

Complete Denture Occlusion: Best Evidence Consensus Statement

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Abstract

Purpose: The occlusal scheme required for an edentulous patient is controversial. The purpose of this Best Evidence Consensus Statement was to evaluate the existing complete denture literature related to occlusal schemes.

Materials and Methods: A literature search was limited to Meta-analyses, Systematic Reviews (SR), Randomized Controlled Studies (RCT) and Clinical Trials. Key Words were: Complete dentures, occlusion, harm; Complete dentures, occlusion alveolar bone loss; Complete dentures, occlusion, stability; Complete dentures, occlusion. Additional related articles were culled from the authors' library and reference lists in the articles found in the PubMed searches.

Results: Of the 165 articles that met the initial search criteria, 34 related to the focus questions and were evaluated and rated.

Conclusions: There is strong support that the average denture patient, with good residual ridges and no neuromuscular problems, will function adequately with a properly fabricated complete denture regardless of the occlusal scheme. There is neither strong support for or against bilateral balanced occlusal schemes as it relates to patient satisfaction, preference or chewing ability. There is some support for increased alveolar bone loss with complete dentures that have a non-balanced occlusion. There is a need for bilateral balanced occlusal schemes for patients presenting with loss of stability and retention as a result of their presenting conditions (PDI III and IV).

The occlusal scheme required for an edentulous patient is controversial.¹ Occlusal schemes for the complete denture (CD) can be categorized into balanced or non-balanced. Examples of non-balanced occlusal schemes are: (1) Anterior Disclusion (AD) with Canine Guidance (CG) in medio-lateral movements, regardless of the cuspal configuration, and (2) Monoplane occlusion with no compensating curves or posterior balancing ramp. Examples of balanced occlusal schemes are: (1) Anatomic Occlusion (AO), (2) Lingualized Occlusion (LO), (3) Buccalized Occlusion (BO), and (4) Monoplane Occlusion (MO) with medio-lateral and antero-posterior compensating curves or posterior balancing ramp. The popularity of LO and BO has created confusion in terminology. Since the goal of the 4 balanced schemes is to achieve bilateral balance, calling a fully AO scheme bilateral balance (BB) creates undue misunderstandings for those reading scientific publications. The 9th Edition of the Glossary of Prosthodontic Terms defines the schemes for denture occlusion: *bilateral balanced articulation*: the bilateral, simultaneous posterior occlusal contact of teeth in maximal intercuspal position and eccentric positions; *anatomic occlusion*: an occlusal arrangement for dental prostheses wherein the posterior artificial teeth have masticatory

surfaces that closely resemble those of the natural healthy dentition and articulate with similar natural or artificial surfaces; *lingualized occlusion*: this form of denture occlusion articulates the maxillary lingual cusps with the mandibular occlusal surfaces in centric occlusion, working and nonworking mandibular positions; *monoplane*: an arrangement of denture teeth in a single plane that is medio-laterally and antero-posteriorly flat; *monoplane articulation*: the arrangement of teeth by which they are positioned in a flat plane; *monoplane occlusion*: an occlusal arrangement wherein the posterior teeth have masticatory surfaces that lack any cuspal height.² Buccalized occlusion is defined by Moradpoor et al³ as "articulation of the mandibular buccal cusps with the opposing maxillary occlusal surfaces while mandibular lingual cusps did not contact the maxillary teeth in centric or eccentric movements, with mandibular buccal cusp tips positioned against the mandibular ridge crest." The above commentary indicated the need for enhanced terminology relative to complete denture occlusion.

The biggest problem facing patients wearing complete dentures is the continual loss of alveolar bone, which was reported in a 25-year study by Tallgren.⁴ That study found that mandibular anterior ridge bone loss was, on average, 4 times

greater than in the maxilla, with the obvious consequence of the aging patient having more difficult treatment issues combined with a reduced ability to manage their CD. Additionally, the patient becomes the key variable. If a patient is a Prosthodontic Diagnostic Index (PDI) Class IV, as opposed to a Class I,⁵ the difficulty of the oral environment requires a more experienced clinician and the need for stability increases as the inherent retention of the denture decreases. A kinesiographic study of 30 denture wearers, whose denture bearing areas were quantitatively classified with the Kapur method, reported a reduction in jaw motion during mastication in participants with resorbed mandibular denture bearing areas.⁶ The purpose of this Best Evidence Consensus Statement was to evaluate the existing complete denture literature related to occlusal schemes.

