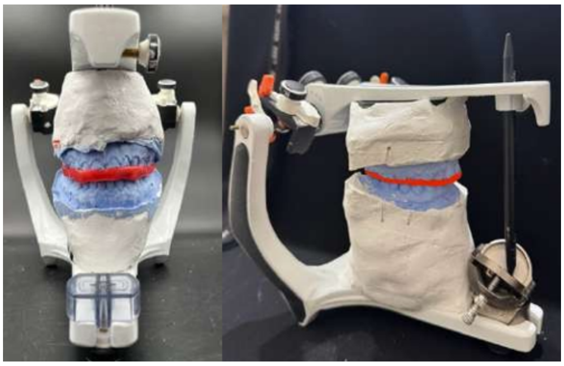

Figure 8. Wax-up result of the splint

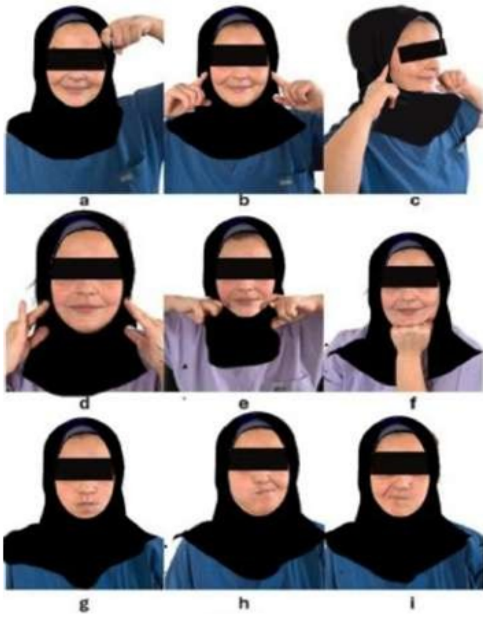

Figure 9. Face yoga movements

Figure 10. Full body yoga

Subsequently, a wax-up was performed with a 4 mm anterior height increase and a canine guidance occlusal scheme. This was followed by a try-in on the patient, and the process was completed with packing and polishing of the splint.

Home treatment continued with face and full-body yoga exercises, performed three times per week for six weeks, with each movement repeated 10 times. The facial yoga exercises were performed bilaterally to enhance overall tightening and relaxation of the facial and neck muscles. The facial yoga movements were as follows figure 9: Bend the index fingers and place them on the forehead, applying pressure to the temporal muscle area. The patient was instructed to massage the temporalis muscles using the index and middle fingers. The patient was asked to massage the masseter muscles using three fingers. The patient used fingers to create tension in the neck muscles. The patient was instructed to press the tongue against the roof of the mouth while raising the chin to engage the neck muscles. The patient was asked to tilt the head to the right and left to stretch the neck muscles, holding each position for a count of 10.

Full-body yoga was conducted under the guidance of a certified yoga instructor, three times per week for six weeks. Hatha yoga was employed, consisting of breathing exercises, warm-up routines, relaxation techniques, yoga asanas to improve posture, and meditation focused on breath control. Each session lasted approximately one hour, with particular emphasis on combined movements involving the upper extremities and neck, along with breathing exercises. During the warm-up phase, muscles were stretched through targeted exercises designed to enhance flexibility and release tension.

As an adjunctive therapy, the patient was instructed to download the BRUXISM+Fix Teeth Grind application to monitor jaw activity and increase awareness, thereby improving jaw control. The app provides hourly notifications (adjustable) to remind the patient to keep the jaw relaxed. The patient was also asked to record the jaw condition in the app (relaxed, grinding, or touching), allowing the application to maintain a log of jaw activity.

During the third visit, the stabilization splint was inserted. Splint stability and retention were checked, and centric and eccentric occlusion were evaluated using articulating paper, followed by selective grinding of any traumatic areas. Vertical dimensions were measured before and after splint insertion. The occlusal height of the splint was set according to the patient's freeway space, which was 4 mm. The patient was instructed to wear the splint 24 hours a day, except during meals, with a follow-up visit scheduled one week after insertion.

Follow-up visits were conducted 1–2 weeks after splint insertion to assess the patient's complaints,

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Figure 11. BRUXISM+Fix teeth grind notification

Figure 12. A. During occlusion, B. Right lateral movement, C. Left lateral movement

muscle condition, and mouth opening. During these visits, any issues related to splint placement, including traumatic occlusion, were evaluated using articulating paper. Additional follow-ups were scheduled two weeks after insertion to reevaluate the patient's symptoms from the first follow-up and continued until the complaints resolved.

Evaluation of outcomes at two and six weeks demonstrated improvements in mouth opening, a reduction in depression levels, and a significant decrease in muscle tension, as summarized in the table below.

Discussion

Temporomandibular disorders (TMD) in patients are often characterized by pain in the masticatory muscles and temporomandibular joint (TMJ), necessitating accurate subjective and objective examinations, diagnosis, and identification of underlying etiology to establish an appropriate treatment plan.[4] Myofascial pain with spreading is a muscular pain condition characterized by active trigger points that not only cause localized pain but also radiate to other regions involving more than two fasciae. One of the primary causes of this condition is the parafunctional habit of clenching, often triggered by psychological stress. During stress, sympathetic nervous system activity increases, elevating muscle tone and inducing repeated, involuntary contractions of the masticatory muscles. This parafunctional activity results in local ischemia due to capillary compression, leading to the accumulation of chemical mediators such as serotonin, bradykinin, prostaglandins, and substance P, which irritate nerve endings and induce pain. This process facilitates the formation of myofascial trigger points that can spread to surrounding muscles via peripheral and central sensitization mechanisms.[3-5]

Studies by Karamat (2022) and Slade (2013) have demonstrated that TMD patients with mild to moderate psychological burden can achieve favorable treatment outcomes through education and behavioral management.[9,10] TMD is a complex condition, and therefore, a multimodal therapeutic approach is recommended. In this case report, a combination of stabilization splint therapy, physical exercises, and cognitive behavioral therapy (CBT) was employed. The stabilization splint provides mechanical unloading of the temporomandibular joint and masticatory muscles, reducing parafunctional activity and intra-articular pressure, which in turn promotes muscle relaxation and decreases mechanical resistance during mouth opening.[1,6] In addition to occlusal intervention, physical exercises play a critical role in alleviating neuromuscular tension and improving mandibular function in TMD patients.

In this patient, TMD-related pain was primarily localized in the masticatory muscles, neck, and lower back. Therefore, postural and body relaxation exercises were recommended. One commonly practiced form of body relaxation is yoga. A study by Atilgan (2024) demonstrated that yoga can be beneficial in managing myofascial pain in TMD patients.[11] This effect is further enhanced through face and full-body yoga, which target the musculoskeletal system and the autonomic nervous system; postural stretching and breath regulation have been shown to increase parasympathetic dominance and peripheral blood flow, thereby reducing the accumulation of pain mediators such as substance P and bradykinin.[11,12]

Furthermore, yoga postures that focus on stretching the neck, upper back, and facial muscles can help release tension in areas commonly associated with trigger points in TMD patients.[12] Controlled breathing techniques have also been shown to reduce stress hormone levels, such as cortisol, which indirectly decreases parafunctional habits like clenching or bruxism that aggravate myofascial pain. Several studies have also indicated that yoga promotes positive neuroplasticity, helping to reduce central sensitization, which underlies the spread of pain. Thus, yoga not only addresses peripheral symptoms such as muscle pain but also contributes to the modulation of pain perception at the central nervous system level.[11] While different physical and conservative treatments can effectively reduce symptoms, managing psychological factors is also essential, as they significantly influence the development and persistence of TMD symptoms which can be effectively targeted through smartphone-based

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cognitive behavioral therapy (CBT).

Smartphone-based CBT interventions play a role in modifying patients' psychological factors and habits, including increasing awareness of parafunctional activities such as clenching.[4,5] The American Academy of Craniomandibular Disorders states that CBT is an important adjunctive treatment for TMD, as care cannot rely solely on brief dental consultations.[13] Therefore, patients need to learn to manage their condition independently. According to Sverdlov (2018), CBT helps TMD patients recognize pain, parafunctional activities such as clenching, and excessive muscle activity. Its primary goal is to encourage patients to voluntarily avoid or limit oral activities, thereby exerting a therapeutic effect on the underlying causes of the disorder.[14] The key to successful CBT is active and voluntary participation by the patient, along with the belief that adherence to CBT will reduce pain. Moreover, smartphone-based applications facilitate care anywhere and can provide feedback based on accumulated and analyzed data.[13,15]

Conclusion

A multidisciplinary approach integrating stabilization splint therapy, face and full-body yoga, and digital cognitive behavioral therapy (CBT) using the BRUX-ISM+Fix Teeth Grind application has been shown to effectively reduce pain and improve mandibular function in TMD patients with myofascial pain with spreading and arthralgia. The innovation in this case lies in the application of a digitally integrated conservative therapy that addresses both physiological and psychological aspects through self-monitoring of jaw activity and parafunctional habits. This model introduces a novel paradigm in TMD management, emphasizing multidisciplinary collaboration, personalized therapy, and the potential to serve as a prototype for digital-based conservative programs in prosthdontics for TMD and orofacial pain rehabilitation.

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CASE REPORT

Management of TMD without surgery using prolotherapy with dexamethasone, aquades, and lidocaine hcl for pain and inflammation relief: A case series

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Keywords: Dexamethasone, Lidocaine HCl, Pain reduction, Prolotherapy, Temporomandibular disorder

ABSTRACT

Background: Temporomandibular Disorder (TMD) is a condition involving inflammation of the temporomandibular joint (TMJ) that causes pain and discomfort. Non-surgical treatments such as prolotherapy using dexamethasone, aquades, and lidocaine HCl have shown potential in managing these symptoms.Case Series: Three TMD patients received prolotherapy treatments containing dexamethasone, aquades, and lidocaine HCl. The treatment effectively reduced pain and inflammation in the patients. Results: Significant reductions in pain and inflammation were observed post-treatment, with improved joint mobility and quality of life for the patients. Conclusion: Prolotherapy with dexamethasone, aquades, and lidocaine HCl is a promising non-surgical treatment for TMD, showing significant reductions in pain and inflammation. (IJP 2025;6(2):142-145)

Introduction

Temporomandibular Disorder (TMD) is a painful condition affecting the temporomandibular joint (TMJ) due to disturbances in the joint and surrounding tissues, which can cause dysfunction.[1,2] The causes of TMD include mechanical factors, such as injury to the joint or surrounding muscles, and psychological factors, such as stress or anxiety. Symptoms include pain around the jaw, difficulty opening the mouth, and clicking sounds in the joint. TMD can significantly affect the quality of life, leading to sleep disturbances, difficulty speaking, eating problems, and contributing to increased anxiety and depression. Overall, TMD is one of the leading causes of chronic orofacial pain, with an incidence rate ranging from 21.5% to 50.5%, more common in women.[3,4]

TMD is divided into three categories: myofascial pain as the most common form, followed by internal joint damage and degenerative joint disease. TMD is a leading cause of non-odontogenic pain in the orofacial region, with 40–75% of individuals showing at least one sign of TMD, such as TMJ sounds, and 33% experiencing symptoms like pain, limited mandibular movement, and masticatory dysfunction that impact their quality of life.[5,6]

Conventional treatment for TMD usually starts with conservative therapy, such as physical therapy to improve joint position and reduce muscle tension. Pharmacological interventions often involve the use of NSAIDs to reduce pain and inflammation. Additionally, antidepressants or muscle relaxants may be used to manage muscle spasms. In more severe cases, surgical therapy may be required after non-surgical treatments fail to provide the desired results. While conventional treatments may offer temporary relief, their effectiveness is often limited in the long term, prompting the search for more permanent alternatives.[4]

Prolotherapy is a non-surgical method that involves injecting an irritant into the affected tissue to stimulate the body's natural healing process. Prolotherapy has been shown to be effective in treating musculoskeletal disorders, including TMD, by stimulating tissue regeneration and reducing inflammation. Its mechanism of action focuses on improving blood flow to the injured area, accelerating cell regeneration, and restoring joint function. Although scientific evidence on prolotherapy is still evolving, studies indicate that it can reduce chronic pain and enhance joint functionality in TMD patients.[7]

The use of dexamethasone (a corticosteroid), lidocaine HCl (a local anesthetic), and aquades in prolotherapy aims to enhance treatment efficacy. Dexamethasone acts as a powerful anti-inflammatory agent, reducing inflammation and swelling that worsen TMD symptoms. Lidocaine HCl provides local anesthesia, directly alleviating pain, while aquades serves as a solvent to dilute the solution. The combination of these three agents offers a dual advantage: long-term inflammation reduction (via dexamethasone) and immediate pain relief (via lidocaine), making it an effective option for managing TMD without the need for invasive surgery.[8-10]

Case Report

Patient 1

A 36-year-old female complained of chronic pain in the left TMJ for 10 months, unresponsive to previous analgesics. The patient had consulted a neurologist and an ENT specialist. Initial VAS was 7/10, MIO was 26 mm. Prolotherapy was performed using a mixture of dexamethasone, 2% lidocaine, and aquades. After the procedure, the

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Figure 1. **Palpation of the TMJ while instructing the patient to open and close the mouth, B. Prolotherapy on the left TMJ articular disc**

Figure 2. **Post-prolotherapy, pain reduced, and the patient was more comfortable**

Figure 3. **A. Palpation of the TMJ while instructing the patient to open and close the mouth, B. Prolotherapy on the left TMJ articular disc, C. Post-prolotherapy, pain reduced, and the patient was more comforta-ble**

Figure 4. **A. Prolotherapy on the left TMJ articular disc, B. Prolotherapy on the left TMJ articular disc, C. Post-prolotherapy, pain reduced, and the patient was more comfortable**

patient reported numbness and a feeling of fullness in the TMJ area, with gradual pain relief. After resting for 30 minutes, the patient was re-evaluated and reported no pain, though some numbness remained. Two hours later, the patient was instructed to open and close her mouth, reporting comfort and no pain in the TMJ area. After 10 days, VAS dropped to 2/10, MIO increased to 35 mm, and masticatory function improved. The patient was not available for follow-up after 8 weeks due to personal reasons.

Patient 2

A 49-year-old female presented with chronic left TMJ pain for 10 months, which did not improve with analgesics. Initial VAS was 8/10, MIO was 28 mm. The prolotherapy procedure was similar to that for Patient 1. Post-treatment, the patient reported numbness, fullness in the TMJ area, and gradual pain relief. After 30 minutes of rest, the patient was evaluated and reported no pain but still felt numb. After two hours, the patient was instructed to open and close her mouth, and the patient felt comfortable with no pain in the TMJ. After 8 weeks, VAS decreased to 2/10, MIO increased to 36 mm, and masticatory function improved. The patient was not available for follow-up after 8 weeks.

Patient 3

A 35-year-old male complained of chronic bilateral TMJ pain for 8 months. Previous treatment with analgesics by 'a general practitioner had not been effective. Initial VAS was 8/10, MIO was 15 mm. Prolotherapy was performed similarly to the previous patients. After the procedure, the patient reported numbness, with pain gradually decreasing. After 30 minutes, the patient was re-evaluated and reported no pain. After two hours, the patient was instructed to open and close the mouth and felt comfortable with no pain in the TMJ. After 10 days, VAS decreased to 4/10, MIO increased to 22 mm, and masticatory function improved.

