



Original Research Article

Evaluation of Different Occlusal Concepts in Implant Retained Mandibular Overdenture – A Systematic Review

Article History:

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Abstract: *Statement of problem* There is still no clear evidence available about the occlusal concept for implant-retained mandibular overdentures. Even though several occlusal schemes like bilateral balanced occlusion, lingualized occlusion, and monoplane occlusion are used to improve the masticatory efficiency, patient comfort but their relative efficacy is not properly defined. Due to inadequate literature, clinical decision-making becomes subjective and inconsistent. So, a systematic review becomes important to critically evaluate the current evidence on various occlusal concepts in implant-supported mandibular overdentures to establish which scheme has the best biomechanical and clinical results. *Purpose* This systematic review compares the effects of different occlusal schemes—bilateral balanced occlusion, lingualized occlusion, monoplane occlusion, and canine-guided occlusion on masticatory efficiency, bite force, electromyography activity, and patient satisfaction, in implant retained mandibular over denture *Materials and methods:* The literature search was conducted in PubMed, Scopus, Science Direct, and Google Scholar for studies published between January 2015 and December 2024, following PRISMA guidelines. The included studies were randomized controlled trials, comparative clinical trials, and cohort studies involving edentulous patients rehabilitated with implant-retained mandibular overdentures. Out of all included studies six studies met the eligibility criteria. The assessed outcomes included masticatory efficiency, bite force, electromyographic (EMG) activity, patient satisfaction, and implant stability. Risk of bias was evaluated using RoB-2 and RoB-I tools. *Results:* There was no significant difference in masticatory performance, EMG activity, or implant stability among the different occlusal concepts. All schemes demonstrated almost similar outcomes in terms of bite force distribution and patient satisfaction. Comparatively bilateral balanced occlusion and lingualized occlusion showed good functional results whereas canine-guided occlusion also showed similar results. *Conclusion:* The systematic review concludes that; no occlusal scheme is clinically superior in implant-retained mandibular overdentures. The choice of scheme should be determined according to clinical circumstances. Further research with larger sample sizes and extended follow-up is needed to strengthen the evidence.

Keywords: Implant overdenture, occlusal scheme, masticatory efficiency, patient satisfaction, implant stability.

INTRODUCTION

In spite of the improvements in dental healthcare and avoidance policies many patients still fail to keep their teeth due to periodontal diseases or caries or trauma.

Latest updates have showed wide improvement in dental wellbeing circumstances but the rise in quality of life expectations has also improved the age and number of the elderly individuals making also the edentulous individuals in necessity need of full mouth

rehabilitation. Complete dentures may introduce its own as an answer to restoring persons' oral esthetics besides mastication ability. But due to anatomical, masticatory and sensitive causes it is not all the time likely to reach the amount of stability and retention needed to offer a prosthesis that is comfy to edentulous patients especially for mandibular prosthesis wearing.^{1,2}

Implant retained overdentures have been a management commonly used for the edentulous patients treatment for the last 25 years and liable to attain good proven results. Many patients particularly those who are not feeling comfort with their dentures enjoyed additional support and retention implants offer for their dentures. Implant supported overdenture has been known as the standard of care for completely edentulous patients and should be the principal choice of treatment for the edentulous mandibular arch.³

The stability and retention of complete dentures can be compromised by displacing forces, which are created during mastication, swallowing, and parafunctional habits. Throughout these functions, the maxillary and mandibular teeth come into contact, and unfavorable displacing forces can overwhelm the retention and stability of the dentures, creating discomfort from trauma to the underlying mucosa.^{4,5} If the fitting and polished surfaces are ideal, it is assumed that the form of the occlusal surfaces and the nature of their contacts become critical for successful denture function. The search for the most appropriate occlusal form and tooth arrangement for complete denture occlusion has been ongoing for almost two centuries.

