Occlusal Schemes for Complete Dentures: A Systematic Review

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Purpose: The aim of this study was to qualitatively review the literature regarding occlusal schemes for complete dentures. ***Materials and Methods:*** An electronic search was executed using PubMed (MEDLINE) with the aid of Boolean operators to combine the following terms: "complete denture," "occlusion," "balanced," "lingualized," "anatomic," "flat," "monoplane," and "canine." The search was limited to English peer-reviewed articles published up to January 2012. The literature search was supplemented by manual searching of relevant journals and the reference lists of selected articles. ***Results:*** A total of 565 articles were retrieved; however, only 12 articles met the inclusion criteria. The included studies evaluated the effects of posterior tooth morphology/arrangement and lateral occlusal guidance. In relation to morphology, the posterior teeth were either anatomical or flat. The posterior tooth arrangements showed conventional bilaterally balanced occlusion (CBBO), lingualized bilaterally balanced occlusion (LBBO), or monoplane occlusion (MO). The lateral occlusal guidance involved either balanced occlusion or anterior tooth–guided occlusion (ATGO). ***Conclusions:*** Within the limitations of this review, it can be concluded that anatomical teeth arranged in CBBO or LBBO are preferable to flat teeth arranged in MO. This is primarily related to patient acceptance. ATGO can also be considered for complete dentures. *Int J Prosthodont 2013;26:26–33. doi: 10.11607/ijp.3168*

Edentulous patients seek denture treatment to restore function and esthetics in the most comfortable fashion. Among the principles considered essential for complete denture success is occlusion.[1] It has been established that complete dentures exhibit different biomechanical characteristics than natural teeth. The denture acts as one unit, and any force applied to a single denture tooth will be directly transferred to the rest of the denture.[1] To overcome this limitation, several occlusal concepts for complete dentures have emerged.[1–3] Altering the posterior tooth morphology and occlusal scheme has been suggested to impact the lateral forces on the denture and residual ridge. It has been argued that any occlusal force applied to one segment of the denture must be balanced by force applied to the other denture segment, ie, balanced occlusion.[1] In contrast, some authors have proposed the use of flat teeth to minimize lateral forces and enhance denture stability.[3] This principle is justified from a mechanical perspective; however, it is not necessarily justified from biologic and physiologic perspectives.[4]

Although complete dentures have been used in prosthodontics for centuries, there is still a lack of compelling evidence supporting any one occlusal philosophy.[4] A systematic review of complete denture occlusion[5] found that only one study complied with the inclusion criteria.[2] Recently, clinical studies have assessed the effect of varying the occlusal parameters for complete dentures. The aim of this systematic review was to qualitatively assess the effect of the occlusal schemes of complete dentures in relation to patients' subjective appraisals and clinicians' objective evaluations of treatment. The points of interest were posterior tooth morphology, posterior tooth arrangement, and lateral occlusal guidance. The null hypotheses were that there are no effects of altering the posterior tooth morphology, posterior tooth arrangement, and lateral occlusal guidance of complete dentures.

Materials and Methods

A comprehensive literature search was completed in January 2012. The search strategy was conducted using the PubMed (MEDLINE) database with the aid of Boolean operators. The following key words were combined: "complete denture," "occlusion," "balanced,"

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"lingualized," "anatomic," "flat," "monoplane," and "canine." No limits were placed regarding year of publication. The search aimed to obtain all clinical studies that compared different denture posterior tooth morphologies, posterior tooth arrangements, or lateral occlusal guidance schemes. Further, an electronic search was manually conducted of the following journals: *International Journal of Prosthodontics, Journal of Prosthetic Dentistry, Journal of Oral Rehabilitation, International Journal of Periodontics and Restorative Dentistry, Journal of Dentistry, Quintessence International, Journal of Prosthodontics,* and *Journal of Prosthodontic Research*. In addition, the references of the selected articles were searched for relevant studies. Potentially relevant studies were identified according to the titles and abstracts. The full-text articles were subsequently reviewed and cross-matched against the predefined inclusion criteria (Table 1).