Discussion

The management of TMD with prolotherapy has shown promising results, though the existing clinical evidence is still under development. A study by Kabbani et al. (2019) demonstrated that prolotherapy can reduce chronic pain in the temporomandibular joint by stimulating tissue healing through irritant injections, which increase blood flow and improve tissue regenera-tion.[11]

However, results vary among individuals, and while many patients report significant improvement in pain symptoms, other studies have shown notable differences in response based on patient characteristics, such as the duration of TMD and severity of the condition (Smith et al., 2020). Thus, while prolotherapy presents a potential therapeutic option, its management must account for clinical variability and the individual patient's condition.[12]

The combination of dexamethasone, aquades, and lidocaine HCl in prolotherapy aims to optimize treatment outcomes by addressing two key aspects of TMD: pain and inflammation. Dexametha-sone, a corticosteroid, acts as a potent anti-inflammato-ry agent, effectively reducing inflammation that often exacerbates pain and muscle tension in TMD. Aquades serves as a solvent, ensuring that the correct dosage of medication reaches the target tissues. Meanwhile,[13-16] lidocaine HCl provides a local anesthetic effect, directly reducing pain experienced by the patient during the procedure. This combination offers a dual benefit: long-term inflammation reduction (through dexametha-sone) and immediate pain relief (through lidocaine), which is crucial for enhancing patient comfort and supporting long-term treatment success.[16]

Nevertheless, it is important to note that while this combination is highly effective in addressing pain and inflammation in TMD, the use of corticosteroids such as dexamethasone should be approached with caution due to the potential side effects associated with long-term use, including reduced healing capacity and potential tissue strength degradation.[17-19]

In comparison with other conventional therapies, prolotherapy demonstrates advantages in terms of chronic pain and inflammation reduction in TMD, which are often not achievable with physiotherapy or pharmacological treatments such as NSAIDs alone. Physiotherapy, generally involving strengthening and stretching exercises, may benefit some patients, but its effects are often limited in the long term without a more robust medical approach. NSAIDs provide short-term relief in reducing pain and inflammation but do not address the root causes of the condition and may induce gastrointestinal side effects with long-term use. Corticosteroid injections may offer faster inflammation reduction, but their effects are typically temporary and often fail to provide long-term improvement.[20,21]

In contrast, prolotherapy focuses on the body's natural healing process, providing more sustained effects in pain reduction and joint function improvement. A study by Lee et al. (2021) showed that prolotherapy can offer more stable results compared to other non-surgical treatments, especially in patients who do not respond to conservative therapy.[20] However, a limitation of prolotherapy is the lack of clear scientific consensus regarding the optimal dosage and the number of sessions required to achieve consistent results.[22,23]

Several important limitations must be considered in this study. First, the small sample size may affect the generalizability of the findings, and the possibility of selection bias in choosing patients who are more likely to respond to prolotherapy may exist. Additionally, the short follow-up duration may limit understanding of the long-term sustainability of prolotherapy benefits. Many studies assess prolotherapy over a period of weeks to months, whereas effective TMD management often requires long-term monitoring to evaluate the stability of the results. Lastly, potential bias in clinical evaluation should also be considered, especially if the outcome measures, such as pain reduction, rely solely on subjective patient assessments.[24,25]

Prolotherapy offers a highly relevant non-surgical solution for patients with TMD who do not adequately respond to conventional treatments. In clinical practice, prolotherapy can be integrated as a more permanent treatment alternative for patients experiencing chronic pain that cannot be managed with other conservative therapies. As part of a broader treatment approach, prolotherapy could be used after patients fail to respond to physiotherapy, NSAIDs, or corticosteroid injections, offering a safer option with lower risks compared to surgical interventions.[26,27]

However, the integration of prolotherapy into clinical practice requires careful individual evaluation, considering factors such as the severity of TMD, previous treatment responses, and potential contraindications to corticosteroid use. A larger evidence-based approach and a better understanding of optimal protocols are needed to ensure long-term effectiveness and prevent complications.[28]

Conclusion

Prolotherapy with dexamethasone, aquades, and lidocaine HCl provides a promising new non-surgical alternative in the management of TMD, with significant reductions in pain and inflammation. However, further research is needed to explore the optimal dosage, treatment duration, and understanding of the long-term benefits of prolotherapy and its potential side effects. Additionally, clear clinical guidelines are required to effectively integrate prolotherapy into clinical practice for maximal benefit to patients with TMD who are resistant to conventional therapies.

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REVIEW

Complete denture fractures: Insights into clinical failures and management strategies

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ABSTRACT

Background: Complete denture fractures are a common complication in edentulous patients, mainly due to a combination of anatomical, biomechanical, material, and technical factors. This condition affects masticatory function, comfort, and quality of life in elderly patients, who are the largest users of dentures. Purpose: This article aims is to review the epidemiology, etiology and contributing factors, and management of complete denture fractures. Review Summary: Various studies show that fractures most often occur within first two to four years of the denture age, especially in the mandible and midline area due to flexural fatigue. The main causes include poor fit, unbalanced occlusion, fall trauma, and material defects such as porosity or an overly thin base. Repairs can be made using autopolymerizing resin, heat-cured resin, microwave polymerization, or visible light-cured resin, with reinforcement techniques such as E-glass fiber reinforcement, which has been shown to increase denture strength. Prevention focuses on proper design, good stress distribution, occlusal balance, and regular monitoring. Conclusion: A clear understanding of the etiology and fracture patterns is essential to improving clinical outcomes in denture fracture management. Strengthening clinical protocols through better diagnostic awareness and preventive strategies can help reduce the overall risk of denture fractures. (IJP 2025;6(2):146-151)

Introduction

Edentulism is defined as the condition of having no natural teeth.[1] Edentulism can be partial or complete. Complete edentulism represents a chronic oral health issue characterized by the total absence of all natural teeth.[2,3] Some studies suggest that the main causes of edentulism are untreated dental caries and chronic and progressive periodontal disease, both of which gradually damage the supporting tissues of the teeth and lead to permanent tooth loss if not properly treated.[4,5] Complete edentulism is not only caused by local factors such as caries and periodontitis but is also closely related to systemic diseases. Conditions such as diabetes mellitus, cardiovascular disease, and chronic inflammation can worsen periodontal health and accelerate tooth loss.[4,6,7] Complete edentulism is strongly influenced by socioeconomic factors. Individuals with low levels of education and income tend to have limited access to dental health services, increasing the risk of total tooth loss.[8,9] The World Health Organization estimates that by 2023, the global prevalence of adults over the age of 60 will be 23%.[10] Based on a national study conducted by Pengpid & Peltzer (2018) using Indonesia Family Life Survey (IFLS-5) data for 2014-2015, the prevalence of complete edentulism in Indonesia in the population aged 50 years and older was 7.2%.[11]

Complete edentulism can limit a person's ability to articulate speech, decrease masticatory efficiency, alter facial appearance, alter quality of life, and can be associated with social embarrassment. Rehabilitation of edentulism patients requires a prosthesis that meets the needs of aesthetics, phonetics, and improves masticatory function.[2,3,12] The most common restorative treatment used for edentulism is the removable complete denture.[13] Various materials have been used for the fabrication of complete dentures. Wood, ivory, bone, and alloys were used in ancient times. Acrylic or polymethyl methacrylate (PMMA) is the most common denture material used for the fabrication of partial or complete dentures due to its good esthetic characteristics, adequate strength, easy repair, low water absorption, and simple processing technique. Disadvantages of acrylic material include porosity, presence of residual monomer, increased finishing time, brittleness, and unevenness.[14]

One of the complications associated with removable complete dentures is denture fracture, which may result from functional stresses and material fatigue. Complete denture fracture influenced by multiple factors, exhibit various characteristics, and can be classified into different categories. The causes of complete denture fractures can be divided into intraoral and extraoral, or material and clinician or technician factors. Intraoral and clinician or technician factors include poor fit, improper occlusion, and inadequate design, which can lead to uneven stress distribution.[15-17] Extraoral causes mainly involve accidental trauma, such as dropping the denture during cleaning. Material defects, like porosity and thin bases, can also contribute to fracture risk. The location of the fracture may vary among individuals. The purpose of this study is to review the epidemiology, etiology and contributing factors, and management of complete denture fractures. By examining current literature and clinical practic-

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Table 1. **Prevalence of complete denture fractures by denture age**

Denture Age	Prevalence	References
0-3 years	19%	Khasawneh & Arab, 2003
4-6 years	29%	
7-9 years	19%	
10-12 years	15%	
13-15 years	9%	
More than 15 years	9%	
Less than 1 year	20%	El-Sheikh & Al-Zahrani, 2006
1-3 years	48.8%	
More than 3 years	31.1%	
0-2 years	15%	Abdel-Rahman, 2011
3-5 years	32%	
6-8 years	24%	
8-11 years	12%	
12-14 years	11%	
More than 15 years	6%	
Less than 1 year	22.05%	Lukram et al., 2015
1-3 years	45.5%	
More than 3 years	29.41%	
0-2 years	21%	Bosânceanu et al., 2017
2-4 years	28%	
4-6 years	16%	
6-8 years	12%	
8-10 years	15.5%	
More than 10 years	7.5%	
0-2 years	21%	Naik, 2017
2-4 years	28%	
More than 10 years	7.5%	
1 year	5.14%	Kamble et al., 2021
1-3 years	34.2%	
More than 3 years	60.5%	
0-2 years	55.2%	Iftikhar et al., 2022
3-5 years	29.3%	
6-8 years	5.2%	
More than 8 years	10.3%	

Table 2. **Prevalence of complete denture fracture by causative factors**

Causes	Prevalence	References
Poor fit	34.5%	Khasawneh & Arab, 2003
Poor occlusion	16%	
Dropping	22.5%	
Defect in acrylic base	15.5%	
Material breakdown	8%	
Setting in the teeth out of the ridge	3.5%	
Accident	2.22%	Sheikh & Al-Zahrani, 2006
Impact	80%	
Mastication	17.7%	
Chewing load	51.6%	Takamiya et al., 2011
Fall	40.3%	
Accident or trauma	5.3%	
Other	2.4%	
Accident	2.94%	Lukram et al., 2015
Impact	77.9%	
Mastication	19.1%	
Accident	39%	Bosânceanu et al., 2017
Instability	32.5%	
Occlusal interferences	14%	
Polymerization defect	3%	
During mastication	5%	
Others	6.5%	
Poor denture fit	44%	Sharma, Singh & Bharti, 2019
Poor occlusion	20%	
Base defect	12%	
Materal breakdown	16%	
Accidental fall	8%	
Accidental fall	28%	Kumari & Bala, 2021
Poor fit	18.6%	
Poor occlusion	26.6%	
Material breakage	16.6%	
Acrylic base defect	10%	
Accidental falling	34.5%	Iftikhar et al., 2022
Poor fitting of the denture	27.6%	
Occlusal prematurity	24.1%	
Denture porosities	13.8%	
Accidental fall	35.7%	Sharma, Paharia & Tiwari, 2023
Poor occlusion	28.5%	
Material breakage	21.4%	
Acrylic base defect	14.2%	

es, the study seeks to support improved durability and longevity of complete dentures in prosthodontic treatment.

Review

Prevalence of Complete Denture Fracture

Most individuals who use complete dentures are elderly patients, a population that is particularly vulnerable edentulism14 In older adults, prolonged tooth loss is frequently associated with progressive alveolar bone resorption, decreased neuromuscular control, and age-related changes in oral and perioral musculature. These physiological alterations of the elder can compromise the retention, stability, and overall functional performance of complete dentures, thereby highlighting the unique clinical challenges encountered in the prosthodontic management of the elderly.[18]

The incidence of denture fractures also varies depending on the gender and age of the denture wearer. Men have been reported to experience denture fractures more frequently than women.[3,19-23] This trend is often attributed to the generally higher occlusal forces observed in male patients, which place greater mechanical stress on the prosthesis.[31-32] The age of the wearer significantly influences the prevalence of complete denture fractures, with elderly being particularly susceptible. A study reported that the highest incidence of denture fractures occurs in patients aged 60 years and older. This finding aligns with evidence indicating that elderly are the most common population using the complete decture.[3]

The likelihood of complete denture fractures has been shown to increase with the age of the denture. As dentures are used over long periods, cumulative mechanical stress, material fatigue, and gradual loss of structural integrity contribute to a higher risk of fracture. This is supported by studies demonstrating that older dentures exhibit a significantly greater proportion of fractures compared with newer ones.[12] Several studies have also reported that most complete denture fractures occur within the first two to four years of the denture age, indicating an early period of vulnerability.[3,20-22,24] Other investigations, have identified a different pattern, in which fractures more commonly occur after three to eight years of the denture age.[19,26]

Causes of Complete Denture Fracture

The causes of complete denture fractures are multifactorial and the data presented across studies show a consistent pattern. Accidental dropping or external trauma is one of the most frequently reported etiological factors. These findings suggested that sudden impact forces, especially those occurring during handling, played a major role in complete denture fracture.[3,16,17,28] This risk was increased in older adults, whose age-related decline in motor coordination made accidental denture drops more common.[33,34] Poor denture fit also contributes significantly to fracture occurrence, as insufficient adaptation of the denture base can increase localized stress and ultimately compromise structural stability.[3,15,17] Similarly, premature

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Table 3. Classification and prevalence of complete denture fracture according to fracture site

Classification	Prevalence	References
Midline	59%	Abdel-Rahman, 2011
Labial flange	12%	
Canine area	18%	
Premolar area	4%	
Tuberosity and retromolar pad area	5%	
Other areas	2%	
Median	34.8%	Takamiya et al., 2011
Border	17.2%	
Median and border	1.7%	
Debonding teeth	55.2%	
Breakage teeth	8.6%	
Midline	70.37%	Ray et al., 2014
Other areas	18.52%	
Teeth were de-bonded from the base	11.11%	
Midline	23.9%	Sharma, Singh & Bharti, 2019
Labial flange	10.8%	
Canine area	15.2%	
Premolar area	17.3%	
Tuberosity area	17.3%	
Other areas	15.2%	
Incisor area	16.6%	Kumari & Bala, 2021
Canine area	20%	
Midline	33.3%	
Molar area	6.66%	
Maxillary tuberosity/retromolar pad area	23.3%	
Midline	32.8%	Iftikhar et al., 2022
Labial flange	24.1%	
Retromolar pad/tuberosity area	5.2%	
Premolar	5.5%	
Canine	20.7%	
Other area	1.72%	
Midline	22%	Sharma, Paharia & Tiwari, 2023
Incisor area	14%	
Canine area	12%	
Labial flange	18%	
Molar area	10%	
Maxillary tuberosity/retromolar pad area	24%	

Figure 1. Fracture site. A. Class I maxillary denture fracture, B. Class I mandibular denture fracture, C. Class II mandibular denture fracture, D. Class III maxillary denture fracture, E. Class IV maxillary denture fracture, F. Class V maxillary denture fracture, G. Class V mandibular denture fracture

contacts and occlusal interferences have been documented as major contributors, these factor indicating that inadequate occlusal balance leads to uneven force distribution and consequently increases susceptibility to midline or base fractures.[3,16,17,26] Material-related problems are also consistently noted such as porosity, polymerization defects, base degradation, and acrylic resin imperfections. These defects weaken the material and reduce its ability to withstand repeated loading.[3,25] In several populations, functional stresses emphasizing the cumulative effect of repetitive or excessive loading on denture leading to the complete denture fracture.[22,24,28]

Classification of Complete Denture Fracture

Fractures in complete dentures have adopted several classification systems to identify and compare the location of structural fractures. Most classifications are based on anatomical regions of both maxillary and mandibular dentures. Fracture sites commonly categorized into the incisor area, labial flange, midline, canine area, premolar area, molar area, and the maxillary tuberosity or retromolar pad regions. This anatomical approach helps explain observed patterns in clinical data, particularly as the prevalence of fractures in mandibular complete dentures has consistently been reported to be higher than in maxillary dentures.[23] Within these anatomical classifications, cumulative evidence shows that midline fractures are the most frequently reported.[3,16,17,19,27] The midline region is structurally vulnerable due to significant tensile stresses generated during mastication and anatomical constraints such as the presence of the labial frenulum, making it a common site of flexural fatigue.