Occlusal overload is often regarded as one of the main causes for peri-implant bone loss and implant/implant prosthesis failure. Studies have suggested that occlusal overload may contribute to implant bone loss and/or loss of osseointegration of successfully integrated implants.^{6,7} The causality of occlusal overloading for peri-implant tissue loss is questionable due to insufficient scientific evidences. However, it needs to be stressed that occlusal overload can cause mechanical complications on dental implants and implant prostheses such as screw loosening and/or fracture, prosthesis fracture, and implant fracture, eventually leading to compromised implant longevity. The rehabilitation of edentulous patients with implant-supported overdentures has become a widely accepted treatment modality due to its enhanced stability and retention compared to conventional dentures. One of the critical factors influencing the success of implant-supported overdentures is the occlusal scheme, which can significantly affect the functional and biomechanical outcomes of the prosthesis. The choice of occlusal scheme plays a vital role in distributing occlusal forces, which in turn

impacts the performance and longevity of the overdentures as well as patient satisfaction^{8,9,10}

Balanced occlusion, lingualized occlusion, and monoplane occlusion are commonly used occlusal schemes in prosthodontics. Balanced occlusion aims to achieve simultaneous bilateral contact during centric and eccentric movements, thereby distributing forces evenly. Lingualized occlusion, on the other hand, focuses on achieving a harmonious relationship between the maxillary palatal cusps and the mandibular fossae, providing a balance between stability and functional efficiency. Monoplane occlusion utilizes flat occlusal surfaces to minimize lateral forces and simplify denture adjustments.

Previous studies^{11,12,13} have shown varying results regarding the effectiveness of these occlusal schemes. Some research suggests that balanced occlusion provides better masticatory performance and patient satisfaction compared to monoplane and lingualized occlusion. Treatment of edentulous patients using a conventional complete removable denture is a common clinical undertaking. However, those patients may experience problems which include pain during mastication, reduced masticatory ability, as well as insufficient stability and retention of the mandibular denture.

The occlusal scheme plays a fundamental role in the ME of complete denture wearers. Two of the most widespread schemes are bilateral balanced occlusion (BBO) and lingualized occlusion (LO). The BBO uses anatomic teeth with contact between the maximal number of the maxillary and mandibular teeth during centric and excursive mandibular movements, reducing undesirable movements of the denture during mastication. 24 In the LO design, only the maxillary lingual cusps articulate with the mandibular occlusal surfaces in centric working and nonworking mandibular positions, with centric contacts only on the lingual cusps of maxillary teeth. This occlusal scheme is an attempt to preserve esthetics and the maintenance of the food bolus penetration in anatomic teeth while maintaining the mechanical freedom of nonanatomic teeth. However, studies determining the most appropriate occlusal scheme for completely edentulous patients are sparse⁷ Therefore, this decision is based on experience and preference. Similarly, for overdentures, the occlusion has typically been based on conventional complete denture preferences.^{14,15}

The introduction of dental implants and, subsequently, the implant-supported mandibular overdenture has improved the quality of life for edentulous patients. The biomechanical aspects of occlusal design, configuration, and anatomy significantly influence the ultimate success of implant. The development of occlusal concepts that is in

harmony with the rest of the stomatognathic system is a major contributing factor in the long-term success rate of the implant-supported prosthesis. Many authors emphasized the role of occlusion as a key factor in implant success. James stated that “nearly all problems of the implants that develop between the first and sixth week post-insertion are directly related to the occlusion.” Lindquist *et al.*, and Miyata *et al.*, studied the longitudinal effects of occlusal forces on osseointegrated implants and found that overloading was the main cause for bone loss around fixtures and/or loss of osseointegration of successfully integrated implants.^{16,17} The prosthesis must therefore be fabricated as accurately as possible in order to achieve long-term success, and occlusion should be a key factor of the overall success rate. Currently, the occlusal philosophies that are proposed for implant overdentures are based on those for conventional complete dentures. These philosophies include bilateral balanced occlusion and lingualized occlusion. There is paucity in literature regarding the studies wherein the impact of different occlusal schemes and their differences in terms of carious masticatory outcomes have been reported. Thus, this systematic review was conducted with the aim to assess impact of different occlusal schemes on masticatory efficiency, bite force, electromyographic activity, patient satisfaction, and implant stability in implant-retained mandibular overdentures.

MATERIALS AND METHODS

Study design

This study was designed as a systematic review which is conducted in accordance with PRISMA (Preferred Reporting items for Systematic review and Meta-Analyses) checklist recommendations.