Search strategy

The search was limited to Meta-analyses, Systematic Reviews (SR), Randomized Controlled Studies (RCT), and Clinical Trials. Complete dentures, occlusion, harm found 1 reference which was not related to the questions. Complete dentures, occlusion alveolar bone loss, found 7 references with 1 related to the question⁷ but not pertinent since bone levels were not studied. Complete dentures, occlusion, stability, found 24 references of which 7^{3,6,8–11} were related to the questions. Complete dentures, occlusion, found 105 references of which 20 were related to the questions,^{12–25} 3 of which had shown up in the previous search.^{2,8,10} Additional related articles were culled from the author's library and reference lists in the articles found in the PubMed searches.^{26–37}

Focus question 1: Does BB result in less alveolar bone loss?

Winter, Woelfel, and Igarashi²⁶ reported on a 5-year cephalometric study of 45 edentulous men and women for whom new dentures were made with either AO, semi anatomic or MO teeth, with all patients fulfilling the full 5-year inclusion criteria. The AO group had significantly less resorption than the MO occlusal group with the semi anatomic group in the middle, which could suggest a treatment dependent gradient. The authors felt this might be because the anatomic teeth gave a more well defined maximum intercuspal position, which may have resulted in less denture movement. (Personal communication – Dr. Julien Woelfel). No other study has corroborated or contradicted these findings. This study did not show up in the PubMed searches, or in any of the Systematic Reviews.

Evidence-based conclusion

Based on the aforementioned study, AO results in less alveolar bone loss than MO.

Focus question 2: Does BB result in more patient satisfaction?

A study of 22 patients that compared dentures fabricated by dental students with BB or CG concluded that “bilateral balancing is not the only occlusal principle suited to setting up

complete dentures.” The authors did diagnose ridge atrophy, flabby tuberosities and retromolar pads, mucosal folds and tori but did not relate these findings in the data analysis. Only 14 patients, 9 with CG and 5 with BB completed the study. They did report that CG dentures produced more denture ulcerations than BB. In addition, the retention of the BB maxillary dentures was significantly better than CG and 7 CG dentures lost retention during laterotrusive or protrusive movements as opposed to 3 for the BB. However, CG mandibular dentures were more stable during eccentric movements than the BB dentures.¹²

Kimoto *et al*¹⁰ in a pilot study of 30 patients who received either BB or LO reported no effects on the patients' general satisfaction, ability to masticate, or stability of their dentures. The LO patients did express greater satisfaction with their denture retention than patients wearing complete dentures with BB. Seven clinicians participated and treated 2 LO and 2 BBO patients. Protrusive balanced contacts for BB and LO were fully described.

Sutton *et al*¹³ in a study of 45 patients for which each participant received 3 sets of complete dentures with a different posterior occlusal form (MO, AO, and LO) each worn for 8 weeks in a randomized order, with data collected using a shortened version the Oral Health Impact Profile for Edentulous Patients (OHIP-EDENT) concluded that participants preferred posterior occlusal schemes with anatomic and LO, compared with monoplane teeth. The same authors, utilizing the same patient base as the previous article, concluded that LO was significantly superior in terms of reduced pain in the mouth, reduced incidence of sore spots, ability to eat, and meal interruptions, compared to MO, with no significant differences between LO and AO.¹⁴

A crossover single blinded study of 38 edentulous patients who received a new maxillary CD and one of 2 identical mandibular CDs, one having BB and the other CG, was performed with patient satisfaction as the outcome. The patients' satisfaction was evaluated 2 weeks post insertion and the occlusal scheme was changed without informing the patient. A reevaluation of the patients' satisfaction was assessed 2 weeks later. After 2 weeks, 63% of the patients preferred BB and 5% CG. After 4 weeks, 47% preferred BB and 11% CG with the remainder at each period having no preference. The authors concluded that BB facilitated adaptation to a new CD.²⁷

Paleari *et al*¹⁵ in a well-designed cross-over study, prognostically stratified RCT of 44 patients who were defined as within PDI Class I parameters, reported that the occlusal scheme, BB or CG, did not influence participants satisfaction or their kinesiographic parameters.