Several authors have proposed specific classifications of complete denture fracture locations, whereas other author have grouped these fracture sites more broadly into five classes: Class I representing midline fractures, Class II for diagonal fractures, Class III for sickle-shaped fractures involving the labial or buccal flange, Class IV describing base fractures with teeth remaining intact, and Class V encompassing fractures due to generalized denture loosening or breakage. Choundary reported that complete denture fractures occurred predominantly at the mandibular midline.[29]

Treatment of Acrylic Denture Fracture

Acrylic denture fracture problems can be treated with several treatment options. Broken acrylic resin dentures are repaired with autopolymerizing acrylic resin, heat-cured acrylic resin, microwave-polymerized acrylic resin, and visible light-cured acrylic resin.[14,26] Autopolymerizing acrylic resin repair is easy to perform due to its easy handling and quick repair at a low cost. Autopolymerizing acrylic resin repair is weaker than other methods and can reduce the transverse strength of the denture by 40-60%. Heat-cured acrylic resin repair provides stronger results than autopolymer-

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izing acrylic resin. Microwave-polymerized acrylic resin has higher resistance than conventional methods. The use of cyanoacrylate adhesive in combination with microwave polymerization was found to be a good technique for repairing tooth debonding in complete dentures and can increase the strength of denture repairs. Visible light-cured acrylic resin repair is a new method that shows potential improved adhesion strength and fracture durability.[14,15,19,21,29,30]

There is also a need for a new and more suitable method of reinforcing the denture base during preparation. One promising approach involves the use of continuous electrical-glass (E-glass) partial fiber reinforcement. This method has been demonstrated to enhance key mechanical properties of denture bases, including transverse strength, ultimate tensile strength, and impact strength. In comparison to metal-wire reinforcement, E-glass fibers offer superior aesthetic outcomes and improved bonding with the resin matrix. In vitro studies have confirmed that unidirectional E-glass partial fiber reinforcement markedly improves the mechanical performance of both complete and partial removable dentures.[22,24,30]

Different prevention measures can be taken to reduce the incidence of denture fracture through maximum denture retention and stability, uniform occlusal loading, and balanced articulation. Additional strategies involve the use of high-strength polymer materials (such as high-impact resins), good processing techniques to eliminate surface defects and inclusions within the denture base, reducing the need for deep frenal grooves through frenectomy, adequate thickness in the anterior region (maximum to suit the tongue space) and placing thin beads around the labial frenum to improve the seal.[22,26]

A majority of the midline fractures can be avoided by the application of established prosthodontic principles during denture construction. The principles include an even and adequate bulk of denture base material cured to achieve optimum polymerization and free of porosity, relief of incompressible tissue in the center of the hard palate, addition of labial flange to increase rigidity of denture base as well as even and balanced occlusion to reduce wedging effect and locking of occlusion. Additionally, advancements in denture base resin materials, along with the careful reduction of stress concentrators such as notches and diastema, can further contribute to the prevention of such fractures.[22]

All repaired dentures were comprehensively evaluated in the mouth for optimal retention, stability, and occlusion. Phonetics, esthetics, and chewing were also assessed and asked of patients. Post-repair evaluation includes retention, stability, and occlusion to ensure patient comfort.[20,23]

Discussion

Complete denture fractures remain a common complication among edentulous patients and continue to present a clinical challenge due to their multifactorial nature. The high rate of fractures in older adults aligns with previous reports showing that elderly denture wearers frequently experience marked ridge resorption, decreased neuromuscular control, and soft-tissue changes. These conditions reduce denture retention and stability, making the prosthesis more difficult to maintain during function. As a result, functional stresses on the denture base increase, which in turn heightens its vulnerability to fracture.[18,25]

Several studies indicate that elderly experience an intraoral retention instability due to poor fit and higher incidence of denture fractures, commonly resulting from accidental dropping especially among elderly patients with reduced manual dexterity.[15,19,24] Evidence from several studies indicates that midline fractures represent the most frequent fracture site, with mandibular dentures demonstrating a higher prevalence of fracture compared to maxillary dentures. Mandibular dentures experience higher mechanical stress because they have a narrower base, less supporting surface area, and greater flexure during function. These anatomical constraints contribute to increased stress concentration along the midline, thereby accounting for its consistent identification as the most frequently reported fracture site across nearly all classifications and studies.[3,29]

The causes of denture fracture are divided into intraoral and extraoral factors and material factors. The impact strength of the denture is strongly affected by the intrinsic mechanical characteristics of the denture base material. Dentures with a strong base can significantly enhance mechanical performance and reduce the risk of fractures, particularly those caused by accidental dropping.[15,21]

Denture fractures are generally attributed to intraoral factors, extraoral factors, and material-related causes, with the mechanical properties of the denture base material playing a critical role in determining overall durability.[22,35,36] The impact strength and intrinsic mechanical behavior of the denture base significantly influence its resistance to fracture, particularly during accidental dropping or sudden impact.[35-38] Recent studies have demonstrated that heat-cured PMMA continues to exhibit superior flexural strength and fracture toughness compared with several newer light-cured or 3D-printed resins, which remain more susceptible to crack propagation and impact-related fracture. Moreover, contemporary material modifications, including fiber reinforcement and nanoparticle fillers, have been shown to enhance the mechanical performance of denture bases and effectively reduce

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fracture incidence, especially in extraoral scenarios.[39-43]

In terms of management, autopolymerizing acrylic resins remain widely used for denture repair due to their accessibility and ease of manipulation. However, their lower transverse strength compared to heat-cured or microwave-polymerized acrylics limits the long-term success of repairs. Emerging materials such as visible light–cured resins and reinforcement techniques using continuous E-glass fibers have shown promising improvements in mechanical strength, impact resistance, and fracture toughness. These advancements suggest that future prosthodontic strategies may benefit from integrating reinforcement systems, particularly for high-risk areas such as the mandibular midline.[19,24,26]

Preventive measures also play an essential role. Ensuring uniform denture base thickness, reducing stress concentrators, optimizing occlusal schemes, and maintaining retention and stability can significantly reduce fracture incidence. Regular follow-up during the critical early years of denture use allows clinicians to detect early signs of wear, maladjustment, or occlusal imbalance before catastrophic fracture occurs.[22]

Overall, the findings of this review emphasize the importance of understanding fracture patterns and contributing factors to improve prosthetic longevity. Enhancing denture design, material selection, and fabrication techniques while integrating appropriate reinforcement can substantially reduce denture fracture rates and improve patient comfort, satisfaction, and oral function. Future research should focus on evaluating the long-term clinical performance of reinforced denture bases, as well as quantifying their cost-effectiveness and patient-reported outcomes.

Conclusion

Complete denture fracture constitutes a prevalent and multifactorial complication in prosthodontic practice, particularly among elderly patients. The condition is predominantly attributed to mechanical stresses arising from occlusal disharmony, inadequate denture adaptation, and accidental trauma, with mandibular midline fractures occurring most frequently as a result of flexural fatigue and anatomical constraints. The highest incidence is reported within the first two to four years of clinical service, reflecting the influence of material properties, fabrication protocols, and patient-specific anatomical factors on prosthesis longevity. Although autopolymerizing acrylic resin is widely employed for repair, its durability is generally inferior to that of heat- or microwave-polymerized resins. A comprehensive understanding of the etiology, prevalence, and classification of complete denture fractures is therefore essential to optimize prosthetic design, minimize fracture risk, and enhance patient-centered clinical outcomes.

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REVIEW

Accuracy of intraoral scanning influenced by different scanning distance and ambient light : A systematic literature review

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Keywords: Accuracy, Ambient light, Intraoral scanners, Precision, Scanning distance

ABSTRACT

Background: Intraoral scanning is now widely used in clinical dental practice. The accuracy of impressions obtained using intraoral scanners is a critical factor in the success of fixed prosthodontic restorations. The accuracy of digital intraoral scanning is influenced by scanning distance and ambient lighting conditions. Objectives: This systematic review aims to evaluate the impact of scanning distance and ambient light on the accuracy of intraoral digital impressions. Methods: Following the PRISMA 2020 guidelines, this study conducted a thorough electronic search across PubMed, ScienceDirect, and ProQuest to identify relevant studies.. The Robins I tool assessed the risk of bias in various study types. Data extraction occurred based on predetermined parameters for studying specimens and assessing outcomes. Results: Multiple studies consistently highlight that maintaining an optimal intraoral scanner (IOS) tip distance, typically around 2,5-10 mm, is critical for achieving high-precision digital models, while both closer and farther distances tend to reduce accuracy. Furthermore, extremes in illumination intensity (0 lux and 1500 lux, especially at 7500 K) leading to diminished scan trueness and prolonged scanning times. Conclusion: Scanning distance and ambient lighting conditions affect the accuracy of digital impressions produced using intraoral scanners. (IJP 2025;6(2):152-156)

Introduction

Intraoral scanning has become an essential part of modern digital dentistry. The accuracy of digital impressions obtained through intraoral scanners (IOS) plays a crucial role in the clinical success of fixed prosthodontic restorations. Compared with conventional impression techniques, digital scanning provides notable advantages, such as improved patient comfort, reduced chair time, and the elimination of distortions caused by impression materials. These devices allow clinicians to quickly create three-dimensional models of the dentition, improving the precision and efficiency of planning and fabricating crowns, bridges, and implant-supported restorations.[1,2]

The performance of intraoral scanners is influenced by a combination of procedural and environmental factors. Procedural factors include the operator's scanning technique, scanning path, device calibration, and particularly the distance between the scanner tip and the tooth surface. Environmental variables, on the other hand, involve illumination, color temperature, humidity, and even patient movement during scanning.[1,2] Among these, scanning distance and ambient lighting are often considered the most critical variables affecting scan accuracy. Scanning distance influences the sensor's ability to capture detailed surface data, while lighting conditions affect how the device interprets reflected light and reconstructs images.[3-6]

Previous studies suggest that optimal scanning distances vary between scanner systems but typically range around 2.5-10 mm. Working too close or too far from the tooth surface can reduce accuracy by oversaturating the sensor or creating missing surface points.[12,14,16] Similarly, changes in lighting conditions can significantly affect scan fidelity. Variations in light intensity (lux) and color temperature can alter both trueness and precision as well as scanning time. Moderate illumination, such as 500 lux at 3900 K, tends to produce more accurate and consistent results than extremely bright or dark conditions.[4-6,10,17] Because lighting environments differ widely between dental offices, controlling this factor remains a challenge in clinical settings.

In addition, intraoral scanners differ in their underlying optical acquisition technology. Systems based on confocal or parallel confocal principles (such as TRIOS or iTero) rely on focused imaging and are generally more tolerant of small variations in distance and lighting. In contrast, triangulation-based scanners (such as CEREC or Medit) depend on projected light geometry and are therefore more sensitive to environmental changes.[10-12,14] Clinical variables, including saliva, patient movement, and soft-tissue interference, may further compromise scanning accuracy.[7-9] It is important to understand how both procedural and environmental parameters—particularly scanning distance and ambient lighting—affect the trueness and precision of intraoral digital impressions. This systematic review aims to summarize current evidence regarding the influence of these parameters on the accuracy and efficiency of intraoral scanning in prosthodontic applications.

Review

The systematic review was reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analy-

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Table 1. Summary of reviewed studies of factors affecting the accuracy of intraoral scans

Author/Year	Study Type	Independent Variables	Scanners Used	Evaluation Parameters	Key Findings
Arakida et al/2018 (17)	In vitro	Ambient light (0, 500, 2500 lux); Temp (3900K–19000K)	3M True Definition (active wavefront sampling)	Trueness, Precision, Scan time	Accuracy : Best accuracy at 500 lux & 3900K; high lux scan time
Kim et al/2019 (12)	In vitro	Scanning distance (0, 2.5, 5.0, 7.5 mm)	TRIOS (confocal), CS 3500 (confocal) PlanScan (triangulation)	2D linear (Rapidform), 3D RMS (Geomagic)	Accuracy : 2.5 - 5.0 mm had best accuracy; 0 mm was worst
Revilla-Leon et al/2020 (15)	In vitro	Light condition (chair, room, natural, no light)	iTero Element (confocal), CEREC Omnicam (triangulation), TRIOS 3 (confocal)	MeshLab RMS (Trueness & Precision)	Accuracy : iTero chair and room light, CEREC Omnicam zero light, Trios 3 room light
Koseoglu et al/2021 (13)	In vivo	Ambient light (0 vs. 1003 lux); Scanning light (Blue vs. White)	Medit i500 (triangulation)	3D deviation	Trueness : The 3900 K and 500 lux condition is the most appropriate lighting condition for taking a digital impression.
Rotar et al/2022 (14)	In vitro	Scanning distance (5, 10, 15, 20, 23 mm)	Medit i700 (triangulation)	Trueness, Precision	Accuracy : 10 mm had highest accuracy
Piedra-Cascon et al/2023 (11)	In vitro	Ambient light (0–10,000 lux, 12 groups)	PrimeScan (confocal)	RMS deviation	Accuracy : 1000 lux group had best accuracy; 0 lux worst
Karakuzu et al/2024 (10)	In vitro	Ambient light (0, 500, 1000, 1500 lux); Color temp (white, blue, yellow)	YOUJOY 3DS 2.0 (triangulation)	RMS, Scan time	Accuracy : Best at 500 lux + yellow; worst at 0 lux
Button et al/2024 (16)	In vitro	Scanning distance (0,2,4mm) and angulation (0°, 15°, 30°, 45°)	i700(triangulation), TRIOS4(confocal), CS 3800(triangulation), iTero(confocal)	RMS, Scan area	Accuracy : i700: Highest accuracy at 0 mm, 15°;TRIOS 4: Best at 2 mm, 15°; CS 3800: Best at 0–2 mm, 0°–15°; iTero: Best at 0–4 mm, 15°.

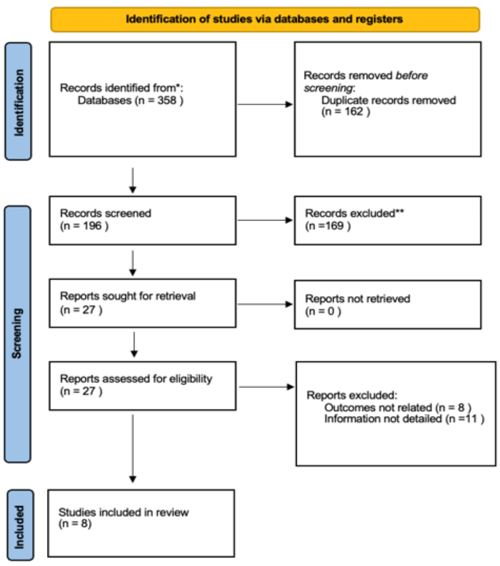

Figure 1. Flow chart of literature screening process

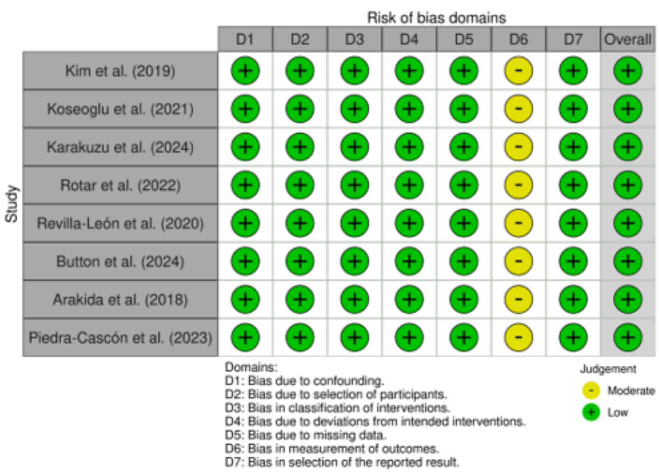

Figure 2. Example of 'Risk of bias' table for a single study

ses) statement.

Objectives

This systematic review aims to evaluate the impact of scanning distance and environmental factors like scanning distance and color temperatures on the accuracy of intraoral digital impressions

PICO question

Population (P): Dental models (typodonts) and patients requiring intraoral scanning — both in vitro (lab-based typodonts) and in vivo (human subjects). Intervention (I): Intraoral scanning performed under different scanning distances and ambient light. Comparison (C): Intraoral scanning performed under other scanning distances or different ambient lighting conditions. Outcome (O): Accuracy, which is further defined by: Trueness: The closeness of the digital model to a "true" or reference model. Precision: The repeatability of the scan, or how close multiple scans of the same object are to each other.

Sources of information and search strategy

An electronic search of three databases was conducted to identify eligible studies: PubMed, Science Direct, and Proquest. The publication time was the period from January 2015 to January 2025. The language or publication type was limited to English. The literature search was conducted in August 2025, using a combination of controlled vocabulary and free keywords: intraoral scanner, scanning distance, ambient light and accuracy. Additional reports were identified through a manual search of the bibliographies of all included studies and relevant systematic reviews. The search strategy for each database was established as follows: ("intraoral scanner" AND "scanning distance") AND ("ac-curacy"), ("intraoral scanner" OR "scanning distance") AND ("accuracy"), ("intraoral scanner" AND "ambient light") AND ("accuracy"), and ("intraoral scanner" OR "ambient light") AND ("accuracy"). These terms were selected after careful consideration of Medical Subject Headings (MeSH) and relevant prosthodontic terminology.

Eligibility criteria

Inclusion criteria; Studies that compared intraoral scans of teeth or typodonts under different ambient light conditions; Studies that compared intraoral scans of teeth or typodonts with different scanning distance; Studies that evaluated at least one of the following outcomes: trueness or precision; In vitro or in vivo studies; Studies published in English language.

Exclusion criteria; Case reports, reviews, expert opinions, or clinical guidelines; Studies lacking detailed values of color temperature of ambient light conditions; Studies lacking detailed values of scanning distance; Studies for which the full text could not be retrieved.

Study selection

Titles and abstracts identified in the search were screened independently by two reviewers using Zotero software. If a title or abstract did not provide sufficient information on eligibility criteria, the full text was obtained. The full text was independently assessed by the same reviewers in order to select studies that met the eligibility criteria as described. Articles that did not meet the eligibility criteria were excluded. Reasons for exclusion were recorded.