Protocol and Registration

A systematic review protocol was developed prior to study commencement. The protocol included the research question, eligibility criteria, data sources, extraction methods, and outcome measures. The protocol was registered with PROSPERO International Prospective Register of Systematic Reviews under registration ID CRD42024568964

Eligibility criteria

The eligibility criteria were based on the **PICOS framework (Population, Intervention, Comparison, Outcomes, and Study design)** as follows:

- **Population (P):** Completely edentulous patients rehabilitated with implant-retained mandibular overdentures.
- **Intervention (I):** Implant-retained mandibular overdentures fabricated using different occlusal schemes, including bilateral balanced occlusion, lingualized occlusion, monoplane occlusion,

canine-guided occlusion, and median lingualized occlusion.

- **Comparison (C):** Comparison among different occlusal concepts applied in implant-retained mandibular overdentures.
- **Outcomes (O):**
 - Masticatory efficiency assessed using sieve method, colorimetric analysis, or number of chewing cycles.
 - Bite force measured using occlusal force transducers.
 - Electromyographic (EMG) activity of the masseter and temporalis muscles.
 - Patient satisfaction evaluated using validated questionnaires or visual analog scales.
 - Radiographic parameters such as marginal bone height and implant stability.

Inclusion Criteria

- Completely edentulous patients aged 50 years and above..
- Sufficient bone height and width for implant placement.
- Residual ridges with normal morphology, free from severe bony undercuts or flappy tissue.
- Patients in good general health, free from systemic diseases affecting implant osseointegration.
- Motivated patients who demonstrated cooperation and signed an informed consent

Exclusion Criteria

- Patients with neuromuscular dysfunction, psychological disorders, or systemic diseases affecting implant osseointegration (e.g., uncontrolled diabetes, osteoporosis).
- Severe alveolar ridge resorption.
- Bruxism, clenching, or other parafunctional habits.
- Patients with xerostomia or oral lesions.
- Smokers (if not reported separately in the study).
- Patients with previous implant treatment in the mandible.

Information sources

The following electronic databases were systematically searched:

- PubMed (Medline)
- Scopus
- Cochrane library
- Web of science
- Embase

- Google scholar

Search methods for identification of studies

All the studies in English language published from January 2015 till December 2024, globally were screened for inclusion criteria. The electronic searches were conducted independently by two researchers and any discrepancies in study selection were resolved through discussion and mutual consensus

Literature search strategy

A comprehensive search strategy was employed using a combination of medical subject headings (MeSH) and free text terms. To combine search terms, the Boolean operators “AND” and “OR” were used.

Keywords included:(Completely edentulous patients rehabilitated with implant-retained mandibular over dentures AND Different occlusal schemes in implant overdentures,

Implant supported mandibular over dentures AND bilateral balanced occlusion, Implant-supported mandibular overdentures with different occlusal schemes AND Masticatory efficiency, Completely edentulous patients rehabilitated with implant-retained mandibular over dentures AND different occlusal schemes in implant overdenture AND Masticatory efficiency AND Bite force, Implant-supported mandibular overdentures with different occlusal schemes AND Masticatory efficiency AND Electromyographic (EMG) activity, Completely edentulous patients rehabilitated with implant-retained mandibular over dentures OR Implant supported mandibular over dentures OR Patients with missing teeth AND Different occlusal schemes in implant overdentures

Study types included

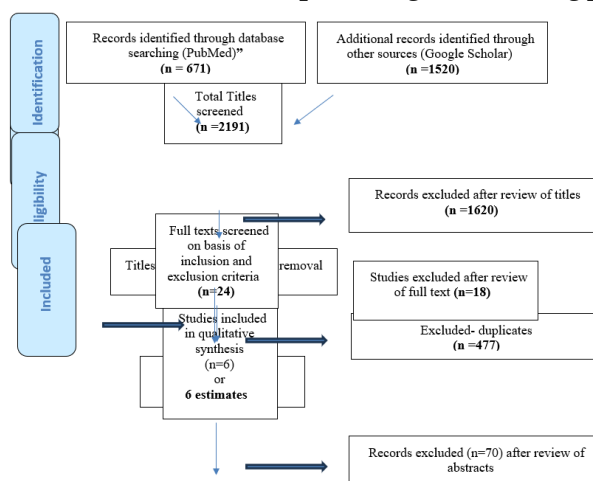
- **Randomized controlled trials (RCTs).**
- **Prospective or retrospective cohort studies.**
- **Comparative clinical trials.**