Schierz and Reissmann¹⁶ in a single-blinded cross-over RCT, evaluated the participants quality of life utilizing a shortened version of the OHIP-EDENT for complete denture patients with BB and CG occlusal schemes fabricated by postgraduate dental students. Nineteen patients were blinded to the occlusal scheme they were receiving. All CDs were made in BB and changed to CG by adding composite resin to the palatal aspect of the maxillary canines using a 55° lateral incisal guide angle. Four of the patients dropped out, 2 of them with the initial CG cohort and 2 from the BB cohort. The authors concluded that the new CDs decreased problems with existing CDs but

found no significant differences between the occlusal schemes studied.

Kawai *et al*⁷ in another randomized double-blind study, stratified by the PDI edentulous classification, reported no differences between LO and BB at the 3- and 6-month postinsertion examination. However, at the 6-month follow up, ratings of satisfaction for the BB mandibular dentures by patients with severe bone resorption were lower, and ratings of pain were higher, than those with LO dentures. Since the LO cohort had teeth fabricated from a hard acrylic resin and the BB cohort had teeth fabricated from porcelain, it would be difficult to determine which variable was responsible, independently or in conjunction, for the outcome.

Moradpoor *et al*³ reported on the patient satisfaction of 86 patients who received CDs performed by dental students with either AO, LO or BO occlusion. Exclusion criteria were well defined, and included severe Class II and III relationships as well as severe ridge resorption. The outcome assessment was a 19-item shortened version of the OHIP-EDENT questionnaire. The only difference reported was for physical pain, which was higher for the AO cohort.

Moradpoor *et al*¹⁷ in the second part of their study reported on a new cohort of 30 patients restored with “partially group function occlusion” (PGFO), which is a variation of CG in which the first premolars are also in contact in lateral excursion. They found that participants reported less satisfaction in terms of comfort, stability, and retention of their denture with PGFO compared to balanced groups; higher physical pain score for the PGFO group compared to BO and LO; and a higher physical disability score for PGFO compared to LO.

Brandt *et al*¹⁸ performed an RCT crossover study to compare BB and CG in 50 patients who started with well-fitting complete dentures in BB at the baseline examination. Patients, with the usual exclusion criteria, were randomized into two groups (BB>CG and CG>BB) with the occlusal scheme switched at the 3-month interval. Dental students fabricated the CDs and only 40 participants, a 20% drop out rate, were analyzed at the conclusion. The authors reported significant differences between the 2 groups with patients preferring the CG dentures with respect to esthetics, phonetics, masticatory efficiency and retention. No mention was made of the demographics of the dropouts, PDI or Kapur classification, or how protrusive contacts were handled.

A clinical study of 15 patients who received 3 different sets of dentures, BB, LO and BO in a randomized order reported that after wearing each set for 6 weeks “with the caution of small sample size,” “BO can improve food avoidance and physical disability aspects of patient satisfaction with complete dentures.” The outcome measure was the Oral Health Impact Profile for Edentulous Patients (OHIP-EDENT). It is important to note that all three styles of occlusion were bilaterally balanced and that all clinical procedures were performed by dental students.⁸

Evidence-based conclusion

The literature presents scattered results with some supporting the concept of improved patient satisfaction with Balanced Occlusal Schemes with other literature concluding there is no dif-

ference between Balanced and Non-Balanced Occlusion for CDs in the patient populations studied.

Focus question 3: Does BB result in better chewing ability?

A crossover study,²⁰ with broad exclusion criteria, compared LO to PGFO for patients who were edentulous for an average of 16.3 years and reported that the occlusal scheme and method of fabrication did not influence perceived chewing ability. Four participants had severe, 11 moderate and 5 mild alveolar ridge resorption. The data were not evaluated by ridge condition. The authors reported that 6 CDs were unstable, with 2 also sliding laterally and that 12 of the CDs “had little retention and were easily dislodged.” The authors, using the same patient population, with patient ratings as the outcome, reported no difference for the occlusal schemes.¹¹