Data extraction

The selection process was conducted in two hierarchical stages. The first stage involved screening by title and abstract, while the second stage entailed comprehensive evaluation of the full text of the articles. Assessment was performed independently, and upon confirmation of the selected studies, data were systematically extracted, including general information such as publication title, author names, journal source, and year of publication.

Quality assessment and risk of bias

The included studies were independently assessed by two reviewers for their methodological quality at the study level, and differences of opinion were resolved by discussion. A risk of bias quality assessment was performed using the ROBINS-I (Risk Of Bias In Non-randomized Studies - of Interventions) to assess the quality and potential bias of the included studies. The ROBINS-I tool was used for non-randomized studies.

Results

Included studies

A total of 358 articles were initially identified from three different databases. After the removal of duplicates, 196 articles underwent a title and abstract screening. Subsequently, 27 articles were subjected to a full-text review. Nineteen articles were excluded for not meeting the eligibility criteria. Lastly, 8 articles were deemed eligible. Figure 1 shows the flow chart of the screening process in the current study, generated using the PRISMA Flow Diagram tool. A manual search was performed, but no additional articles meeting the inclusion criteria were found.

Quality assessment of studies

Two independent reviewers assessed the risk of bias in each study across several domains, including randomization, deviations from intended interventions, missing data, outcome measurement, and reporting. Discrepancies were resolved through discussion and consensus. All studies demonstrated low risk across most domains, with only minor methodological limitations in one domain (D6) rated as moderate. Overall, the studies were judged to have acceptable methodological quality and provide reliable evidence table 2.

Scanning distance and light conditions influencing the accuracy outcome of intraoral scans

In an in vitro study, Kim et al. examined the effect of scanning distance on the accuracy of three intraoral scanners—TRIOS 3, CS 3500, and PlanScan—using a standardized dental model.[12] Resin frames with heights of 0, 2.5, 5.0, and 7.5 mm were fabricated to maintain consistent distances. Accuracy was analyzed using both two-dimensional linear measurements and three-dimensional root mean square (RMS) deviations. The most accurate results were obtained at 2.5–5.0 mm, while 0 mm (tip contact) produced the least accuracy due to sensor oversaturation. TRIOS 3 and CS 3500 (confocal) outperformed PlanScan (triangulation), and all scanners demonstrated clinically acceptable RMS values below 100 µm.

Rotar et al. evaluated scanning distances of 5, 10, 15, 20, and 23 mm in an in vitro study.[14] The highest accuracy was recorded at 10 mm (trueness 23.05 µm; precision 4.2 µm), while accuracy decreased at both shorter and longer distances. The authors attributed this to light oversaturation at close range and loss of reflected light at greater distances.In a comparative in vitro study, Button et al. analyzed four intraoral scanners—i700, Trios 4, CS 3800 and iTero—to assess scanning accuracy and area discrepancies at varying distances and angulations.[16]

In an in vivo study, Koseoglu et al. investigated the effect of four lighting conditions—room light with white (RLW), room light with blue (RLB), zero light with white (ZLW), and zero light with blue (ZLB) scanning modes—on scanning accuracy.[13] The RLB condition yielded the highest trueness, whereas ZLW resulted in the lowest accuracy. The authors recommended maintaining moderate room illumination with blue scanning light. Karakuzu et al. analyzed four illuminance levels (0, 500, 1000, and 1500 lux) and three color temperatures (white, blue, yellow) in an in vitro study.[10] Both lighting intensity and color temperature significantly influenced accuracy. The best results occurred at 500 lux with yellow light, while 0 lux and 1500 lux conditions reduced trueness.

Revilla-León et al. compared iTero Element, CEREC Omnicam, and TRIOS 3 under four lighting environments—zero (0 lux), natural (500 lux), room (1003 lux), and chair (10,000 lux)—in an in vitro setup.[15] Lighting significantly affected all scanners, but the optimal condition varied: iTero performed best under chair and room light, CEREC Omnicam under zero light, and TRIOS 3 under room light.

Arakida et al. tested several lighting combinations, varying illuminance (0, 500, and 2500 lux) and color temperature (3900 K–19,000 K).[17] The best accuracy was obtained at 500 lux and 3900 K, while higher

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brightness prolonged scanning time and reduced trueness.

Similarly, Piedra-Cascón et al. examined a confocal-based PrimeScan under twelve ambient lighting conditions (0–10,000 lux).[11] The most accurate results were achieved at 1000 lux, whereas 0 lux yielded the poorest performance.

Discussion

Several studies have demonstrated that scanning distance exerts a significant and nonlinear influence on the accuracy of intraoral scanning. An intermediate distance between the scanner tip and the tooth surface generally provides the highest accuracy, while distances that are either too close or too far reduce trueness and precision. Kim et al., reported that scanning at 2.5–5.0 mm produced optimal results, whereas direct contact at 0 mm led to oversaturation and reflection artifacts.[12] Similarly, Rotar et al., using Medit i500 identified an optimal working distance of approximately 10 mm, with accuracy deteriorating at both shorter and longer distances.[14]

Button et al. examined four intraoral scanners—TRIOS 4 (confocal), iTero Element 5D (parallel confocal), Medit i700 (triangulation), and CS 3800 (active triangulation)—and found that both scanning distance and angulation significantly affected trueness and surface coverage.[16] Moderate distances (2–4 mm) and 15 degree scanning angles produced the most accurate results, while deviations increased when the scanner tip was positioned too close or angled obliquely. Triangulation-based systems showed greater sensitivity to distance and angulation changes, whereas confocal systems maintained more stable performance. These findings support manufacturer recommendations emphasizing a stable working distance within the optical depth of field of the scanner.

The difference in behavior between confocal and triangulation scanners can be explained by their optical design principles. Confocal and parallel confocal systems (e.g., TRIOS, iTero) capture reflected light from specific focal planes, reconstructing a 3D surface from multiple focused images using optical sectioning. This depth-based imaging method reduces sensitivity to small distance fluctuations and ambient light changes [11,12,15]. In contrast, triangulation-based scanners (e.g., CEREC, Medit, PlanScan) operate by projecting structured light patterns or laser beams onto the surface and calculating depth from reflection angles. This geometric triangulation requires precise alignment between the projector and sensor; deviations in distance or angle reduce measurement accuracy.[3,14,16] Triangulation systems are thus more sensitive to light interference, surface gloss, and translucency.[10,15] Clinically, maintaining a scanning distance of approximately 2.5-10 mm while avoiding tip contact or excessive withdrawal is essential for reproducible results.

Ambient light intensity and color temperature also influence the accuracy and efficiency of intraoral scanning. Changes in illumination can disrupt the scanner's exposure calibration and alter the reflected optical signal quality, affecting surface reconstruction.[11,15,17] Arakida et al., using the 3M True Definition, found that 3900 K and 500 lux condition is the most appropriate lighting condition for taking a digital impression.[17]

Revilla-León et al. compared CEREC Omnicam, TRIOS 3, and iTero Element under different light intensities and found that the Omnicam performed best in complete darkness, while iTero and TRIOS achieved better accuracy under room or chair lighting conditions.[15] These results highlight that the optical design of the scanner dictates how lighting influences performance. Confocal systems tolerate a broader range of lighting environments because they rely on focused light collection from specific depths, which reduces the impact of stray or ambient light.[11,17] In contrast, triangulation systems depend on light projection geometry; thus, external illumination can distort structured light patterns, reducing scanning precision.[4,10,15] Clinically, maintaining consistent, moderate illumination (approximately 500–1000 lux at 3900–4100 K) is recommended. Environmental stability, combined with operator awareness and adherence to manufacturer guidelines, remains crucial for accurate digital impressions.

Conclusion

The accuracy of intraoral digital impressions are highly dependent on scanning distance and ambient light. Because current manufacturer guidelines do not fully account for these variables, clinicians must carefully manage scanning parameters, particularly the working distance between the scanner tip and the tooth surface, while maintaining consistent and moderate ambient lighting during the procedure. An optimal scanning distance of approximately 2.5 - 10 mm and controlled illumination, typically within 500–1000 lux, are recommended for achieving accurate digital impressions. Existing evidence remains largely limited to in vitro conditions and single-scanner evaluations, underscoring the need for comprehensive in vivo research that simultaneously examines scanning distance, lighting, and other environmental factors.

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REVIEW

Stress distribution and flexural strength analysis of anterior ceramic fixed prostheses based on connector designs using finite element analysis

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Keywords: Anterior fixed prostheses, Flexural strength, FEA, Lithium disilicate, Zirconia

ABSTRACT

Background: Anterior ceramic fixed prostheses, such as bridges and resin-bonded fixed partial dentures (RBFPDs), often use zirconia or lithium disilicate. Their success depends on optimal flexural strength and favorable stress distribution to abutment teeth, both influenced by connector design. Objective: This systematic review evaluates the influence of connector design on stress distribution and flexural strength of anterior zirconia and lithium disilicate prostheses using Finite Element Analysis (FEA) or in vitro testing. Methods: Following PRISMA guidelines, studies published between 2015 and 2025 were searched in PubMed, Scopus, and Google Scholar. Eligible full-text English articles examined anterior fixed prostheses made of zirconia or lithium disilicate through FEA or in vitro testing. Results: Seven studies met the criteria. Round connectors in both materials showed the highest flexural strength under oblique loading, while triangular zirconia connectors performed best under vertical loading. Zirconia exhibited uniform stress distribution, whereas lithium disilicate showed balanced stress. Rectangular lithium disilicate connectors displayed more even stress distribution than trapezoidal designs. Double-ended RBFPDs had lower stress than single-ended designs. Conclusion: Connector design and ceramic material critically influence stress distribution and flexural strength in anterior fixed prostheses. (IJP 2025;6(2):157-162)

Introduction

The rehabilitation of anterior tooth loss presents a clinical challenge that requires balancing aesthetic and biomechanical demands. One of the most widely used prosthodontic approaches is the fabrication of fixed dental prostheses in the anterior region using ceramic materials such as zirconia and lithium disilicate. Both materials are known for their excellent optical and physical properties; however, they exhibit fundamental differences in light transmission capability, rigidity, and fracture resistance.[1,2]

Zirconia is a polycrystalline ceramic material with high stress distribution and flexural strength, making it the preferred choice for cases with high occlusal loads. In contrast, lithium disilicate, a silica-based glass ceramic, offers superior translucency and adhesion, making it highly suitable for anterior teeth restorations with high aesthetic demands.[3,4] Although both materials have been extensively used, the success of a three-unit fixed restoration is greatly influenced by the design of the connector the area linking the pontic and the retainer which serves as the load transmission zone.[5]

An improper connector design can lead to excessive stress concentration and ultimately trigger structural failure, especially in anterior teeth that receive complex lateral loading. Therefore, the selection of connector dimensions and geometry becomes an important factor in supporting the mechanical strength of the restoration.[6] In this context, the Finite Element Analysis (FEA) method has become a highly useful numerical analysis tool for evaluating stress distribution in restorative structures non-destructively. Through 3D modeling and masticatory condition simulations, FEA can provide a more accurate representation of the biomechanical response of a restoration design before being clinically tested.[7,8] a highly useful numerical analysis tool for evaluating stress distribution in restorative structures in a non-destructive manner. Through 3D modeling and mastication simulation, FEA provides a more accurate representation of the biomechanical response of a restoration design prior to clinical testing.[7,8]

Several in vitro and FEA studies have examined the relationship between connector design and the type of ceramic material on the stress distribution and flexural strength of a fixed dental prosthesis. However, the findings remain heterogeneous and have not yet produced an optimal connector design for each material type, particularly in anterior fixed dental prosthesis cases.[9] In addition, there are still limited systematic reviews that specifically focus on evaluating stress distribution and flexural strength in anterior fixed dental prostheses made of zirconia and lithium disilicate with varying connector designs using the FEA method.

Based on this background, this systematic review aims to analyze the stress distribution and flexural strength of anterior fixed dental prostheses made of zirconia and lithium disilicate with varying connector designs through finite element analysis and in vitro approaches. This review is expected to provide a strong scientific basis for clinicians in determining the connector design and material of anterior fixed dental prostheses in relation to flexural strength and stress distribution.

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Table 1. Literature search strategy according to PICO criteria

Component	Description
Population (P)	Tooth models with a single anterior tooth loss rehabilitated using a fixed dental prosthesis.
Intervention (I)	Use of zirconia and lithium disilicate materials.
Comparison (C)	Different connector designs.
Outcome (O)	Biomechanical performance in terms of stress distribution and flexural strength of anterior fixed dental prostheses.

Table 2. Summary database

Data Base	First screening based on keywords	Custom Range (2015-2025)	Subject Area	Document type, Source type, Language, Open access	Title screening	Abstract screening	Full text screening
PubMed	39	10	9	8	6	3	3
Google Scholar	101	44	6	6	6	4	4
Scopus	37	15	8	4	4	3	0
TOTAL	177	69	23	18	16	10	7

Table 3. Risk of bias assessment of included studies according to the applied

Appraisal Tools

Article Title	Type of Study	Checklist / Tools Assesment	Conclusion Assesment	Level Quality
Effect of Two Connector Designs on the Fracture Resistance of All-ceramic core materials for Fixed Dental Prostheses: An in- vitro study	In-vitro	JBI Checklist for Quasi- Experimental Studies	Clear objectives, standardized groups and tools, significant results. Model not a clinical form. Worthy of inclusion.	High
Evaluation of Flexural Strength of Zirconia Using Three Different Connector Designs: An In Vitro Study	In-vitro	JBI Checklist for Quasi- Experimental Studies	High compliance with the checklist, few clinical limitations. Suitable for review.	High
Finite Element Analysis (FEA) of the Stress Behavior of Some Dental Materials	FEA	Critical Appraisal Checklist for FEA Studies	The model is very simple, many technical parameters are not explained. It is only suitable as a general reference, not as primary data.	Low
Mechanical Evaluation of Two Different Zirconia- Reinforced Lithium Silicate Ceramics: A Finite Element Analysis	FEA	Critical Appraisal Checklist for FEA Studies	All FEA technical criteria were met, high quality, eligible for systematic review.	High
Optimal design of the retainer and connector for a lithium disilicate resin- bonded fixed dental prosthesis: Finite element and Weibull analyses	FEA	Critical Appraisal Checklist for FEA Studies	The FEA methodology is very robust, with realistic models based on CT scans and comprehensive biomechanical parameters. It is suitable for systematic review.	High
Structural Integrity of Anterior Ceramic Resin- Bonded Fixed Partial Dentures: A Finite Element Analysis	FEA	Critical Appraisal Checklist for FEA Studies	Clinical model based on 3D scanning, complete parameters, valid analysis. Suitable for systematic review.	High
Biomechanical analysis of stress distribution and failure risk in mandibular incisors restored with resin- bonded fixed partial dentures using CAD/CAM materials and restoration designs	FEA	Critical Appraisal Checklist for FEA Studies	An anatomically realistic approach, thorough in material selection and design, and supported by probabilistic failure analysis (Weibull).	High

Review

Literature Search Strategy

This systematic literature review was conducted to analyze the stress distribution and flexural strength of anterior ceramic fixed dental prostheses based on connector design using the Finite Element Analysis (FEA) method. The review was structured according to the PICO framework (Population, Intervention, Comparison, and Outcome), as presented in table 1.

This strategy aimed to critically analyze relevant literature regarding the influence of connector design and ceramic material type on stress distribution and flexural strength in anterior fixed dental prostheses. The Inclusion criteria for this systematic review were: Articles published in English between 2015 and 2025; Studies using anterior fixed dental prosthesis models; Studies involving zirconia and lithium disilicate materials; Evaluations of stress distribution and flexural strength; Studies employing the Finite Element Analysis (FEA) method or in vitro testing; Full-text open access articles. The exclusion criteria were: Review articles, case reports, or descriptive/narrative studies lacking quantitative data; Studies using posterior fixed dental prosthesis models; Articles with restricted access.