Study Selection Process

The present systematic review was structured according to the PICO framework to ensure clear and transparent selection of studies and a focused question

In this process, one reviewer initially assessed the titles and abstracts identified through the search strategy, considering whether they met the inclusion criteria. Subsequently, the full texts of all the studies meeting these criteria were acquired. The full-text articles were then thoroughly reviewed, and then decided if they met the inclusion criteria. In cases of uncertainty regarding a study's eligibility, the problem was resolved through consultation/discussion with a second author. In case of discrepancies in data extraction, both reviewers developed consensus before making a decision. Rayyan QCRI software was used to remove duplicates and MS Excel 2013 was used to store the data. Ultimately, the systematic review included five studies identified through the search process. The “screening process of studies is presented in the form of PRISMA flow-chart (Figure1).

Figure 1: PRISMA Flow chart presenting the screening process



DATA COLLECTION PROCESS

A standardized data extraction form was prepared in Microsoft Excel with the help of an expert. Initially 2-3 entries were made in the Excel and it was reviewed by an expert. Any disagreement between the authors was resolved by discussion.”

DATA ITEMS

Data items included for extracting the data were:-

1. Study Id- Number given to each included study
2. Author's name- Name of the author
3. Year of publication- Year in which the study was published
4. Study design- Whether the study was comparative, randomized, or clinical study
5. Clinical parameter: Patients with implant retained mandibular over dentures
6. Intervention: Details about different occlusal schemes
7. Follow-up duration: The duration for which the patients were followed-up.
8. Sample size- Number of patients included in the study
9. Outcome- Masticatory efficiency, Bite force measurement. using occlusal force transducers.
10. Inference- The conclusion of the study

Remark- The remarks by the author”

RISK OF BIAS

The risk of bias was assessed by Risk-of-bias VISualization tool (ROBVIS) tool. The risk of bias of the included studies is presented as a “Traffic Light” Plot of individual studies and a summary diagram. For non-randomized interventional studies, the risk of bias assessment was done using Robbins-I Tool (RoB-I) and for randomized controlled studies, RoB2 tool was used with its domains.

RESULTS

The present systematic review was conducted to evaluate the different occlusal concepts in implant retained mandibular overdenture by assessing masticatory efficiency, bite force, electromyographic activity, patient satisfaction, and implant stability. The screening process was undertaken in three steps that included screening of titles followed by screening of abstracts and finally screening of full text for inclusion in the review. The characteristics of the studies included in the systematic review are presented in the below tables.

Table no.1- Details of the studies included in the systematic review

	Author	Year	Study design	Sample size
1	Abdelhamid AM et al	2015	Prospective cross-over non-randomized study	n=12
2	El-Dayem MA et al	2016	Comparative clinical study	n=10
3	El-sadany H et al	2020	Comparative clinical study	n=10
4	Rocha C et al	2021	Randomized crossover clinical trial	n=14
5	Lasheen AM and Eldein AM	2022	Randomized controlled study	n=20
6	Kuriakose R et al	2024	Randomized controlled trial	n=60

The table 1 represents Six studies included in the systematic review as per the pre-defined eligibility criteria. All studies compared different occlusal schemes in implant retained mandibular overdentures and assessed their clinical and radiographic outcomes. With respect to publication year, the studies were published from 2015 to 2024. Regarding study design, three studies were randomized controlled studies/trials with parallel (two) and crossover study design (one). Remaining 3 studies were non-randomized comparative clinical studies. The sample size across different studies varied from as less as 10 patients to a maximum of 60 patients. All the studies involved completely edentulous patients or those wearing dentures.