Table 1 Inclusion Criteria

Human clinical study
Investigation of conventional complete dentures
Presence of follow-up period after denture insertion
Inclusion of at least 10 participants
Publication in peer-reviewed journal
Written in English

Results

Study Search

The electronic search identified 565 articles. Following analysis of the titles and abstracts, 530 articles were excluded, leaving only 35 articles suitable for inclusion. After the application of the inclusion criteria, 16 articles were deemed suitable for full-text analysis. Of these, 8 articles were found to be acceptable for inclusion.[2,3,6–10] The manual searches revealed an additional 4 articles.[11–14] Two of the studies were performed on the same participants[9,10]; however, both studies were included because they applied different assessment methods. Therefore, a total of 12 articles were considered acceptable for this systematic review.[2,3,6–14]

Description of Studies

Since the selected studies differed markedly in relation to study design, a qualitative analysis of the studies was conducted. The analysis was primarily related to the significant variations in tooth selection, tooth morphology, follow-up period, and assessment method. The assessment methods were divided into two main categories:

- Subjective evaluation.[2,3,7–12,14] This included patients' perceptions of the new dentures in relation to comfort, retention, stability, mastication, speech, and esthetics as well as the use of a visual analog scale or an oral health–related quality of life questionnaire.
- Objective evaluation.[2,6,10–13] This included variables that can be assessed by the clinician, including the number of denture adjustments required, retention, stability, maximum occlusal force, mandibular movements, and objective mastication tests.

In relation to study design, the included studies were mostly crossover trials. However, a few were randomized or nonrandomized prospective trials.

Classification of Studies

For the purpose of uniformity, the studies were classified into two broad categories according to the occlusion variables assessed: *(1)* posterior tooth morphology and arrangement and *(2)* lateral occlusal guidance. In relation to tooth morphology, the included studies examined anatomical teeth or flat teeth. The teeth were considered anatomical if they showed a cusp angle. If the cusps were lacking (0 degrees), the teeth were classified as flat.[1]

The posterior tooth arrangements involved conventional bilaterally balanced occlusion (CBBO), lingualized bilaterally balanced occlusion (LBBO), or monoplane occlusion (MO). CBBO can be defined as the simultaneous occlusal contact of the maxillary and mandibular teeth in centric and eccentric positions. This occlusal scheme is distinguished by the establishment of occlusal contacts between mandibular buccal cusps and maxillary central fossae and between maxillary palatal cusps and mandibular central fossae (Fig 1a).[1] While still considered a balanced tooth arrangement, LBBO is characterized by maxillary palatal cusps contacting mandibular central fossae. It differs from CBBO by eliminating the contacts between the mandibular buccal cusps and maxillary central fossae. The selected studies accomplished LBBO by modifying the anatomical mandibular posterior teeth and tilting the maxillary posterior teeth (Fig 1b) or by applying anatomical maxillary posterior teeth against flat mandibular posterior teeth (Fig 1c). Regarding MO, balanced or nonbalanced occlusion can be established,[1] but the selected studies did not clarify the nature of lateral occlusal guidance. A special feature of MO is that the occlusal contacts comprise surfaces rather than points (Fig 1d).

