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REVIEW

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

Sonia Nduma Nola Padang,[1] Ismet Danial Nasution,[2]* Ricca Chairunnisa[2]

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ABSTRACT

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

Introduction

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

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

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

In addition to ridge morphology, the type of jaw relationship and occlusal scheme play crucial roles in determining how masticatory forces are distributed to the supporting tissues. Patients with skeletal Class III malocclusion characterized by mandibular prognathism experience complex alterations in occlusal force distribution. When combined with a resorbed ridge, this creates a significant biomechanical challenge in complete denture treatment.[4]

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

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

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

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

*Corresponding author: ismetdanial@yahoo.com

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scheme in patients with complex ridge conditions.

Table 1. Search strategy according to PICO criteria.

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

Table 2. List of primary keywords and related terms.

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

Table 3. Summary database.

Data Base	First screening based on keywords	Duplicate	Subject Area	Free Full Text	Title screening	Inclusion criteria screening
PubMed	563	362	201	135	12	3
Cochrane	103	60	42	25	3	0
Science Direct	498	348	149	72	6	2
Total	1.164	770	291	232	21	5

Table 4. Summary of reviewed studies.

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

Methods

Search Strategy

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

Inclusion and Exclusion Criteria Inclusion Criteria: Original research articles published in English; Published between 2015 and 2025; Studies evaluating stress distribution, mucosal pressure, or complete denture stability; Comparative studies assessing different occlusal schemes (monoplane, lingualized, or balanced occlusion); Focused on completely edentulous patients with flat alveolar ridges.

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

Data Extraction

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

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

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

Study Selection

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

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

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

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Table 5. Risk of bias and quality assessment.

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

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

Data Synthesis

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

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

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

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

Results

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

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

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

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

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

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

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

therapy.

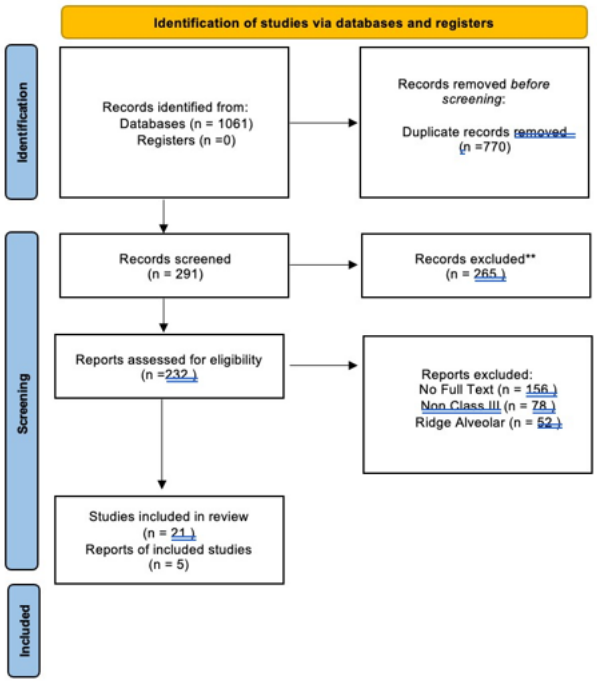

Figure 1. PRISMA Flowchart of Study Selection Process.

Discussion

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

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

In addition to occlusal schemes, ridge morphology plays a crucial role in determining the functional success of dentures. Flat or severely resorbed ridges reduce the surface area available for load distribution, thus requiring individualized rehabilitative approaches. Several studies have indicated that additional interventions—such as the use of soft denture liners and extended denture bases—can help stabilize functional loads and enhance patient comfort.[14]

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

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

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

Conclusion

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

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

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

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

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

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