Data Selection and Extraction Process

The literature search was systematically conducted through the PubMed, Google Scholar, and Scopus databases. Search terms were developed based on the research question using appropriate keywords combined with Boolean operators (AND, OR, NOT), and quotation marks ("…") were applied to ensure precise search phrases in each database. The Boolean keyword combinations used were as follows, Google Scholar: (("anterior fixed prostheses" OR "anterior bridge" OR "anterior RBFPD") AND ("zirconia" OR "lithium disilicate") AND ("connector design") AND ("finite element analysis" OR "FEA") AND ("flexural strength" OR "stress distribution")) PubMed: (("anterior fixed prostheses[All Fields]" OR "anterior bridge[All Fields]" OR "anterior RBFPD[All Fields]") AND ("zirconia[MeSH Terms]" OR "lithium disilicate[All Fields]") AND ("connector design[MeSH Terms]") AND ("finite element analysis[MeSH Terms]" OR "FEA") AND ("flexural strength[MeSH Terms]" OR "stress distribution[All Fields]")) Scopus: TITLE-ABS-KEY ("anterior fixed prostheses" OR "anterior bridge" OR "anterior RBFPD") AND TITLE-ABS-KEY ("zirconia" OR "lithium disilicate") AND TITLE-ABS-KEY ("connector design") AND TITLE-ABS-KEY ("finite element analysis" OR "FEA") AND TITLE-ABS-KEY ("flexural strength" OR "stress distribution").

The selection process was carried out in two stages. The first stage involved screening based on titles and abstracts, while the second stage consisted of a fulltext evaluation of the selected studies. The assessment was performed independently, and after final confirmation of eligible studies, data were systematically extracted. Extracted data included general information such as publication title, author names, journal source, and year of publication.

Study Selection

The process of literature search and selection was conducted systematically using the established PICO strategy and predefined inclusion and exclusion criteria.

From the initial search results using the keyword strategy developed based on the PICO approach, a total of 177 articles were identified. After further filtering based on publication year (2015–2025),

Table 4. **Data extraction results**

Research	Type of anterior GTC	Material	Abutment	Connector Design	Method	Result
Sharma et al, 2020	FPD	Yttrium-tetragonal zirconia polycristals, Milled Lithium disilicate glass ceramic and Lost-wax/ heat-pressed lithium disilicate glass ceramic	3 unit all-ceramic FPD anterior	10 rectangular bars with dimensions 30 mm (L) x 5 mm (W) x 5 mm (H) 5 bars are made with sharp curved connectors and 5 bars are made with round curved connectors.	In vitro study	The curved connector design on yttrium-tetragonal zirconia polycrystals and lost-wax /heat-pressed lithium disilicate glass ceramics can be considered as the preferred solid ceramic core materials for FDPs, as they have the highest failure load and flexural strength.
Ahmed, M et al, 2020	FPD	Zirconia	3 unit all-ceramic FPD anterior 11 and 21	Round connector Oval connector Triangle connector	In vitro study	The highest flexural strength was found in triangular connectors with vertical loading and the lowest with oblique loading.
Fransesco, P et al,2025	FPD	Zirconia, lithium disilicate (IPS e.max CAD) dan 3Dprinted composite (Varseosmile crown plus)	(3 unit all-ceramic FPD)	(-)	FEA	Lithium disilicate exhibits a balanced stress distribution and has proven to be a versatile material suitable for anterior restorations and restorations with moderate loads. Its superior aesthetic properties make it an attractive choice for anterior areas.
Botsali, M et al., 2024	1.Tooth-supported anterior crown 2.Tooth-supported posterior crown 3. Tooth-supported 3 unit bridge 4.Implant-supported anterior crown 5.Implant-supported posterior-crown 6.Implant-supported 3-unit bridge	Zirconia-reinforced lithium silicate ceramics	Caninus and Premolar 2	(-)	FEA	Tooth-supported restorations exhibit lower stress distribution values compared to implant-supported restorations of the same type. Stress distribution is higher and more widely distributed across a larger surface area under oblique loading compared to vertical loading. Overall, the stress distribution generated in the single crown model is higher than the stress generated in the bridge model. The implant-supported bridge model under oblique loads shows the highest stress distribution. However, neither the zirconia-reinforced lithium silicate milling nor the pressed form affects the stress concentration area and distribution.
Liu, Y et al., 2025	Resin Bonded Fixed Partial Denture (RBFPD) cantilever design	Lithium disilicate	Caninus	Rectangular and trapezoid	FEA	The shape of the connector, the type of retainer, and the placement of the retainer affect the RBFPD stress distribution, and the lowest stress distribution is observed in the rectangular group. The Labial Contact-RBFPD group showed the lowest maximum principal stress distribution (348.2 MPa) and minimum principal stress (49.1 MPa) under regional loading and the lowest equivalent stress (273.4 MPa) and maximum principal stress (356.0 MPa) with a protrusive position. The Labial Veneer RBFPD group showed the lowest equivalent stress (52.0 MPa), the lowest maximum principal stress (47.5 MPa) and the lowest minimum principal stress (1.04 MPa) at the maximum intercuspal position, the lowest minimum principal stress (1.04 MPa) at the protrusive position, and the lowest equivalent stress (46.7 MPa) at the lateral position.
Osman, M et al., 2023	Resin Bonded Fixed Partial Denture (RBFPD) cantilever design	Lithium disilicate dan zirconia	Central Incisor	Rectangular and trapezoid	FEA	The Palatal Veneer-RBFPD group showed the lowest equivalent stress (268.5 MPa) under regional loading and the lowest maximum principal stress (37.7 MPa) and minimum principal stress (2.02 MPa) under lateral loading. Higher loads indicate greater maximum equivalent stress distribution on both materials, regardless of connector width and shape. Loads of 200 N and 150 N simulated on lithium disilicate prostheses with various shapes and dimensions resulted in connector fracture. In contrast, loads of 200 N, 150 N, and 100 N with rectangular connectors simulated on zirconia were able to withstand the load. However, two trapezoidal zirconia connectors were unable to withstand the load and resulted in fracture.
Wang, H et al., 2024	Resin Bonded Fixed Partial Denture (RBFPD)	1.IPS e.max CAD 2.IPS e.max ZirCAD 3.Vita Enamic 4.Lava Ultimate Vitablocs MarkII	Left & right central incisor mandibula	Single ended & double ended	FEA	Oblique loading produces the highest stress and displacement for single-ended RBFPDs. Lava Ultimate has the largest displacement and main stress distribution, while IPS e.max ZirCAD shows the highest equivalent stress distribution. IPS e.max CAD shows the lowest displacement and main stress among double-ended RBFPDs under oblique loading.

document type, English language, and openaccess availability, 18 articles were deemed eligible for further review.

The first screening stage was carried out based on the article titles, resulting in 16 articles. Subsequently, a comprehensive abstract review was performed, yielding 10 articles that were considered relevant and met the criteria for full-text evaluation. After the final assessment for eligibility according to the inclusion and exclusion criteria, seven articles were found to meet all requirements and were ultimately included in the final analysis, which is presented in table 2.

The PRISMA 2020 flow diagram was utilized in this study to illustrate the article selection process in a transparent and systematic manner. The diagram outlines the stages of identification, screening, eligibility

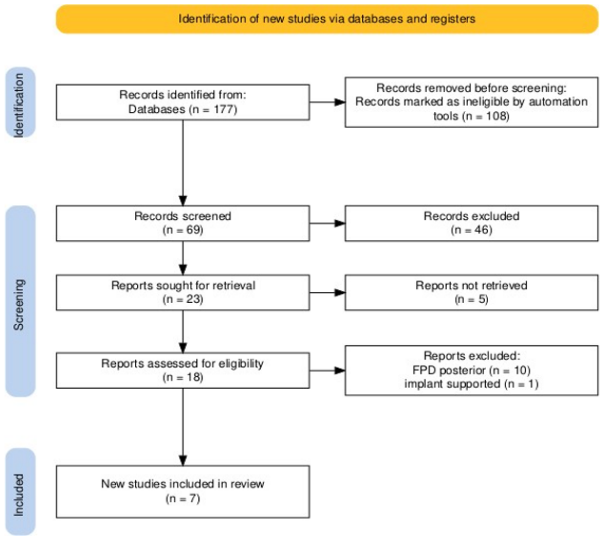

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses)

assessment, and final inclusion of studies that met the criteria for qualitative analysis. Screening was performed based on the predefined inclusion and exclusion criteria, while also considering the methodological rigor and relevance of each study to the objectives of this systematic review. The complete literature selection process is presented in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram below.

Quality Assessment

Methodological quality assessment was performed on all articles included in this systematic review to evaluate the risk of bias and the appropriateness of data for further synthesis. The assessment instruments were adapted according to the type of study being reviewed. For in vitro studies, the JBI Checklist for QuasiExperimental Studies was applied, as it is appropriate for evaluating nonrandomized laboratory experiments. Meanwhile, for Finite Element Analysis (FEA) based studies, the Critical Appraisal Checklist for FEA Studies was used. This checklist was structured based on biomechanical validity principles, including geometric model accuracy, material property validity, boundary conditions, mesh quality, and transparency in discussing methodological limitations.

The seven included studies, five were FEA based and two were in vitro studies. The quality assessment results indicated that most studies demonstrated high methodological quality, meeting nearly all relevant evaluation parameters.

This assessment provides an essential foundation for weighting the evidence of each study during the data synthesis and final interpretation stages. The detailed quality appraisal results are presented in Table 3 below.

Data Synthesis

In analyzing anterior ceramic fixed dental prostheses particularly regarding connector design and material type a comprehensive synthesis was conducted based on seven published scientific studies. These studies employed various methods, including Finite Element Analysis (FEA), in vitro testing, and dynamic loading simulations, to evaluate stress distribution and flexural strength in zirconia- and lithium disilicate–based fixed dental prostheses.

Various connector designs, such as round, triangular, oval, and sharp, were investigated. The findings revealed that both the shape and cross-sectional area of the connector significantly influence stress concentration and flexural strength. The triangular connector design demonstrated the highest flexural strength under vertical loading, while the sharp-edged connector exhibited the lowest strength under oblique loading conditions.

While zirconia showed a more uniform stress distribution and superior longterm durability, lithium disilicate provided a better balance between stress distribution and esthetics, making it the preferred material for restorations in the anterior region.

Overall, these findings emphasize that optimizing connector design particularly in terms of height, geometry, and dimensions is a key factor in determining the long-term clinical success of anterior ceramic fixed dental prostheses.

Result

Among the included studies, five studies (71%) analyzed stress distribution in anterior ceramic fixed dental prostheses using the Finite Element Analysis (FEA) method. These studies included those conducted by Francesco et al. (2025), Botsali et al. (2024), Osman et al. (2023), Wang et al. (2024), and Liu et al. (2025). The results of these investigations consistently indicated that the stress distribution pattern is strongly influenced by connector design, loading direction, and material properties. Connector designs with rounded or rectangular cross-sections consistently reduced stress concentration in the cervical area of the pontic compared with sharp or angular designs, leading to a more even distribution of occlusal forces across anterior ceramic bridges.[5,11,13-15]

Conversely, only three studies (43%) focused on evaluating the flexural strength of ceramic restorations, including those conducted by Sharma et al. (2020), Ahmed et al. (2020), and Osman et al. (2023). The smaller number of studies addressing flexural strength, compared to those examining stress distribution, can be scientifically explained by methodological differences between destructive in vitro testing and FEA simulations. Flexural strength tests require standardized physical specimen fabrication and load-to-failure testing, which are subject to high variability and limited clinical representation. In contrast, the FEA approach allows for non-destructive simulations with broader

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variations in design parameters, connector geometry, and material types, making it a more commonly employed method in modern ceramic prosthodontic research.[10,12,13]

Regarding the loading direction, five studies (71%) Ahmed et al. (2020), Botsali et al. (2024), Osman et al. (2023), Wang et al. (2024), and Liu et al. (2025) investigated oblique loading. Most of these studies reported that oblique loading produced higher maximum equivalent stress values and greater deformation compared to vertical loading, thereby increasing the risk of fracture in the connector and pontic regions. These findings underscore the importance of considering the direction of occlusal forces in the design of anterior prostheses, particularly in cases involving eccentric contacts or lateral loading.[5,10,13-15]

In addition, five studies (71%) also analyzed vertical loads on restorations, including Ahmed et al. (2020), Francesco et al. (2025), Botsali et al. (2024), Wang et al. (2024), and Liu et al. (2025). Vertical loading generally results in a more localized stress distribution around the connector, with lower equivalent stress values compared to oblique loading. These combined results indicate that loading conditions have a direct influence on the mechanical behavior of ceramic prostheses and should be an important variable in connector design.[5,10,13-15]

Discussion

Anterior fixed dental prostheses (FDPs) have high aesthetic and functional demands, making the selection of materials and prosthesis design crucial for longterm clinical success. Based on the synthesis of the seven systematically reviewed studies, it was found that both ceramic material type and connector design significantly influence stress distribution and flexural strength of anterior restorations ceramic anterior fixed denture.

The stress distribution in fixed dental prostheses (FDPs) and resin-bonded fixed partial dentures (RBFPDs) is greatly influenced by the material type and connector design used. Based on Finite Element Analysis (FEA) and in vitro studies, it was observed that round, rectangular, and triangular connector designs provided more uniform stress distribution compared to the oval design. The study by Francesco et al. (2025) reported that lithium disilicate demonstrated a wellbalanced stress distribution. Botsali et al. (2024) found that tooth-supported FDPs exhibited lower stress values than implant-supported FDPs. Meanwhile, Osman et al. (2023) indicated that rectangular connectors simulated in zirconia could withstand higher loads, whereas two trapezoidal zirconia connectors failed under similar conditions, resulting in fracture.[5,11,13]

According to Wang et al. (2024), oblique loading produced the highest stress values in single-ended RBFPDs and the lowest in double-ended RBFPDs. Liu et al. (2025) also reported that connector shape, retainer type, and retainer position influenced stress distribution within RBFPDs.[14,15] The lowest stress values were found in the group with rectangular connectors, particularly those featuring a rectangular cross-section with rounded concavities, which effectively reduced stress concentration in the cervical pontic area, thereby decreasing the risk of fracture.[12,14] This is in line with the theory that states that geometric changes such as sharp angles, small curves, small radius in the embrasure area of the connector often causes stress concentration, where the local stress values are significantly higher than the average stress across the section. This phenomenon, known as the notch effect, is a primary cause of crack initiation in ceramic restorations. A small radius (sharp curvature at the connector) increases tensile stress, thereby facilitating crack initiation and accelerating fracture failure. In contrast, a larger radius or more rounded connector cross-section reduces stress concentration and enhances fracture resistance.

From the material perspective, zirconia demonstrates superior structural resistance under both vertical and oblique loads, with lower equivalent stress values compared to lithium disilicate, particularly under oblique loading (Wang et al., 2024; Francesco et al., 2025). However, lithium disilicate exhibits a more balanced stress distribution and biomechanical behavior better suited for the anterior region, making it the material of choice for cases with high esthetic demands.[11,13,15]

The flexural strength of anterior ceramic restorations also varies significantly depending on the material type, connector design, and type of fixed dental prosthesis. Ahmed et al. (2020) found that in zirconia, the triangular connector design exhibited the highest flexural strength under vertical loading, whereas the round design performed better under oblique loading. This finding indicates that connector geometry should be adapted to the dominant direction of occlusal forces. Similarly, Sharma et al. (2020) reported that yttria-stabilized tetragonal zirconia and lithium disilicate showed distinct mechanical behaviors depending on their structural configuration and loading conditions. Sharma et al. (2020) found that heat-pressed lithium disilicate exhibited the highest failure load and flexural strength compared to the CAD/CAM-fabricated restorations with sharp-edged connectors.[10,12]

This finding is consistent with the theory that flexural strength (σf) refers to the maximum stress achieved on the outer surface fibers of a specimen at the point of fracture during bending. The flexural strength of ceramic restorations is synergistically influenced by several factors, including connector geometry (crosssectional area, moment of inertia, and fillet radius), material properties (Young's modulus, fracture toughness, and transformation mechanisms in Y-TZP), supporting conditions (tooth-supported vs.

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implant-supported), and loading direction (vertical vs. oblique).

From a structural mechanics perspective, the flexural strength capacity of a cross-section is determined by its moment of inertia (I) and cross-sectional area (A). For components such as bridge connectors, increasing the effective cross-sectional area and selecting a shape with a higher moment of inertia—for example, a rectangular section with a wider base or a rounded section with an adequate radius—reduces the maximum tensile stress at the outer fibers during bending of the pontic. Therefore, rectangular or round connectors with sufficient fillet radius demonstrate lower peak stress compared to triangular or sharply notched connectors.