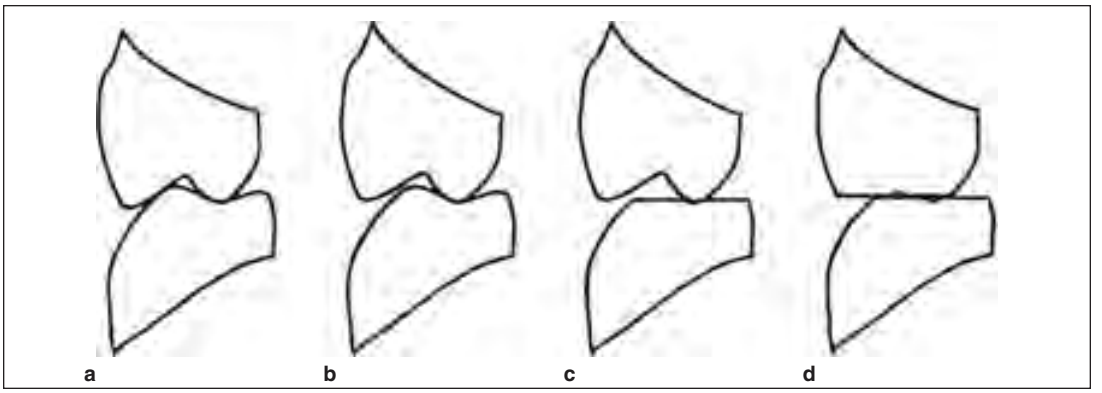

Fig 1 Altering posterior tooth morphology and arrangement: **(a)** anatomical maxillary and mandibular teeth arranged in CBBO; **(b)** anatomical maxillary and mandibular teeth arranged in LBBO; **(c)** anatomical maxillary tooth and flat mandibular tooth arranged in LBBO; **(d)** flat maxillary and mandibular teeth arranged in MO.

Regarding the lateral occlusal guidance, the identified studies compared dentures with bilaterally balanced occlusion (CBBO or LBBO) to dentures with anterior tooth–guided occlusion (ATGO). The established ATGO was either canine guided[6,14] or canine and first premolar guided.[7,12]

Summary of Studies

The included studies are summarized in Tables 2 and 3. Eight studies[2,3,8–11,13] evaluated the effects of posterior tooth morphology and arrangement (Table 2), and four studies[6,7,12,14] evaluated the effects of lateral occlusal guidance (Table 3).

In relation to posterior tooth morphology and arrangement, one study compared LBBO with MO.[2] The LBBO was composed of anatomical maxillary teeth against flat mandibular teeth. Two studies compared LBBO with CBBO.[11,13] The LBBO was formed by altering the mandibular teeth to eliminate the contacts of the mandibular buccal cusps. Two studies compared MO with CBBO.[3,8] Two studies of the same participant group compared CBBO, LBBO, and MO.[9,10]

The crossover study by Brewer et al[3] was the only study to find more patients who preferred MO to CBBO. However, the authors clearly stated that many of their participants were not aware of any difference. The other crossover study comparing CBBO with MO demonstrated a subjective patient preference for anatomical teeth over flat teeth.[8] This preference was attributed to the esthetic advantages and better denture stability. Likewise, a crossover study that compared LBBO with MO found a subjective patient preference for LBBO.[2] In the same study, the objective clinical assessment revealed that MO required a greater amount of time for clinical adjustment.[2] However, this difference was insignificant. A nonrandomized prospective study comparing LBBO and CBBO[11] found minimal subjective and objective differences. Instead, the alveolar bone level was found to be more correlated with masticatory performance.[11] After an objective comparison, the randomized prospective study by Matsumaru[13] found that LBBO was more efficient in terms of mastication and preservation of intercuspal position for patients with severe alveolar bone resorption. However, the same study found no differences between LBBO and CBBO for patients with less severe alveolar bone resorption.[13] Two crossover studies that assessed the difference between LBBO, CBBO, and MO found that the use of anatomical teeth in LBBO or CBBO was subjectively superior to the use of flat teeth in MO.[9,10]

In relation to tooth guidance, three studies compared ATGO with CBBO,[6,12,14] and one compared canine guidance with LBBO.[7] The crossover study by Peroz et al[12] found that dentures with anterior tooth guidance are subjectively more satisfying to patients than those with CBBO in relation to esthetics, mandibular denture retention, and chewing ability. Objective clinical assessments revealed that complete dentures with ATGO showed less stable maxillary dentures and more stable mandibular dentures.[12] The crossover study by Farias Neto et al[6] found a minimal difference between ATGO and CBBO in relation to the objective masticatory efficiency test. After comparing LBBO and ATGO, Heydecke et al[7] found that subjective assessments revealed a patient preference for complete dentures with ATGO in relation to chewing tough food. However, the crossover study by Rehmann et al[14] showed the opposite outcome. They found that more patients preferred CBBO to ATGO immediately after insertion (first 2 weeks). However, the difference between the two lateral occlusal schemes tended to diminish over time.

Discussion

Although complete dentures are one of the most basic prosthodontic treatments, many important treatment variables have not been scientifically validated.[4] Today, complete denture treatment is faced with numerous challenges, including the scarcity of expertise regarding high-quality complete dentures, greater proportions of elderly patients with a significant need for advanced care, and lack of sound evidence supporting specific guidelines.[4] This review illustrates the limited evidence regarding the occlusal schemes for complete dentures. Although the included studies provide the best available evidence, they have multiple inherent limitations that place the results at a greater risk of bias. For example, the crossover trials cannot include a washout period, which may introduce a carry-over effect on patient responses. Further, the studies varied significantly in terms of design and evaluated parameters.