Table 2- Details of the study participants, intervention, and comparator of the studies included in the systematic review

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion
1	Abdelhamid A Met al	aged 45 – 65 years	completely edentulous patients	Bilateral balanced occlusion	Canine guided occlusion and control group (denture with intra-oral adjustment)	4 weeks	Electromyographic evaluation of the masseter muscles	NR	The recordings of the masseter muscle associated with canine guidance occlusion were higher than bilateral balanced occlusion but with no statistically significant difference except between the right masseter muscles during clenching.	Both bilateral balanced occlusion and canine guidance occlusion can be used successfully in implant-retained mandibular overdentures without affecting masseter muscle activity.
2	El-Daayem M A et al	aged 50 -	completely edentulous	Implant retained mandibular	Implant retained mandibular	clinical and radiographic ally	Clinical - Gingival index, plaque index, probing depth.	Morbidity test, percussion	There was no statistically significant difference between median	From the clinical point of view, satisfactory results were obtained

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion
		68 years	us patients	lar overdenture with ball and socket attachment the artificial teeth were arranged in a median lingual	overdenture with ball and socket attachment the artificial teeth were arranged in a monoplanar occlusion.	mediatly after overdenture delivery and after 6 and 12 months	Radiographic - marginal bone height and its change	ntest	lingualized and monoplane occlusion in implants supporting a mandibular overdenture retained by ball & socket attachment.	d when two dental implants were placed in the intraforaminal region of the mandible and connected with ball and socket attachment to support and retain mandibular overdenture.

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion	
				al i z e d o c c l u s i o n							
3	El-sadany H et al	age ranged from 50 - 60 years	Total 50 patients	five patients were denture with bilateral balanced occlusion	five patients were denture with canine guided occlusion.	1 month	masticatory efficiency test : number of swallows, time of swallows for soft and hard food	N R	With soft food, there was no significant difference among the three groups, while for chewing hard type of food; the greatest mean was recorded in occlusion after oral adjustment, whereas the lowest mean was recorded in bilateral balanced occlusion	The two groups selected in the study, bilateral balanced occlusion as balanced concept and as a non-balanced concept canine guided occlusion both can be considered for usage effectively in implant retained	

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion	
									n.	overdentures without disturbing chewing efficiency.	
4	Rocha C et al	N R	Patients with bimaxillary complete dentures and maxillary complete	bilateral balanced occlusion	lingualized occlusion		masticatory efficiency was measured by the sieve method for both occlusal schemes.	N R	Repeated measures ANOVA showed no statistically significant difference in the masticatory efficiency with the 2 occlusal schemes for conventional complete dentures (P=.707) or overdentures	A mandibular single implant improved the masticatory efficiency of patients with complete dentures, but the occlusal scheme did not influence this factor.	

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion	
			edentulous and single implant-retained mandibular overdentures								
5	Lasheen AM and Eldin AM	aged - 50 - 60 years	complete dentulous	two implant assisted mandibular	two implant assisted mandibular	surface Electromyography (sEMG)	Masseter and Temporalis muscle activities were evaluated using surface	NR	The cumulative implant success rate at the end of follow-up period	Lingualized Occlusal scheme coupled with resilient denture liners	

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion
			malocclusion patients	bular over denture and maxillary complete denture with Bilateral Balance Occlusion (BBO) using semi	ar over denture and maxillary complete denture with Lingu alized Occlusion (LO) using semi	at insertion, three, six and 12 months of follow-up period.	Electromyography (sEMG)		was 100%. There were no statistical significant differences along the time intervals ($P \geq 0.05$) between both groups;	used for implant assisted overdentures improved the masticatory muscle activity providing better masticatory efficiency and patient comfort.

Sr. no	Author	Age group	Population	Interventions/treatments used (Test group)	Comparator (Control group)	Follow-up period	Primary outcomes	Secondary outcome, If any	Results	Conclusion
				- anatomical teeth.	h.					
6	Kuriakose Retal	NR	Edentulous patients who received mandibular implant-supported overdentures	Group A (balanced occlusion), Group B (lingualize occlusion)	Group C (monoplane occlusion)	baseline, 3 months, and 6 months post-insertion	Clinical assessments, including bite force measurement and masticatory efficiency	Patient satisfaction by validated questionnaire.	There were statistically significant differences between the groups in terms of bite force, masticatory efficiency, and patient satisfaction ($P < 0.05$).	Balanced occlusion provided superior functional outcomes and higher patient satisfaction for implant-supported overdentures compared to lingualized and monoplane occlusion schemes.