Osman et al. (2023) confirmed that increasing the height of the connector without increasing its width results in greater stress and reduces overall flexural strength. Meanwhile, in the FEA model by Botsali et al. (2024), restorations supported by natural teeth show lower stress and more stable flexural strength compared to implant-supported models, emphasizing the importance of periodontal support in maintaining the mechanical integrity of fixed dentures. Thus, the best flexural strength is obtained in zirconia materials with round and triangular connector designs and rectangular connector dimensions that can withstand occlusal loads without triggering structural failure of anterior ceramic fixed prostheses.[5,13]

Based on the synthesis of literature published between 2020 and 2025, studies employing the finite element analysis (FEA) method consistently demonstrated the influence of connector design and ceramic material type on stress distribution and flexural strength in anterior ceramic fixed dental prostheses.

Findings from Sharma et al. (2020) and Ahmed et al. (2020) revealed that zirconia exhibits superior resistance to high loads and provides a more uniform stress distribution, whereas lithium disilicate offers a balanced stress pattern. Rectangular and round connector designs were consistently associated with reduced stress concentration and enhanced flexural strength in anterior ceramic restorations.[10,12]

Conclusion

This systematic review confirms that the biomechanics of anterior fixed dentures are greatly influenced by the type of ceramic material used, namely zirconia and lithium disilicate, as well as the connector design. Zirconia with a triangular connector design has higher flexural strength compared to round and oval connectors in vertical load applications. Zirconia with a round connector design proved to be superior to triangular and oval connectors in oblique load applications, demonstrating even stress distribution and the highest flexural strength, making it an excellent choice for long-term fixed dental prosthesis restoration. Meanwhile, lithium disilicate with a round connector design shows balanced stress distribution, the highest flexural strength, and high aesthetic properties, making it an attractive choice for anterior fixed dental restorations. The Finite Element Analysis (FEA) approach has been proven to be a tool for accurately analyzing stress distribution and flexural strength, as well as assisting in more optimal dental restoration planning.

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INDONESIAN JOURNAL OF PROSTHODONTICS

ORIGINAL ARTICLE

Inhibitory effect of cinnamomum burmanii extract against Staphylococcus aureus on acrylic resin denture bases

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ABSTRACT

Background: Denture base acrylic resin properties is susceptible to bacteria colonization which further induce post insertion problems. Objectives: This study aimed to evaluate the antibacterial effect of Cinnamomum burmanii extract against Staphylococcus aureus on heat-cured acrylic resin denture base material. Materials and method: An in vitro post-test only control group design was used with 28 acrylic resin plates (9x9x3 mm) contaminated with S. aureus (0.5 McFarland). Samples were randomly divided into seven groups (n=4): positive control (0.2% chlorhexidine), negative control (aquades), and five treatment groups immersed in C. burmanii extract at concentrations of 25%, 12.5%, 6.25%, 3.125%, and 1.56%. Immersion was performed for 8 hours, after which bacterial colony counts were determined using the Total Plate Count method. Results: Phytochemical screening of the extract showed the presence of flavonoids, alkaloids, tannins, and triterpenoids. All concentrations of C. burmanii extract reduced S. aureus colonies compared to the negative control, with a significant overall difference among groups. The 25% concentration demonstrated the lowest mean colony count and showed an antibacterial effect approaching that of 02% chlorhexidine. Conclusion: These findings suggest that C. burmanii extract, particularly at 25% concentration, has potential as a natural denture cleanser alternatives for reducing S. aureus colonization on acrylic resin bases. (IJP 2025;6(2):163-165)

Keywords: Acrylic resin, Antibacterial, Cinnamomum burmanii, Dentures, Staphyloccus aureus

Introduction

Acrylic resin-based dentures are widely used in dental practice due to their lightweight, aesthetic properties, and affordable cost. However, the porosity properties of acrylic resin make it susceptible to colonization of bacteria such as Staphylococcus aureus, which can lead to denture stomatitis and various oral cavity infections.[1] Several previous studies have shown that bacterial colonization on the surface of acrylic resins may contribute to increased oral and systemic infections.[2]

Efforts to overcome bacterial growth have been carried out with the development of disinfectant materials. The literature shows that the use of chemical cleaners such as chlorhexidine 0.2% is effective in reducing the number of bacteria in dentures.[2] However, long-term use of chlorhexidine can cause side effects, such as discoloration of dentures and mucosal irritation.[3] Therefore, a safer and more effective cleaning alternative is needed. One of the natural ingredients that is known to have antibacterial properties is cinnamon extract (C. burmanii).[3] Several studies have proven that C. burmanii contains antibacterial compounds such as cinnamaldehyde, flavonoids, and tannins.3 These compounds are able to inhibit the growth of various pathogenic bacteria.[4,5]

Staphylococcus aureus is one of the opportunistic pathogenic bacteria that can colonize the surface of acrylic resin denture base. This is especially evident in users with poor dental hygiene and oral cavities. The formation of S. aureus biofilms on acrylic plates has the potential to trigger denture stomatitis, crown infections, and even systemic infections in individuals with weak systemic conditions. Studies on the effectiveness of C. burmanii in inhibiting S. aureus on acrylic resin bases are still limited. Therefore, this study aims to evaluate the extent to which C. burmanii extract can inhibit the growth of S. aureus as a more natural and safe denture cleaner.

Material and Methods

This experimental laboratory study used post-test only control group design.[5] The sample sizes used were 28 heat-cured acrylic resin plates, which were divided into seven treatment groups: Positive control in the form of 0.2% chlorhexidine and negative control in the form of aqueduct and treatment with C. burmanii extract at concentrations of 25%, 12.5%, 6.25%, 3.125%, and 1.56%. Inclusion criteria of the study were acrylic resin plates with a size of 9x9x3mm that have been exposed only to S. aureus. Resin plates that have been physically damaged during treatment including thoe with other bacterial contamination in the study sample were excluded.[6]

The research procedure was carried out by first sterilizing the acrylic resin plates in an autoclave at 121°C for 15 minutes. Plates were further contaminated with S. aureus suspension (McFarland standardization 0.5) and incubated for 24 hours. The samples were then soaked in the test solution for 8 hours according to the treatment

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Table 1. **Number of S. aureus colonies after soaking procedure**

Group	Mean ± SD
Klorheksidin glukonat 0.2%(+)	1.25±1.893
Akuades (-)	300±40
Ekstrak 25%	1.25±1.893
Ekstrak 12.5%	3.00±1.826
Ekstrak 6.25%	9.75±17.519
Ekstrak 3.125%	23.50±21.111
Ekstrak 1.56%	27.75±6.602

Table 2. **Phytochemical test result of cinnamon extract**

Parameter	Result
Flavonoid	Positif (+)
Alkaloid (Wagner)	Positif (+)
Alkaloid (Meyer)	Positif (+)
Alkaloid (Dragendorf)	Positif (+)
Tanin	Positif (+)
Saponin	Negatif (-)
Quinon	Negatif (-)
Steroid	Negatif (-)
Triterpenoid	Positif (+)

group criteria. After the procedure, the number of S. aureus colonies was calculated using the Total Plate Count method.[10] This research has received approval from the Ethics Commission of the Faculty of Dentistry, Trisakti University with the number 837/S1/KEPK/FKG/7/2024.

Results

The results showed that C. burmanii extract at all concentrations had an inhibiting effect on the growth of S. aureus colonies. The group with a concentration of 25% showed the highest inhibition, approaching the effectiveness of chlorhexidine 0.2% table 1. In addition, phytochemical test showed antibacterial compounds contained in cinnamon extract according to several test parameters table 2.

Discussion

The results of this study showed that C. burmanii extract has a significant antibacterial effect against S. aureus on the acrylic resin. This antibacterial effectiveness increases as the concentration of the extract increases, with a concentration of 25% showing the most optimal results, approaching the effectiveness of 0.2% chlorhexidine as a positive control.[7]

These findings are in line with previous research showing that C. burmanii contains active compounds such as cinnamaldehyde, flavonoids, and tannins that have antibacterial effects against various oral pathogens.[7] Further evidence indicates that C. burmanii extracts can inhibit the growth of S. aureus, Candida albicans, and Streptococcus mutans, which are important pathogenic microorganisms in the oral cavity.[7] The present study extends this body of evidence by specifically confirming the effectiveness of C. burmanii in inhibiting the growth of S. aureus on acrylic resin denture base material, a substrate that has been only limitedly investigated to date.[7]

The main limitation of this study is the absence of long-term evaluation of the effectiveness of C. burmanii extract under simulated or actual clinical use conditions. In addition, potential changes in the physical properties of acrylic resin denture bases following immersion in the extract were not assessed. Therefore, further studies are required to evaluate the safety, optimal concentration, and long-term stability of this extract when used as a denture cleansing agent.[9] Despite these limitations, the present findings may serve as a basis for the development of plant-based denture cleansers that are potentially safer than conventional chemical agents such as chlorhexidine.[10] The use of natural ingredients such as C. burmanii may provide a more environmentally friendly alternative and reduce adverse effects'in denture wearers.[11] Overall, this study contributes preliminary evidence supporting C. burmanii extract as a natural alternative for denture hygiene care and highlights the need for further research on its clinical effectiveness and safety in broader applications.[11,12]

Conclusion

The results of this study showed that C. burmanii extract is effective in inhibiting the growth of S. aureus on acrylic resin denture base material. A concentration of 25% yielded the greatest reduction in bacterial colony counts, with an effect comparable to that of 0.2% chlorhexidine. Further studies are needed to evaluate the long-term effectiveness of C. burmanii extract and its impact on the physical properties of acrylic resins. In addition, clinical trials are further needed to confirm the safety and clinical applicability of this extract as a more natural and environmentally friendly alternative to conventional denture cleansers.

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INDONESIAN JOURNAL OF PROSTHODONTICS

ORIGINAL ARTICLE

The perspective of prosthodontic treatment in adolescent

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Keywords: Adolescent, Medicine, Perspective, Prosthodontic treatment

ABSTRACT

Background: Tooth loss among adolescents may impair masticatory function, alter speech articulation, and affect facial aesthetics. Prosthodontic treatment provides essential restorative options for replacing missing teeth. However, despite its importance, a considerable gap remains in the literature regarding adolescents' perspective toward prosthodontic treatment. Objective: This study aims to evaluate the adolescents' perspective toward prosthodontic treatment. Methods : A self-administered questionnaire were given to participants. The perspective of prosthodontic treatment was evaluated using three sections: awareness, knowledge, and attitude. The data respondent were collected and categorized into poor, fair and good. The statistical analysis was performed using reliability and validity tests, as well as the Kolmogorov–Smirnov test ($P > 0.05$).Write your abstract here. Maximum 200 words, single paragraph, in English. Include background, objective, method, result, and conclusion. Result: The adolescents have fair awareness, knowledge, and attitude regarding the prosthodontic treatment. Conclusion: These study showed that adolescents' fair perspective of prosthodontic is still insufficient, highlighting the need for improved early education. (IJP 2025;6(2):166-170)

Introduction

Tooth loss is remains as one of the global burden of oral disease.[1] Tooth loss may caused by several factors, including dental caries, periodontal disease, and traumatic injury.[2] The World Health Organization (WHO) reported that the prevalence of tooth loss 6.82% with the number of cases 350 million people around the world.[1] The Indonesian Health Survey 2023 reported tooth loss was the second most prevalent oral problem after dental caries with the prevalence 21%. The most vulnerable for the tooth loss is in elderly with the prevalent 37.2-46.5%. However, tooth loss may affect individuals of all ages, including those in adolescence groups (10-19 years old). The prevalence of the permanent tooth loss in Indonesian adolescence was 37.2% in the age 10-14 and 36% between 15-24.[3]

Permanent tooth loss effects the masticatory function, articulate speech, and aesthetic of the individual. Tooth loss also can contribute to the psychological and social problem which lead to the quality of life.[4] These consequences can be particularly significant for adolescents, as the adolescents represents a critical transitional period between childhood and adulthood, characterized by significant social, physiologic, and psychological changes. It also well documented that tooth loss was associated with a substantially higher risk of bullying in school-aged children.[5]

Prosthodontic treatment offered the restorative treatment for tooth that can restore mastication, aesthetic and articulation.[6] There are several prosthodontic treatment options in adolescence available for replacing missing teeth, including fixed prostheses such as crowns and bridges, removable partial and complete dentures, as well as implant-supported dentures.[6,7] The prosthodontic treatment can be performed by the prosthodontist and the general dentist. However, the presence of unlicensed denture makers poses a significant challenge, as they perform denture fabrication and treatment without adequate consideration of the surrounding oral tissues. This practice often leads to various complications and may compromise the patient's oral health.[8] Despite the importance and availability of prosthodontic treatment, many individuals in the community still lack adequate awareness and understanding of this treatment. Research on adolescent oral health has traditionally focused on the most prevalent oral diseases, such as dental caries and periodontal diseases.[2] Even knowledge and awareness about the various prosthodontic treatment in tooth loss were reported in literatures,[7,9-12] the perspective (knowledge, awareness, and attitude) of prosthodontic treatment in adolescence is still unexplored. Given these concerns, understanding how adolescents perceive prosthodontic treatment becomes increasingly important. Adolescence is a formative period during which health-related beliefs, behaviors, and attitudes begin to develop and may persist into adulthood. Their perceptions of tooth loss and prosthodontic treatment can influence treatment-seeking behavior, acceptance of dental interventions, and long-term oral health outcomes.[2] Therefor this study aims to evaluate the perspectives of prosthodontic treatment in adolescence. This study is essential to identify gaps in knowledge, targeted educational strategies, and promote restorative oral health behaviors.

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Table 1. The questionnaire result

Awareness	Score	Frequency	%
The regular visit for dental check-ups			
Never	1	29	13.74
No, but have visited a dentist before	2	70	33.18
No, only when there is a complaint	3	82	38.86
Yes, once a year	4	12	5.69
Yes, every 6 months	5	18	8.53
The experience the loss of a permanent tooth			
No	1	38	18.01
Yes	2	173	81.99
The urgency of replacing missing teeth with dentures			
Not required at all	1	26	12.32
Not required	2	24	11.37
Required, but not urgent	3	69	32.70
Required in the near future	4	52	24.64
Required as soon as possible	5	40	18.96
The purpose of replacing missing teeth with a denture			
I do not understand	1	11	5.21
I understand partially	2	75	35.55
I understand completely	3	125	59.24
Knowledge			
The healthcare facility that appropriates for making dentures			
Wrong	1	7	3.32
Right	2	204	96.68
Source of information and knowledge about denture			
1-2 sources	1	106	50.24
3-4 sources	2	90	42.65
5-6 sources	3	15	7.11
Type of the denture			
I do not know the type of denture	1	30	14.22
Understand 1-2 type of dentures	2	157	74.41
Understand 3-4 type of dentures	3	24	11.37
The appropriate method for denture care			
I do not understand	1	13	6.16
I understand how to take care of dentures.	2	198	93.84
Atitude			
The motivation for denture treatment			
Health education programs	1	76	36.02
Dentist	2	50	23.70
Teachers or schoolmates	3	7	3.32
Parents or siblings	4	49	23.22
Myself	5	29	13.74
Denture improve the performance			
No	1	45	21.33
Yes	2	166	78.67
Entrustment of denture fabrication to an unlicensed denture maker			
Yes	1	87	41.23
No	2	124	58.77
The willingness to clean the denture if the respondent has one			
I will clean it	1	8	3.79
I will not clean it	2	203	96.21

Material and Methods

A cross-sectional study was conducted at a junior high school located in the central region of Surabaya, East Java, Indonesia. A total sampling method were used in this study. The self-administered questionnaires were distributed to all 3rd grade students. Prior to the administration of the questionnaire, both the students and their parents or guardians were provided with detailed information about the study and asked to provide written informed consent. The questionnaire was divided into three sections: awareness, knowledge, and attitude. Responses were structured in a multiple-choice format and subsequently categorized for analysis. The collected data were systematically evaluated to determine whether they met the inclusion criteria. These criteria are as follows: 1) Participants must be students enrolled at the designated elementary school located in central Surabaya, 2) Students must complete the questionnaire, and 3) Participants are required to attend the oral health educational program.

The data collected in this study were analyzed using SPSS software to assess the reliability and validity of the questionnaire. After that the data distribution was evaluated using the Kolmogorov Smirnov test (P<0,05). The data were categorized into three categories (poor, fair, and good) according to the median. The questionnaire was administered prior to the oral health education program to minimize bias and accurately assess the participants' baseline knowledge of prosthodontic treatment. This approach ensured that the responses reflected their initial understanding, while still allowing the students to later receive correct and comprehensive information during the educational session.