Posterior Tooth Morphology and Arrangement

In general, anatomical teeth are preferred over flat teeth in both subjective and objective assessments. Therefore, the null hypothesis that tooth form has no influence on denture success was rejected. According to patients' subjective evaluations, almost all included studies reported the superiority of anatomical teeth arranged in CBBO or LBBO in comparison to flat teeth arranged in MO. The study by Brewer et al[3] was the only exception. In that study, many patients did not recognize the difference in tooth morphology. After the researchers informed the patients regarding this issue, many of them preferred the flat teeth when given the choice. However, since this study was conducted over 40 years ago, the participant sample may not be representative of the current population. It is possible that today's patients have much higher treatment expectations and esthetic demands.

The rest of the studies comparing anatomical teeth to flat teeth confirmed the superiority of anatomical teeth.[2,8–10] The anatomical teeth were perceived to be superior due to their enhanced esthetics and their effect on masticatory ability.[2,8,10] Shetty[8] found that flat teeth arranged in MO were associated with a more prognathic mandibular appearance in 87.5% of patients. Other possible advantages of anatomical teeth were a reduction in cheek biting, speech improvement, and cleansability.[2] Although flat teeth are reported to enhance denture stability,[3] one study revealed that only 12.5% of patients noticed such a benefit.[8]

Interestingly, the preference for anatomical teeth over flat teeth may be caused purely by esthetics. A recent study found no difference in food comminution with or without significant posterior tooth wear.[15] This finding may reinforce the idea that patient preferences are more related to esthetics than function.

The objective assessments were generally limited in the included studies. There is a possibility that anatomical teeth arranged in balanced occlusion require less chairtime for clinical adjustments than flat teeth arranged in MO.[2] However, this assumption cannot be confirmed due to the lack of statistical differences. If such a difference exists, it may be related to the presence of cusp height, with contact points that facilitate occlusal adjustment in comparison with flat teeth, which exhibit contact surfaces. Sufficient cusp height allows for selective occlusal grinding to eliminate interferences.[1]

When comparing CBBO and LBBO, the included studies found no difference in the subjective evaluations[9–11,13]; therefore, the null hypothesis regarding posterior tooth arrangement was accepted. Likewise, the objective assessments revealed that these two posterior tooth arrangements required a similar number of clinical adjustments.[10,11] Kimoto et al[11] found that alveolar bone level influenced masticatory performance. This finding is supported by Matsumaru,[13] who found that LBBO is advantageous for patients with severe ridge resorption in terms of masticatory efficiency and preservation of intercuspal position. However, the same study found no such difference for patients with moderate resorption. These results are in accordance with other investigations showing that the alveolar bone level can influence the success and patient acceptance of complete dentures.[16,17]

Therefore, it appears that as long as the teeth are anatomical in shape, different posterior tooth arrangements for complete dentures are equally acceptable. LBBO is more advantageous than CBBO in cases of severe resorption. The discrepancy between the objective and subjective assessments of denture performance illustrates the importance of patient-related psychologic factors on the success of complete dentures.

Lateral Occlusal Guidance

Although balanced occlusion is considered mandatory for complete denture occlusion, this systematic review revealed four studies that used anterior tooth guidance.[6,7,12,14] Therefore, the null hypothesis regarding lateral occlusal guidance was accepted. Interestingly, none of the included studies provided compelling evidence of the superiority of balanced occlusion. One study revealed a possible subjective patient preference for ATGO. This preference was related to esthetics, mandibular retention,

Table 2 Summary of Included Studies Assessing the Effect of Posterior Tooth Occlusal Morphology and Arrangement