A double-blinded controlled crossover clinical trial of 24 edentulous patients, who wore CDs with BB or CP for 3 months with each occlusal scheme, reported no difference for masticatory efficiency or patient satisfaction between the occlusal schemes tested. CDs were performed by dental students and masticatory efficiency was evaluated by colorimetric bead analysis. The authors stated that additional RCTs are needed to “account for the influence of gender, mucosal resiliency and alveolar ridge height on masticatory efficiency.”²¹

A single-blinded study of 30 CD patients compared BB and LO, with all patients starting with a BB CD and after 3 months a LO CD. After each 3-month period, electromyographic EMG measurements of the anterior temporalis and masseter muscles were made while the participants were asked to chew on gum and peanuts. In addition, patient satisfaction was measured on a 1 to 5 analog scale. Patients’ satisfaction was higher for LO than BB. Complete dentures with LO demonstrated increased masticatory performance, maximum voluntary contraction, and decreased chewing time. There was no mention of the alveolar ridge morphology of the participants. A limitation of this study is that all patients received the BB CD first and the LO CD second and were blinded to the change, creating an Order Effect, which undermines the internal validity of the study. In addition, EMG activity may differ based on facial morphology.⁹

A study²⁸ comparing 2 CD occlusal schemes, BB and Neutrocentric, on 10 patients, reported no difference in the masticatory performance and maximum occlusal force between the cohorts. The patients were all PDI I or II and had dentures, fabricated by one experienced clinician, with high retention and stability scores (Kapur 6 minimum).

Evidence-based conclusion

The literature presents weak evidence that, in the patient populations studied, occlusal scheme did have an impact on the participants masticatory ability.

Systematic reviews

A Cochrane Review in 2008²⁹ on denture chewing surface designs in edentulous patients found only one article³⁰ that met the inclusion criteria. That 1983 cross-over study compared

LO and monoplanes teeth, and reported 29 patients preferred the LO denture, 5 the monoplanes denture with 5 having no preference.

A Systematic Review (SR)³¹ in 2013 reporting on 7 clinical trials that compared BB with CG concluded that “BB is not imperative for successful treatment with conventional CDs in average patients when masticatory function and patient satisfaction are considered as treatment outcomes.” In one of their references, Trapozzano,³² did not use CG as an occlusal scheme. He used 20° posterior teeth in both arrangements with the non-balanced arrangement finalized with the articulator locked in centric relation. Interestingly, 9 of the 12 patients tested in this cross-over study had a greater chewing efficiency with the BB occlusion. Eight subjects in this study had an unfavorable ridge type and form, and despite the fact that the BB was more efficient for all of them, 4 had no preference for either occlusal scheme. Another reference, Motwani,³³ using a methodology similar to Trapozzano, also did not use CG.

Another SR²² reported on 7 articles that met their inclusion criteria and analyzed the following occlusal schemes: “anatomic occlusion, balanced occlusion, canine guidance occlusion, lingualized occlusion, monoplanes occlusion, and bilateral-balanced and canine-guided design.” They were not able to analyze the data statistically due to the heterogeneity and bias of the studies. They reported that 3 of the 7 studies found LO with higher patient satisfaction, and stated that LO and BB could be used successfully for conventional CDs with high levels of patient satisfaction. As such, their conclusion that “The conventional prosthodontic wisdom that complete dentures require a balanced occlusal design is not supported by the literature,” seems questionable.

Abduo²² in an SR of 12 studies performed a qualitative assessment of the influence of 3 occlusal schemes in complete denture patients and reported that the use of anatomic teeth in BB or LO is equally acceptable to patients in relation to masticatory ability, esthetics, comfort, and speech. There was some evidence that LO could be beneficial for patients with severely resorbed ridges in terms of mastication and stability. They felt that patient preference was mainly due to the better esthetics of anatomic teeth. The authors did not report on PDI or Kapur classifications.

Klineberg *et al*²³ in an extensive review of occlusion for CDs, partial removable dentures and implants, reported on studies from 1966 to 2006. For CDs BB, LO and monoplanes arrangements were reviewed and LO occlusion was preferred. Early studies on CDs were observational and some of the citations were expert opinion. Interestingly, they cited Woelfel’s 1962 study but not the one he did with Winter in 1974.