Results

The total number of the students that enrolled in the 3rd grade of junior high school were 237 and the number of students who participated in this study was 227. The response rate for this study was 96.18 %. However, the total 16 students were exclude from this study because they did not complete the questionnaire. The student's participants consisted 54.50% (n=115) girls and 45.50% (n=96) boys. The average age for the patient were 14,91 years old with < 14 years are 16.10% (n=34), 15 years old 58.30% (n=144), and >15 years old was 15.60% (n=33). The result of the questionnaire was shown in the table 1. Before evaluating the data, the questionnaire was evaluated using the reliability test. The result of the realibilty test showed that the Cronbach's α was 0.426. Cronbach's α of 0.426 indicates that the internal consistency of the questionnaire is modest, suggesting that while the instrument captures the intended construct, certain items may benefit from refinement to enhance cohesiveness and reliability. The validity of the date showed that that the questionnaire items achieved acceptable item–total correlation values, supporting the appropriateness of the instrument for measuring the intended constructs (r>0.13098).

The awareness of the showed that mostly the students (38.86%) did not the regular visit for check up to the dentist because they only came to the dentist when they have the tooth complain. Among the students 38 students (18%) have a tooth loss on the permanent tooth and none of them use the denture to replace the missing tooth. They thought that replacing the tooth with a denture is required but not urgent (32.70%). However, most of them (59.24%) understand completely regarding the purpose of the replacing missing teeth with a denture.

In the knowledge section, it is showed that they had known (96.68%) the place where the healthcare facility that appropriate for making dentures. They had some of source of information to learn about the denture but mostly the students got the denture information from 1-2 sources (40.24%). The most common source knowledge about denture was from dentist and other medical profession (27.82%), social media (27.82%), parents or family (21.33%), printed communication media (9.90%), teachers or friends (9.56%), and textbook (3.58%). In total 30 students

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(14.22%) do not understand at all regarding the types of dentures and majority of them had known 1-2 types of dentures (74.41%). For those who understand the type of denture, the proportion of each type of denture was fixed denture (26.28%), implant-supported denture (25.64%), removable complete denture (24.68%), and removable partial denture (23.40%). Most of students also understanded the appropriate method for denture care (93.84%).

The evaluation for the attitude shows that the motivation for denture treatment was the majority from the health education program (36.02%) while only a small proportion were self-motivated (13.74%). However, they believed that the denture treatment can improve their performance and confidence (78.67%). Unfortunately, many students still entrust denture fabrication to an unlicensed denture maker (41.23%). Even though they understood the appropriate method for denture care but they were unwilling to clean their dentures (96.21%).

The data distribution of this study was not normal P<0,05. Therefore, according to the median result we categorized each section. The maximum total score for awareness was 15, with scores ranging from <9 classified as poor, 9-10 as fair, and >11 as good. The knowledge domain had a maximum score of 10, in which scores of <7 was categorized as poor, 7 as fair, and >8 as good. The attitude domain had a maximum score of 11, with scores of <6 classified as poor, 6-8 as fair, and >9 as good. The students' awareness, knowledge, and attitude regarding prosthodontic treatment were all categorized as fair, with mean scores of 10.2, 8.53, and 7.88, respectively.

Discussion

Early permanent tooth loss in adolescents can leads to functional problems such as impaired mastication, improper tooth alignment, and difficulties in pronunciation. Prosthodontic treatment can be successfully provided to address tooth loss not only in older adults but also in adolescents.6 Understanding the perspective of prosthodontic treatment during adolescence is crucial because this developmental stage adolescence vulnerability to socioeconomic risk factors and a higher likelihood of adopting unhealthy behaviors that may persist into adulthood forever. Gaining insight into tooth loss among adolescents also supports better clinical decision-making and helps evaluate the effectiveness of interventions, services, and oral health programs.[2]

This study was mainly participated in by the female students. These participations is consisted with the greater proportion of the female students in the 3rd grade of in that junior high school. The majority age of the participants was 15 years old aligning with the typical age distribution of the 3rd grade of the junior high school in Indonesia.

In this study, we found that most adolescents did not regularly check their dental condition. This finding is consistent with the Indonesian Family Life Survey-5 Which reported that the majority of Indonesian (84.6%) never visit dentist.[13] This is a typical condition in Indonesia, as Indonesians only visit the dentist when they have an oral problem. Oral disease is considered an unthreatening condition therefore routine checkups are uncommon in Indonesia.[14,15]

We also found that some of the participants have tooth loss problem and did not perform the prosthodontic treatment. The main cause of tooth loss among adolescents related to their caries experience, dental trauma, or periodontal disease. Most tooth loss occurred in the permanent first molars, which are particularly susceptible because they erupt earlier than other permanent teeth, making them more prone oral disease.[4] Although the majority of the participants understood that tooth loss needs to be replaced with a denture. However, they thought that the prosthodontic treatment is not an urgent matter since it is not a threatening disease. Moreover, the other reasons they did not undergo prosthodontic treatment might include be financial constraints, inadequate knowledge, fear of have the treatment, lack of time, and do not have any motivation.[11,12,16,17] The participant aware of the purpose using the denture. Evidence shows that younger respondents tended to prioritize aesthetic enhancement of their smile, while concerns about chewing efficiency were secondary. Conversely, in older age groups, the ability to chew properly emerged as the foremost issue.[7]

The evaluation of knowledge indicated that the participants knew the appropriate healthcare facility for making dentures. In Indonesia, the presence of unlicensed practitioners remains widespread, commonly known as tukang gigi. Tukang gigi have long served as an alternative source of dental care for individuals from lower- to middle-income groups. According to regulations issued by the Ministry of Health, their scope of practice is strictly limited to the fabrication and placement of removable acrylic dentures. However, in the realization that they perform procedures beyond these legal boundaries that lead to several serious problems for the patients by the government.[8] Despite of this, in the attitude section, the participants still entrust the denture fabrication to the unlicensed once as this might be more affordable compared with services provided by licensed dentists.

Sources of information and knowledge about dentures can be accessed in many ways. However, most participants learn about dentures from only one to two sources, with the primary sources are the dentist and social media. This is aligned with a previous study that mentions that the dentist was the most significant source of information regarding the prosthodontic treatment.[10] In the current digital era, social media become a prominent platform for disseminating health-related information. Its widespread accessibility and interactive features enable innovative approaches to enhancing oral health awareness and promoting positive oral-health behaviours within the community.[18] However, these findings is contrasting with previous studies that reported that social media was the least preferred source of information regarding prosthodontic treatment. The earlier study suggested that information disseminated through social media often lacks adequate authenticity and credibility, thereby reducing trust to that information.[7]

Most students were familiar with only one or two types of dentures. The most commonly recognized option was fixed denture prostheses; however, the differences in recognition among the various denture types were not substantial. This study is contrasts with previous studies that reporting dental implants were the most widely recognized treatment option, followed by complete dentures, and then by crowns and bridges.[7] This is might be happened due to implant treatment has a high successful rate and the survival rate.[19,20] However, in other study the complete removable denture is the most well-known prosthodontic treatment.[16]

In this study we also evaluated the knowledge of about denture care. As the prosthodontic treatment does not end after the insertion but a long-term care. Most of the adolescence understand that the denture should be take care after the insertion. The knowledge is important because the low level of denture hygiene knowledge were significantly associated with how well they maintain their prostheses.[21] In contrast to their knowledge, the participant lacked the motivation to clean their denture. It may cause biofilm formation, induce denture stomatitis, degrade the material, cause halitosis, and increase the risk of pneumonia.[22]

Motivation can strongly influence an individual's thinking and decision-making, including decisions related to prosthodontic treatment. Choices regarding whether to seek the prosthodontic treatment can arise from both intrinsic motivation, which originates within the individual, and extrinsic motivation, which is influenced by external factors such as family, peers, environment, or social media.[23] In this study, we found that most participants' motivation to pursue prosthodontic treatment was predominantly driven by extrinsic factors, while intrinsic motivation played a comparatively smaller role.

In this study, the awareness, knowledge, and attitude toward prosthodontic treatment among adolescents were still at a fair level, indicating the need for improvement. One potential approach is through health education programs, which have been shown to enhance adolescents' awareness, knowledge, and attitude regarding prosthodontic care. However, this study has several limitations should be acknowledged. The study population was primarily composed of 14–15-year-olds, limiting the representativeness of the findings across the entire adolescent age range of 10–19 years. Additionally, the sample was relatively small and drawn from a specific geographic and socio-demographic context, which may restrict generalizability. Finally, data were collected via self-reported questionnaires, which are subject to reporting bias. Future research should include larger, more diverse populations and employ objective measures to more comprehensively evaluate adolescents' knowledge, attitudes, and behaviors regarding prosthodontic treatment.

Conclusion

Adolescents exhibited fair levels of awareness, knowledge, and attitudes toward prosthodontic treatment, indicating a need for targeted educational interventions. Structured health education programs may improve understanding, perception, and oral health behaviors related to prosthodontic treatment.

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ORIGINAL ARTICLE

Differences in milling speed and sintering speed using cad/cam technique on the marginal gap of zirconia dental crown

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Keywords: CAD/CAM, Marginal gap, Milling, Sintering, Zirconia

ABSTRACT

Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) is a digital approach to fabricating dental restorations, including zirconia crowns. Compared to conventional techniques, CAD/CAM offers a more efficient and precise workflow. The laboratory workflow in CAD/CAM process provides advantages such as high accuracy and a broader selection of materials, although it generally requires more time than chairside workflows. Manufacturing parameters—particularly milling speed and sintering speed— may influence the mechanical characteristics of restorations, especially marginal gaps, which are critical for long-term clinical success. Excessive marginal gaps can lead to restoration failure. This study aims to examine the effects of milling and sintering speeds on the marginal gap of zirconia crowns made using CAD/CAM technology. This experimental laboratory study involved 24 zirconia crowns divided into six groups based on combinations of three milling speeds (fast, normal, gentle) and two sintering speeds (conventional and speed). Marginal gaps were measured using micro-computed tomography (micro-CT), and data were analyzed with a two-way ANOVA followed by a Post-Hoc LSD test. Results revealed significant differences in marginal gaps related to both milling and sintering speeds ($p < 0.05$). The combination of gentle milling and speed sintering resulted in the smallest marginal gap (86.36 µm), while fast milling with conventional sintering produced the largest (118 µm). All values remained within the clinically acceptable range (50–120 µm). In conclusion, both milling speed and sintering speed significantly affect the marginal gap of zirconia dental crowns, highlighting the importance of optimizing these parameters for improved restoration quality. (IJP 2025;6(2):171-176)

Introduction

Tooth loss is an indicator of dental damage, which can be caused by caries. Molar teeth 1 and 2 are teeth that are at high risk of caries and ultimately tooth loss.[1] The impact of tooth loss without replacement with dentures can affect physical conditions such as reduced aesthetics, mastication, and speech ability. Additionally, tooth loss can affect both physical and psychological conditions, such as reduced self-confidence and limitations in social activities.[2]

Dental rehabilitation for tooth loss is generally divided into two types: removable dentures (RD) and fixed dentures (FD). The most functional rehabilitation for edentulous areas that closely resembles natural teeth is FD treatment. The supporting teeth, which serve as anchors, can be natural teeth or implant restorations.[3] FPDs are common and effective dental restorations that replace one or more teeth. Theoretically, FPDs can use dental implants or adjacent teeth as abutments to secure the prosthesis in place. These prostheses are typically made from durable and aesthetically pleasing materials, such as porcelain or ceramic. This effectively restores the functionality and aesthetics of the lost teeth.[4]

Zirconia is a ceramic material frequently used for dental restorations due to its similarity to the natural colour of teeth and its strength. Zirconia restorations have been widely used over the past few decades for FPD prostheses. This may be due to the optimal aesthetics and biocompatibility of zirconia.[5] Restorations can be fabricated conventionally or digitally. In recent years, Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) technology has evolved alongside its application in dentistry, including its use in full mouth rehabilitation.[6] CAD/CAM in dentistry can be used to enhance the effectiveness of dental restoration design and fabrication, particularly dental prosthetics, including crowns, veneers, inlays and onlays, dental bridges, dental implant restorations, removable dentures, and orthodontic appliances.[7]

This digital technology represents a modernization of existing conventional techniques, such as the method of obtaining impressions. Conventional techniques use impression materials, while digital techniques utilize intraoral scanners. Conventional prosthesis manufacturing involves waxing and conventional casting, whereas digital systems can employ CAD/CAM technology.[6] There are several advantages if operators use a digital workflow involving CAD/CAM, such as producing chair-side restorations and improving restoration quality.[7] Other advantages include faster treatment time, shorter patient visits, reduced patient discomfort, no need for plaster models, and more predictable final results.[6]

The restoration production process, choosing between laboratory-based CAD/CAM workflows and chairside workflows, is

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Table 1. Mean and standard deviation of marginal gap between groups (µm)

Milling group	Sintering group	n	Marginal gap (µm)	
			Mean	Standard deviation
Fast	Conventional	4	118.00	± 2.582
	Speed	4	104.14	± 0.712
Normal	Conventional	4	112.73	± 0.628
	Speed	4	113.80	± 0.845
Gentle	Conventional	4	101.22	± 1.970
	Speed	4	86.36	± 3.648

Note:
n = number of samples in each group

Table 2. Results of the two-way ANOVA test to determine the difference in milling speed and sintering speed on the marginal gap

Source	Sum of squares	df	Mean square	F	Sig.
Milling	1820.120	2	910.060	214.369	0.000*
Sintering	509.645	1	509.645	120.049	0.000*
Interaction millingsintering	318.424	2	159.212	37.503	0.000*

Note:
(*): significant (p<0.05) df: degrees of freedom
F: significance value
Sig.: significance

Table 3. Result of the Post-Hoc LSD test

Milling and sintering treatment	Milling and sintering treatment					
	FM+CS	FM+SS	NM+CS	NM+SS	GM+CS	GM+SS
FM+CS		13.86*	5.27*	4.20*	16.78*	31.64*
FM+SS			-8.59*	-9.66*	2.92	17.78*
NM+CS				-1.07*	11.5*	26.38*
NM+SS					12.58*	27.44*
GM+CS						14.86*

Note:
(*): significant (p<0.05)
FM+CS : fast milling + conventional sintering
FM+SS : fast milling + speed sintering
NM+CS : normal milling + conventional sintering
NM+SS : normal milling + speed sintering
GS+CS : gentle milling + conventional sintering
GS+SS : gentle milling + speed sintering

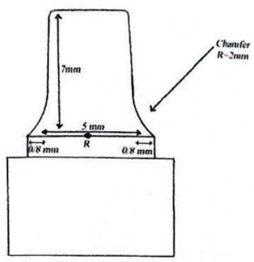

Figure 1. Die design

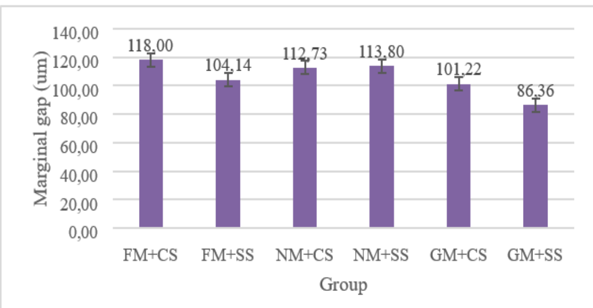

Figure 2. Diagram of the average marginal gap in micrometers between groups (FM+CS: fast milling + conventional sintering; FM+SS: fast milling + speed sintering; NM+CS: normal milling + conventional sintering; NM+SS: normal milling + speed sintering; GM+CS: gentle milling + conventional sintering; GM+SS: gentle milling + speed sintering)

an important consideration, particularly regarding time efficiency, cost, restoration type, and quality of results. Chairside workflow allows restorations to be completed in a single clinical visit since the entire process (from digital scanning, design, to milling) is performed on-site, making it highly time-efficient.[8] Conversely, laboratory workflow requires additional time as it involves transferring digital data to a dental laboratory for design and fabrication processes. However, laboratory workflow offers several significant advantages, such as a wider range of material options, the use of high-precision CAD/CAM equipment, and the involvement of professional dental technicians who can enhance morphological detail, aesthetics, and restoration margin fit. Therefore, despite requiring a longer processing time, the laboratory workflow remains the preferred choice for cases demanding high accuracy and maximum aesthetic results.[9,10]

The CAD/CAM process can be divided into three distinct steps: data acquisition, indirect restoration design, and restoration manufacturing. The manufacturing phase involves transforming the CAD model into a physical component through processing, finishing, and polishing. Two primary methods used to create these restorations are additive manufacturing (3D printing) and subtractive manufacturing (milling). Milling is a type of restoration fabrication that utilizes subtractive manufacturing technology from a large solid block.[7,11] Dry milling is more commonly used in zirconia manufacturing.[12] The milling speed of zirconia material using a laboratory milling machine workflow has three different speeds: fast, normal, and gentle.[13] In chairside production, milling speed is also divided into three categories: super-fast, fine, and extra-fine.