Study	Study design	No. of participants	Tooth form	Tooth arrangement	Follow-up
Brewer et al (1967)[3]	Crossover	25	Anatomical (cusp angle not specified) Flat	CBBO MO	Varied for each set of dentures (range: 1 d to 6 mo)
Clough et al (1983)[2]	Crossover	30	Anatomical maxillary (30 degrees) against flat mandibular Flat	LBBO MO	3 wk for each set of dentures
Shetty (1984)[8]	Crossover	40	Anatomical (cusp angle not specified) Flat	CBBO MO	6 mo for each set of dentures
Kimoto et al (2006)[11]	Nonrandomized prospective	14 14	Anatomical (20 degrees) Anatomical (20 degrees)	CBBO LBBO	2 mo
Sutton et al (2007)[10]	Crossover	45	Anatomical (33 degrees) Anatomical (33 degrees) Flat	CBBO LBBO MO	8 wk for each set of dentures
Sutton and McCord (2007)[9]	Crossover	45 (4 lost)	Anatomical (33 degrees) Anatomical (33 degrees) Flat	CBBO LBBO MO	8 wk for each set of dentures
Matsumaru (2010)[13]	Randomized prospective	11 11	Anatomical (33 degrees) Anatomical (33 degrees)	CBBO LBBO	3 mo

CBBO = conventional bilaterally balanced occlusion; LBBO = lingualized bilaterally balanced occlusion; MO = monoplane occlusion; VAS = visual analog scale; OHIP = Oral Health Impact Profile.

and chewing ability.[12] The objective clinical assessment also showed enhanced mandibular retention.[12] Heydecke et al[7] supported the idea that complete dentures with ATGO enhance chewing efficiency, especially for harder foods. Another study revealed no difference in chewing efficiency between the two schemes.[6] Rehmann et al[14] found that balanced occlusion may enhance patient adaptation in the early phase of denture insertion. The authors attributed this benefit to the enhanced stability of dentures with balanced occlusion.[14] Over time, however, this difference tended to diminish. Interestingly, the two studies[6,7] reporting the superiority of ATGO included the first premolar in the lateral occlusal guidance. Whether this accounts for the patient preference found in those studies is difficult to confirm. In addition, the differences between the studies could be related to the inevitable differences in the establishment of ATGO in terms of the steepness of guiding planes. None of the studies illustrated the steepness of anterior tooth guidance in protrusion and lateral excursion, which may influence denture stability and patient adaptation. These studies should be interpreted with caution because they were limited in sample size; further, one study suffered from a major withdrawal of participants.[12]

Assessment method	Main findings
Subjective (patient preference)	Significant preference for MO ▪ 2 patients preferred CBBO (8%); reasons for preference: esthetics and mastication ▪ 11 patients preferred MO (44%); reasons for preference: morphology, comfort, esthetics, mastication ▪ 10 patients had no preference (40%) ▪ 2 patients excluded (8%)
Subjective (chewing efficiency, speaking ability, esthetics, comfort) Objective (no. of adjustments required)	Significant preference for LBBO ▪ 20 patients preferred LBBO (66%); reasons for preference: esthetics, mastication, comfort, stability, speech ▪ 5 patients preferred MO (17%) ▪ 5 patients had no preference (17%) ▪ MO required more clinical adjustments than LBBO; insignificant difference
Subjective (chewing efficiency, esthetics, stability, comfort)	Significant preference for CBBO ▪ 5 patients had no preference (13%) ▪ 40 patients reported no chewing deficiencies with CBBO (100%) ▪ 35 patients reported chewing deficiencies with MO (88%) ▪ 5 patients reported improved stability with MO (13%) ▪ 20 patients were not concerned about esthetics (50%) ▪ 15 patients reported esthetic limitations of MO (38%) ▪ 35 patients reported a prognathic mandibular appearance (88%)
Subjective (VAS for satisfaction, chewing efficiency, stability, retention) Objective (no. of adjustments required and mastication test)	No significant difference between CBBO and LBBO in relation to satisfaction, chewing efficiency, stability, retention ▪ Height of the alveolar ridge was correlated with masticatory performance ▪ Slightly better but insignificant masticatory performance for CBBO ▪ Slightly fewer but insignificant number of clinical adjustments for CBBO
Subjective (VAS for satisfaction, chewing efficiency, speaking abilities, esthetics, retention) Objective (no. of adjustments required)	Significant preference for CBBO and LBBO ▪ Reasons for preference: esthetics, chewing efficiency, cleansability ▪ Similar stability and speaking ability ▪ Insignificant difference in number of denture adjustments ▪ 4 patients excluded
Subjective (OHIP questionnaire)	Significant preference for CBBO and LBBO ▪ Reasons for preference: less painful, fewer sore spots, better ability to eat, less interruption during meals than MO ▪ Insignificant difference between CBBO and LBBO ▪ 4 patients excluded
Objective (maximum occlusal force, masticatory performance, mandibular movements)	Better masticatory efficiency and preservation of intercuspal position for LBBO than CBBO for patients with severe alveolar ridge resorption ▪ No significant difference for patients with average alveolar ridge resorption ▪ No significant difference in lateral deviation from intercuspal position, occlusal force, or chewing cycle time between CBBO and LBBO