Sr. no	Aut hor	A ge group	P o p ul at ion	Int er ve nti on s/t re at me nts us ed (T est group)	Co mpa ra tor (C ont rol group)	Fol lo w-up period	Primar y outco mes	Se co nd ar y ou tc o m e, If an y	Results	Conclu sion
			er de nt ur es .							

ASSESSMENT OF RISK OF BIAS

Risk of bias assessment of all the included studies was performed. From a total of 6 studies, 3 included studies had non-randomized study design and 3 included studies had randomized controlled study design. For non-randomized interventional studies, the risk of bias assessment was done using Robbins-I Tool (RoB-I) and for randomized controlled studies, RoB2 tool was used with its domains.

The RoB-I tool revealed that the risk of bias summary shows that all the 3 included studies show low risk of bias in all the domains assessed; i.e. the quality assessment shows overall low risk of bias for the domains: confounding, intervention classification, measurement and selection of reported results. Thus, it can be interpreted that almost all the non-randomized interventional studies included showed overall low to moderate risk of bias. (Figure 2a and Figure 2b).

Figure 2a - Risk of bias summary: review authors' judgements about each risk of bias item for each included non-randomized interventional studies.

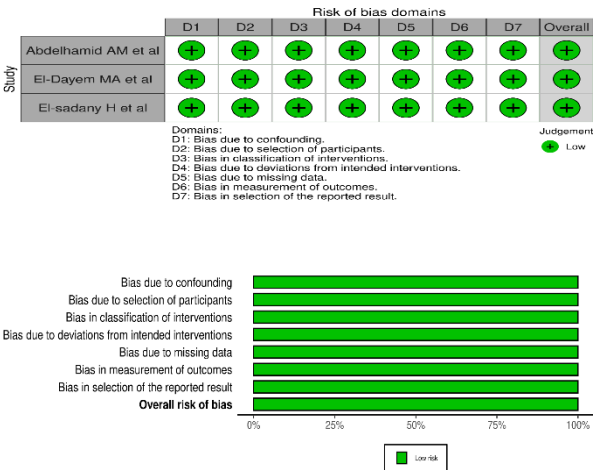


Figure 2b - Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included non-randomized studies

The RoB2 tool revealed that the 3 included studies had overall low risk of bias as well as low risk for all the domains except for D3, bias due to missing outcome data with reference to 2 studies. (Figure 3a). The summary plot showed that more than 50% high risk of bias was noted for missing outcome data domain and almost 100% low risk of bias

for all the other domains across the included studies. (Figure 3b).

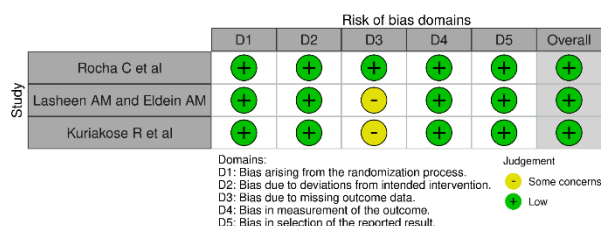


Figure 3a: Risk of bias traffic light plot using RoB-2 tool

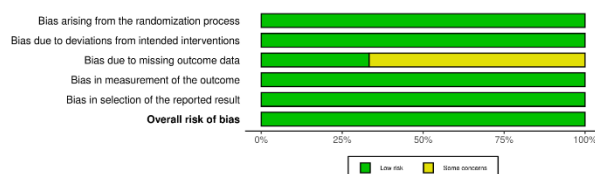


Figure 3b: RoB2 "Summary Plot" distribution of risk of bias among the studies

QUANTITATIVE DATA ASSESSMENT

From all of the included studies; 3 studies showed similar outcome data in terms of masticatory efficiency of the muscles while clenching, while having soft food and while having hard food. Only 2 studies involved the outcome reported from electromyographic activity (in terms of Root mean square and in terms of EMS record) and 1 study just reported the number and time of swallows with respect to the food consumed. A quantitative data assessment is presented in Table 3 and Table 4 with respect the outcome mentioned above. But a meta-analysis couldn't be performed due to the difference in the method and type of outcomes reported across the included studies.