Sintering is a process that involves heating restorative materials such as ceramic and zirconia after the milling process. Heating is typically performed in a specialized oven at high temperatures below the melting point. The high heat causes the particles to bond tightly and fuse together, thereby strengthening the structure.[14] Conventional sintering of zirconia materials requires a long time, necessitating two restorative visits and temporary restorations.[15] Conventional sintering is performed at a heating rate of 10°C/minute and a waiting time of 120 minutes at a final temperature of 1550°C, with a total time of 8 hours. High-speed sintering, on the other hand, is performed at a heating rate of 120°C/minute and a holding time of 20 minutes at a temperature of 1600°C. High-speed sintering or speed sintering only requires 54 minutes to complete16. The processing of zirconia using a milling and rapid sintering system has now been developed. Faster processing times can reduce the number of patient visits and eliminate the need for lengthy procedures, thereby eliminating the need for two visits and temporary restorations.[15] Changes in milling speed and sintering speed in both chairside and laboratory workflows using CAD/CAM techniques will affect the

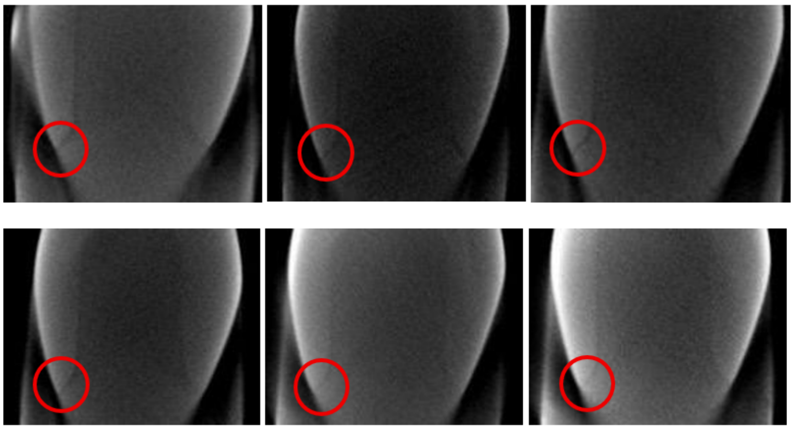

Figure 3. Marginal gap image using micro-CT (a) FM+CS: fast milling + conventional sintering; (b) FM+SS: fast milling + speed sintering; (c) NM+CS: normal milling + conventional sintering; (d) NM+SS: normal milling + speed sintering; (e) GM+CS: gentle milling + conventional sintering; (f) GM+SS: gentle milling + speed sintering

mechanical properties of zirconia. Additionally, the marginal gap in zirconia dental crowns can also be influenced by faster
milling and sintering14,15,17.

The marginal gap is defined as the vertical distance between the preparation margin and the cervical margin of the restoration. The clinically tolerated marginal gap range is 50 to 120 µm. Poor marginal adaptation can lead to plaque accumulation, microleakage, recurrent caries, and periodontal disease. Additionally, internal fit is a critical factor for restoration success, as a decrease in internal fit of the dental crown leads to reduced retention18. Marginal gap measurement can be performed using Micro-Computed Tomography (Micro-CT) scanning. This is a non-destructive tool that comprehensively depicts the 3D details of the scanned object. This examination is used to determine the marginal gap in a restoration by measuring the thickness or width of the luting cement localized at the adhesive interface19.

The marginal gap in zirconia crowns can be influenced by milling speed and sintering speed. Faster milling processes can result in cracks, chipping, and surface intaglio damage in zirconia material17. Sintering processes with shorter speeds or times and higher temperatures can affect the marginal gap14.

Research on milling speed and sintering speed in the fabrication of zirconia dental crowns in a laboratory workflow is important because both parameters directly affect marginal precision, mechanical properties, and production efficiency of restorations. Optimization of these parameters is necessary to improve restoration quality without compromising time efficiency in the laboratory workflow. This study was conducted to gain knowledge about the potential differences in milling speed and sintering speed using CAD/CAM techniques on the marginal gap of zirconia dental crowns in laboratory workflows.

Material and Methods

Stage 1. Obtaining Ethical Clearance

Ethical clearance was obtained from the Secretariat of the Ethics Committee of the Faculty of Dentistry – RSGM UGM Prof Soedomo, Universitas Gadjah Mada before commencing the research. The Ethical Clearance number is 244/UN1/KEP/FKGRSG-M/EC/2024.

Stage 2. Creation of the metal master die

The metal master die for the research samples was made at Building B, Materials Laboratory, Faculty of Engineering, Department of Mechanical and Industrial Engineering, Gadjah Mada University, Yogyakarta. The metal die was made from stainless steel with a chamfered finishing line design figure 1 in a quantity of 24 pieces.

Stage 3. Zirconia fabrication and zirconia group division

Zirconia crown fabrication was performed at the CAD/CAM DLC Laboratory, Faculty of Dentistry, Gadjah Mada University. Zirconia disks (Upcera ST White) were placed in a 5-axis milling machine (milling machine inLab MC X5 Dentsply Sirona). The samples were divided into 6 groups: Group 1: zirconia fast milling dental crowns with conventional sintering (4 samples). Group 2: zirconia dental crowns with fast milling and speed sintering (4 samples). Group 3: zirconia dental crowns with normal milling and conventional sintering (4 samples). Group 4: zirconia dental crowns with normal milling and speed sintering (4 samples). Group 5: zirconia dental crowns with gentle milling and conventional sintering (4 samples). Group 6: Gentle milling zirconia dental crowns with speed sintering (4 samples) Sample preparation using CAD/CAM: Data acquisition. The model is placed on the table and scanned using the Intraoral Scanner Primescan (Dentsply Sirona) to perform the scanning process. This process transfers the data/condition of the die on the gypsum model to the computer. Computer-aided design (CAD). The scan results are entered into specialized software (InLab CAD) to design the restoration according to the model, size, and material desired by the operator. This process is referred to as CAD (computer-aided design assisted by the Biogeneric Copy feature). Computer-aided manufacturing (CAM). The fabrication of the crown sample is performed using CAM with a milling process (computer-aided restoration fabrication), which is fully controlled by the computer based on the data entered during the CAD process. The manufacturing process involves milling a monolithic zirconia disk in inLab MC X5 milling machine (Dentsply Sirona) using dry milling, divided into three milling speed groups: fast milling, normal milling, and gentle milling. Sintering. The sintering process involves placing the zirconia crown in the white stage (white chalk color) into a high-temperature sintering machine, resulting in densification (Dentsply Sirona sintering machine inLab

Profire). The crown is positioned with the inner surface facing downward. Specimens are sintered using different methods. Sintering is programmed according to the Dentsply Sirona inLab Profire sintering machine program as follows: Conventional sintering is performed at a heating rate of 10°C/minute and a waiting time of 120 minutes, with a final temperature of 1550°C, taking approximately 8 hours to complete. Speed sintering is performed at a heating rate of 120°C/minute and a waiting time of 20 minutes, with a final temperature of 1600°C, and takes approximately 54 minutes to complete.

Stage 4. Cementation of zirconia crowns

The zirconia dental crowns that have been produced are cemented onto the metal die using self-adhesive resin cement as recommended by the manufacturer. Preparation of the restoration and metal die. The surface to be cemented is sandblasted with 50-micron aluminum oxide at 30 psi to create a matte surface. The zirconia restoration is then cleaned with alcohol and dried. The metal die is cleaned of all debris using a chip blower. Application of resin cement. The resin cement is applied to the zirconia restoration. The zirconia restoration is then inserted into the prepared die. During restoration insertion, a specimen-holding mechanism is pressed with a 5 kg load for 6 minutes21. Tack curing is performed for 2 seconds, followed by removal of excess resin cement from the edges of the restoration. In the final insertion stage, light curing is performed for 20 seconds per surface (occlusal, facial, lingual), and polishing is performed using an Eve Diacomp polishing bur on the zirconia crown.

Stage 5. Radiographic imaging and micro-CT data processing

This stage was conducted at the Department of the Faculty of Mathematics and Natural Sciences (FMIPA) at the Bandung Institute of Technology (ITB). Radiographic imaging was performed using a μ-CT Scanner SkyScan 1173 High-Energy micro-CT. This device projects the structure of a material in three dimensions (3D projection) using X-ray irradiation. The zirconia crown is positioned to remain stationary and stable during the micro-CT test. The test is conducted in a single exposure with high resolution at 130 kV for 4 hours. Xrays are then emitted to capture the radiographic image. The X-rays are emitted from one side toward the receptor on the opposite side, while the sample rotates. Then, measurements of the marginal distance of the restoration from the finishing line on the mesial, distal, buccal, and lingual surfaces of each sample were taken. Measurements were taken by measuring perpendicularly from the internal margin surface of the crown or restoration to the outer edge of the tooth margin finishing line or by measuring the length of the radiolucent area at the edge of the restoration.

Measurements of the mesial and distal sides were taken using sagittal sections, while measurements of the buccal and lingual sides were taken using coronal sections. The middle slice of the sample was selected for marginal gap measurements.

Results

A study on the differences in milling speed and sintering speed using CAD/CAM techniques on the marginal gap of zirconia crowns has been conducted. This study was performed on 6 groups with different milling and sintering treatments. Marginal gap values were obtained by measuring the perpendicular distance from the internal margin surface of the crown or restoration to the outer edge of the final margin line of the tooth on all four sides of the sample (mesial, distal, buccal, and lingual sides), with the values averaged. The mean and standard deviation of the marginal gap values are presented in table 1.

Figure 2 illustrates the average marginal gap across six groups with different milling and sintering speeds. The highest average marginal gap was observed in the fast milling and conventional sintering group (FM+CS) at 118 μm. The lowest average was in the gentle milling and speed sintering group (GM+SS) at 86.36 μm. The marginal gap in the conventional sintering group was higher than that in the speed sintering group for both fast milling and gentle milling. However, in the normal milling group, the marginal gap in conventional sintering was lower than that in speed sintering, with an average difference of 1.07 μm.

The research results obtained are quantitative data tested using a two-way ANOVA analysis. The prerequisite for conducting this test is that the data must be normally distributed and homogeneous. The Shapiro-Wilk test results show that the mean marginal gap percentage in each treatment group is normally distributed. This is evident from the significance value, which is greater than 0.05 in both the milling and sintering groups. The Levene's test for homogeneity showed that the mean marginal gap had the same variance in both the milling and sintering groups. This was proven by a significance level greater than 0.05 ($p > 0.05$). Next, a two-way ANOVA test was performed because the data were normally distributed and homogeneous. The results of the two-way ANOVA test can be seen in table 2.

Table 2 presents the results of a two-way ANOVA test on the differences in milling speed and sintering speed on marginal gap. Based on the results of the two-way ANOVA test, it shows that: There is a significant difference in the effect of milling speed on the marginal gap in zirconia dental crowns ($p<0.05$). There is a significant difference in the effect of sintering speed on the marginal gap in zirconia dental crowns ($p<0.05$). There is a significant difference in the interaction between milling speed and sintering speed on the marginal gap of zirconia dental crowns ($p<0.05$). The data were further analyzed using the Post-Hoc LSD test

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to determine the significance of differences between treatment groups, with the results presented in table 3.

Based on the results of the Post-Hoc LSD test in table 3, it was found that in the relationship between groups, all groups showed significant differences ($p<0.05$) and there were meaningful differences between each group ($p<0.05$) except between NM+CS and NM+SS, and FM+SS and GM+CS, which showed non-significant differences ($p>0.05$), indicating similarity in results between these two approaches. Overall, other comparisons between groups, particularly between the gentle milling + speed sintering (GM+SS) group and the other groups, showed significant differences in both milling speed and sintering speed.

Discussion

Research data were obtained from measurements of the marginal gap on each side of the sample after scanning using micro-CT. This device was chosen because it is the gold standard for measuring marginal gaps. It is a non-destructive, accurate tool for measuring small gaps such as marginal gaps. Micro-CT can reconstruct 3D images in great detail, including the gap between the crown and abutment. Micro-CT was chosen over CBCT, which operates using X-rays, because the structures projected by the micro-CT device show more accurate details, reaching 5 micrometers per pixel.[22]

Research findings on the differences in milling speed and sintering speed regarding marginal gaps in zirconia dental crowns have proven that milling speed (gentle milling) and sintering speed (speed sintering) reduce marginal gaps in zirconia dental crowns. The results of this study indicate that all treatment groups had clinically acceptable marginal gap values. The clinically tolerable marginal gap range is 50 to 120 μm.[18] The average marginal gap in the gentle milling and speed sintering groups was 86.36 μm. This average was the smallest value compared to all treatment groups, especially compared to fast milling and conventional sintering, which showed an average of 118 μm. This may be due to differences in milling speed and sintering speed.

Milling speed is divided into three categories: fast, normal, and gentle. There is a significant difference, as indicated by the variation in average marginal gaps across all treatment groups. Zirconia dental crown fabrication using gentle milling resulted in smaller marginal gaps compared to normal milling and fast milling in both the conventional sintering and speed sintering groups. When the milling bur rotates at a low speed, it tends to move slowly and produce smoother milling results. High milling speeds can cause vibrations or oscillations in the milling bur. These vibrations can cause deviations in the cutting path, especially in thin areas such as the crown edge surface. These results are consistent with the research,[13] who stated that zirconia crowns produced at faster milling speeds result in occlusal grooves and cusps with coarse overall anatomical details, more aggressive subtractive material removal processes, and surface imperfections, including in the restoration margin area. This is also consistent with the research,[17] who stated that fast milling produces restorations with significantly larger marginal gaps compared to slower milling speeds. Lowspeed milling has a smaller and more distributed cutting load on the tool, resulting in more stable outcomes. This will affect the compatibility of the restoration results with the original CAD design.[23]

Sintering speed is divided into two types: conventional sintering and speed sintering. The heating process in sintering has a sequence that must be determined according to factory regulations. Speed sintering uses two sequences with a temperature increase of 120 degrees per minute, while conventional sintering has five sequences with a temperature increase of 2-8 degrees per minute. Speed sintering shows a smaller or nearly identical marginal gap compared to conventional sintering in this study. Slower sintering or conventional sintering can lead to higher sintering shrinkage, resulting in greater inconsistency and unevenness. This aligns with the research,[14] who stated that speed sintering produces a smaller marginal gap in zirconia crowns compared to conventional sintering due to several interrelated factors, including grain size, crystal phase stability, and minimal dimensional distortion.

The speed sintering process has a high heating rate and a short peak temperature holding time, thereby limiting grain growth and producing a microstructure with smaller and more uniform grain sizes.[24] The smaller grain size in zirconia allows the densification process to occur uniformly, including in marginal areas, resulting in more homogeneous shrinkage during sintering. Larger grains can cause microcracks, leading to inconsistencies in the final product. Additionally, faster sintering maintains the stability of the tetragonal phase in zirconia, particularly in the 3Y-TZP type, thereby minimizing the transformation of the tetragonal phase back to the monoclinic phase, which can cause volume expansion and cracks. This phase stability also supports dimensional precision in the final product.[25] The combination of small particles, stable crystalline phase, and controlled shrinkage is the influencing factor of the speed sintering group in this study, resulting in zirconia crowns with smaller marginal gaps and better adaptation quality.

The conventional sintering group showed research results consistent with the theoretical explanation of milling and sintering speed. Unlike the speed sintering group, which had a marginal gap sequence from lowest to highest as gentle milling, fast milling, and normal milling. The results of this study are inconsistent with the findings,[17] who reported that fast milling

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produced restorations with significantly larger marginal gaps compared to slower milling speeds. This discrepancy may arise due to differences in zirconia block density, which linearly affects zirconia shrinkage. The shrinkage process is determined by various factors, such as the material composition itself, density distribution, and sintering process parameters. Density distribution, known as the primary characteristic of the material, determines local shrinkage and dimensional accuracy after final sintering. Additionally, nonuniform sintering shrinkage can cause restoration mismatch.[26] The sintering process for the samples in this study was performed simultaneously for work efficiency and to avoid prolonged downtime for the milled zirconia crowns. During the sintering heating process, the heating direction in the system proceeds from the outside to the inside, ensuring temperature stability and enabling control of the material's microstructure.[14]

Conclusion

Based on the conducted research, it can be concluded that there are differences in milling speed and sintering speed using CAD/CAM techniques on the marginal gap of zirconia dental crowns. Gentle milling and speed sintering have the smallest marginal gap values.

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