Based on the included studies, it appears that the benefits of balanced occlusal contacts have been overrated in the literature and still lack compelling supporting evidence. This is further reinforced by the argument that balanced occlusion is lost as soon as a bolus is masticated.[1,4] Some clinical observations have shown that balanced occlusion is lost within a relatively short period of time without the patient noticing any difference.[18,19] Therefore, it could be assumed that balanced occlusion is beneficial immediately after denture insertion but loses this advantage over the long term.

The difference between the subjective and objective assessments illustrates the impact of esthetics on denture acceptance. It is possible that many patients prefer ATGO because it allows for a more esthetic appearance. It seems that the effects of lateral occlusal guidance have been exaggerated and the available clinical trials failed to identify the superiority of any lateral occlusal scheme. Therefore, even though the objective assessments were inconclusive, patient acceptance of complete dentures with ATGO may be related to superior esthetics and the patient's improved perception of the overall treatment. This topic clearly needs further investigation.

Table 3 Summary of Included Studies Assessing the Effect of Lateral Occlusal Guidance

Study	Study design	No. of participants	Lateral occlusal guidance	Follow-up	Assessment method
Peroz et al (2003)[12]	Crossover	22	CBBO ATGO (up to first premolar)	3 mo for each set of dentures	Subjective (VAS for chewing efficiency, speaking ability, esthetics, retention) Objective (retention)
Heydecke et al (2007)[7]	Crossover	20	LBBO ATGO (up to first premolar)	3 mo for each set of dentures	Subjective (chewing efficiency)
Rehmann et al (2008)[14]	Crossover	38	CBBO ATGO	Alternating the dentures each day for up to 4 wk	Subjective (patient preference)
Farias Neto et al (2010)[6]	Crossover	24	CBBO ATGO	3 mo for each set of dentures	Objective (masticatory efficiency)

CBBO = conventional bilaterally balanced occlusion; LBBO = lingualized bilaterally balanced occlusion; ATGO = anterior tooth–guided occlusion; VAS = visual analog scale.

Conclusions

Within the limitations of this systematic review, the following conclusions can be drawn:

- The use of anatomical teeth in CBBO or LBBO is equally acceptable to patients in relation to masticatory ability, esthetics, comfort, and speech. There is some evidence that LBBO is beneficial for patients with severely resorbed ridges in terms of mastication and stability.
- ATGO can be cautiously considered as an option for lateral occlusal guidance of complete dentures; however, clear clinical and technical guidelines are still needed.
- Esthetic factors may affect patient perceptions of the occlusal scheme.

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	Main findings
	Preference for ATGO ▪ Reasons for preference: esthetics, mandibular denture retention, chewing ability ▪ Objective assessment revealed that ATGO for maxillary dentures led to more frequent loss of retention; mandibular denture was more stable ▪ 3 patients lost to follow-up
	Significant preference for ATGO ▪ 10 patients preferred ATGO; reasons for preference: chewing ability, especially for hard food (50%) ▪ 5 patients preferred LBBO (25%) ▪ 5 patients had no preference (25%)
	Significantly better adaptation and less rocking movement with CBBO; difference diminished over time After 2 wk: ▪ 24 patients preferred CBBO (63%) ▪ 2 patients preferred ATGO (5%) ▪ 12 patients had no preference (32%) After 4 wk: ▪ 18 patients preferred CBBO (47%) ▪ 4 patients preferred ATGO (11%) ▪ 16 patients had no preference (42%)
	No significant difference between CBBO and ATGO ▪ 3 patients excluded

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