Lemos *et al*²⁴ in an SR of 17 studies, compared BB with LO, CG, and monoplanes occlusion. The outcome assessments were patient satisfaction and quality of life, and masticatory performance and muscle activity. The authors concluded that BB did not perform better than other occlusal schemes and that LO was found to have positive effects in patient satisfaction and quality of life and was no different from BB in masticatory performance. CG dentures were found to be desirable in patients where a decreased muscle activity was required. The authors pointed out that the mean follow-up of the included studies was 2.96 months, with a range of 1 to 6 months, “which can be

considered short.” They did not report on PDI or Kapur classifications.

An SR to determine the difference between BB and CG found only 7 articles that matched the inclusion criteria. They felt that the majority were not randomized or blinded, “lacked an in-depth investigation of all of the relevant variables,” were rated “poor to moderate” and concluded that differences between occlusal schemes were small.²⁵ One of the articles they quoted was by Trapozzano, who did not use CG.³²

Evidence-based conclusions

The findings from Systematic Reviews present scattered results with some weak support for Balanced Occlusal Schemes in the populations studied. Systematic Reviews need not be limited to RCTs. Sackett³⁴ states, “Evidence-based medicine is not restricted to randomized trials and meta-analyses. It involves tracking down the best external evidence (from systematic reviews when they exist; otherwise from primary studies) with which to answer our clinical questions.” Evaluating the available evidence is more fruitful for the clinician looking for answers relative to the patient they are treating than saying we need more RCTs.

Consensus discussion

One aspect rarely reported on is the doctor-patient relationship. It has been suggested that patient satisfaction with a CD is equally, if not more, a function of the doctor-patient relationship, than a technically perfect denture.^{35–37} Balanced occlusion connotes that in addition to medio-lateral movements there is simultaneous contact of the anterior and posterior teeth as the patient moves into protrusion. This can be accomplished if the cusp height of the posterior teeth is in harmony with the incisal guidance. If the cusp height is too short or the cuspal incline is not steep enough to provide contacts in protrusive, a compensating curve or posterior balancing ramp would be needed. Balanced occlusion can be achieved with AO, LO and BO and is operator dependent. In an occlusal scheme with anterior guidance (AG) the posterior teeth would not be in contact in all eccentric movements. With CG, the assumption is that it is combined with AG, but this is not made clear in the studies cited. LO and BO may require a compensating curve to achieve balance in protrusive and again it is not clear in most of the studies how, and if, that was accomplished.

It is obvious from the literature that the average denture patient, with good residual ridges and no neuromuscular problems, will function adequately with a properly fabricated complete denture regardless of the occlusal scheme. Most of the studies had similar and strict exclusion criteria that do not represent the entire edentulous patient cohort. This is understandable in a research project conducted in a dental school and geared towards a general practice environment. The patients included in these studies may not be representative of the ones typically seen in a prosthodontist’s office. In addition, with one exception, all of the articles looked at short term outcomes related to quality of life and mastication, not alveolar bone loss or post treatment maintenance and complications including repairs, rebases or replacement. Vertical dimension is a

critical component in any occlusal scheme. Restoring lost vertical dimension in the totally edentulous patient is a common quandary for the clinician. There have been no studies on vertical dimension changes, relative to long term outcomes, in this patient population.

Ultimately, since *do no harm* is of paramount importance, the only research which does not suffer from chronology bias and reported on alveolar bone loss was Winter, Woelfel, and Igarashi's²⁶ publication.

Consensus conclusions

1. There is strong support that the average denture patient, with good residual ridges and no neuromuscular problems, will function adequately with a properly fabricated complete denture regardless of the occlusal scheme.
2. There is neither strong support for or against Bilateral Balanced Occlusal Schemes as it relates to patient satisfaction, preference or chewing ability in the aforementioned cohort of patients.
3. There is some support for increased alveolar bone loss with complete dentures that have a non-balanced occlusion.
4. The scattered results and lack of strong evidence in either direction lead the authors to believe that confounding variables are playing a role in study outcomes. As a result, additional well-defined clinical trials are needed that prognostically stratify the patient population (PDI Class), and provide longer follow-up for outcomes including complications, maintenance and other outcomes.
5. The authors' expert opinion collectively support the need for bilateral balanced occlusal schemes for patients presenting with loss of stability and retention as a result of their presenting conditions (PDI III and IV).

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