Table 3 represents the outcome; Masticatory efficiency, in terms of soft food consumed and Table 4 represents the outcome; Masticatory efficiency, in terms of Hard food consumed. It can be noted that the mean values of masticatory efficiency for soft food and hard food are almost similar in both the occlusal schemes for studies conducted by El-sadany H et al (Number of swallows) and Lasheen AM and Eldein AM (EMG records); whereas for study conducted by Abdelhamid AM et al (Root mean square of EMG signals), there was a comparable difference seen in the mean values between both occlusal schemes for both hard and soft food.

DISCUSSION

This systematic review examined the impact of various occlusal schemes on masticatory efficiency, bite force, electromyographic activity, patient satisfaction, and implant stability of implant-retained mandibular overdentures. Occlusal overloading is one of the predominant cause of peri-implant bone loss and prosthetic failure particularly when post-insertion oral hygiene is poor. Thus, a proper occlusal scheme

is essential for long-term implant success, especially in patients with parafunctional habits, As implants do not have periodontal ligament and cannot adjust to occlusal discrepancies; stress should be distributed equally on the osseointegrated fixtures to avoid mechanical or biological difficulties.¹⁸

The majority of researchers recommend the application of lingualised occlusion in implant-supported removable prostheses due to the fact that it locates occlusal forces over the ridge crest, minimizes lateral stress, and limits processing errors.¹⁹⁻²¹ Monoplane occlusion, which has flat posterior teeth, minimizes horizontal stress and can be applied in severely resorbed ridges.^{18,19} Bilateral balanced occlusion (BBO) provides simultaneous anterior and posterior tooth contacts during all movements, enhancing denture stability. Canine-guided occlusion (CGO) releases posterior teeth on excursions, guarding the temporomandibular joint and minimizing strain on the muscles^{22,23}

Masticatory efficiency is a measure of prosthesis functioning influenced by occlusal design and muscle coordination. Post-insertion implant complications have, in most studies, been found to be associated with occlusal design.^{24,25} Although LO might diminish lateral forces and BBO improves mastication by favoring many contacts, this review evidenced no statistical difference in masticatory efficiency or peri-implant parameters between various occlusal concepts. Regular oral hygiene and cleansable attachment use probably contributed to healthy peri-implant soft tissues, as supported by findings of Gotfredsen and Holm, Mericske-Stern, and Zarb.^{26,27} Radiologic measurements also revealed similar marginal bone loss in schemes, with results that aligned with findings by Naert et al. and Mohamed and Ibrahim, whose reported yearly bone loss within

expected parameters.^{28,29}

Standard test foods like banana (soft) and carrot (hard) worked well for assessing chewing performance with minimal variation.^{32,28} In general, comparative studies involving different occlusal schemes invariably found no significant differences in masticatory efficiency or EMG activity^{30–32}

Within the limitations of short follow-up periods and absence of subjective assessment, it is the opinion of this review that both lingualized and bilateral balanced occlusal concepts may successfully be employed in implant-supported overdentures. Proper management, and patient oral hygiene are still the prime factors for ensuring implant stability and prosthetic success.

CONCLUSION

Within the limitations of this study the results lead to that both bilateral balanced occlusion and canine guidance occlusion can be used successfully in implant-retained overdentures without affecting masticatory function. However, the procedures involved in construction of dentures with bilateral balanced occlusion are more complex and time consuming. Greater muscle activity of both muscles is shown when chewing hard food due to higher muscle force needed to comminute hard food compared to soft food.

Recommendations

The present study recommends the following:

- Further investigations for a longer follow-up period and for a larger sample to confirm widespread use of canine guidance occlusal concept and involving subjective assessment using questionnaires for the patients' satisfaction
- Evaluation of the effect of different attachment types on masticatory function using the canine guidance concept in implant-retained overdentures
- Evaluation of canine guided occlusal concept using a different method of evaluation of masticatory function other than electromyography

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