



Occlusion: A Contemporary Overview and Recommendations



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Dental occlusal concepts have developed over time, essentially by trial and error. Most have stood the test of observation, and more recently science has verified some of the viewed occlusal successes. The purpose of this article is to examine and distill, in an evidence-based manner, the commonalities that allow practitioners of one occlusal philosophy or another to achieve consistent success. Medline and the Cochrane Collaboration were used to procure relevant articles. (Int J Periodontics Restorative Dent 2015;35:775–782. doi: 10.11607/prd.2544)

Dental occlusion is defined by the *Glossary of Prosthodontic Terms* as “the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues.”¹ Decades ago, leaders in the profession (eg, McCollum, Mann, Pankey, Schuyler, Stallard, Stuart) gave dentistry guidelines for optimal occlusal schemes.² Most of these have stood the test of time and observation, and science has verified some of the viewed occlusal successes.³ Other occlusal schemes and concepts have also been proposed.⁴ Although the occlusal philosophies share some essential, fundamental commonalities, the reality is that if teeth never contact, what could possibly go wrong with a patient’s dentition? Is one occlusal philosophy, therefore, superior to another? Gibbs and Lundeen showed that maxillary and mandibular physiologic tooth contact is the exception rather than the rule.⁵ Teeth contact when chewing (only for a split second and only if the food bolus is penetrated) and when swallowing. These tooth contact events might occur a couple of thousand times a day and might add up to 10 to 15 minutes in total, with most contact being of the light variety. Therefore, success with occlusion and occlusal therapy (especially as related to restorative dentistry and prosthodontics)

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Fig 1 Full-coverage maxillary hard acrylic dental orthotic for protection of patient dentition during sleep. While the patient is awake, protection is obtained by keeping the teeth apart.⁶⁻¹⁰

ironically is optimized when patients keep their teeth apart during the waking hours and all discussions of occlusion, for the most part, become moot. Lack of daytime tooth contact is the critical piece of evidence that is the centerpiece to occlusal success, no matter which philosophy a practitioner chooses to espouse. On the other hand, sleep disorder bruxism and clenching, where interarch tooth contact while sleeping can be excessive, requires therapeutic adjuncts, such as dental hard acrylic full coverage orthotics, to be worn to prevent tooth wear or restorative/prosthetic misadventures (Fig 1).⁶⁻⁸ Furthermore, the effects of diurnal (waking) nonfunctional eccentric tooth contacts need to be addressed and mitigated as well with patient evaluation and education (re: habits, behavioral modification, medication sequelae, etc) and biomechanical (eg, mutually protected occlusion) strategies.^{2,4,9,10}

Gnathology

As dental occlusion refers to the static relationship of teeth, in reality the dental practitioner must take a gnathologic approach to oral care ("the science that treats the biology of the masticatory mechanism as a whole: that is, the morphology, anatomy, histology, physiology, pathology, and the therapeutics of the jaws or masticatory system and the teeth as they relate to the health of the whole body, including applicable diagnostic, therapeutic, and rehabilitation procedures").¹ Brill et al described four aspects of periodontal sensory appreciation as stereognosis (shapes), topognosis (localization of contacts), projection (tactile), and perception (brain interpretation).¹¹ Further studies have elicited that teeth with their accompanying periodontal receptors, whether freestanding or acting beneath overdentures, allow

patients greater discrimination of forces.¹² As for stereognosis, structures other than those in the periodontal ligament (eg, tooth form, lips, tongue, mucosa) are involved in the physiologic functioning of the stomatognathic system, which is of critical importance when implants and implant-borne prosthetics are considered.¹³ A practitioner, hence, needs to be cognizant of and allot for the neutral zone ("the potential space between the lips and cheeks on one side and the tongue on the other, that area or position where forces between the tongue and cheeks or lips are equal").^{1,14} The concept of thinking wax, whereby the alveolus is envisioned as consisting of wax instead of bone and a practitioner could readily position the dentition as wished similar to a removable prosthesis try-in, can aid the practitioner in establishing this element of physiologic harmony, or neutral zone.¹⁵

Fig 2a Afferent noxious sensory input into the central nervous system (CNS) via first order neurons synapse in the brain stem nucleus caudalis (NC) with second order neurons reaching the thalamus before tertiary neurons relay the input to the cortex for sensory (pain) discrimination. Efferent signaling and inflammatory mediator release also can occur via primary neurons (eg, sterile myositis in TMD conditions). Repeated application of noxious stimulation from any region generally increases sensitivity of peripheral receptors with concomitant threshold lowering and widening of receptive fields. PAG = periaqueductal gray; RN = red nucleus; LC = locus coeruleus; MRN = medullary raphe nuclei; RF = reticular formation; STN = subthalamic nucleus; NO = nucleus oralis; NI = nucleus interpolaris; NC = nucleus caudalis.

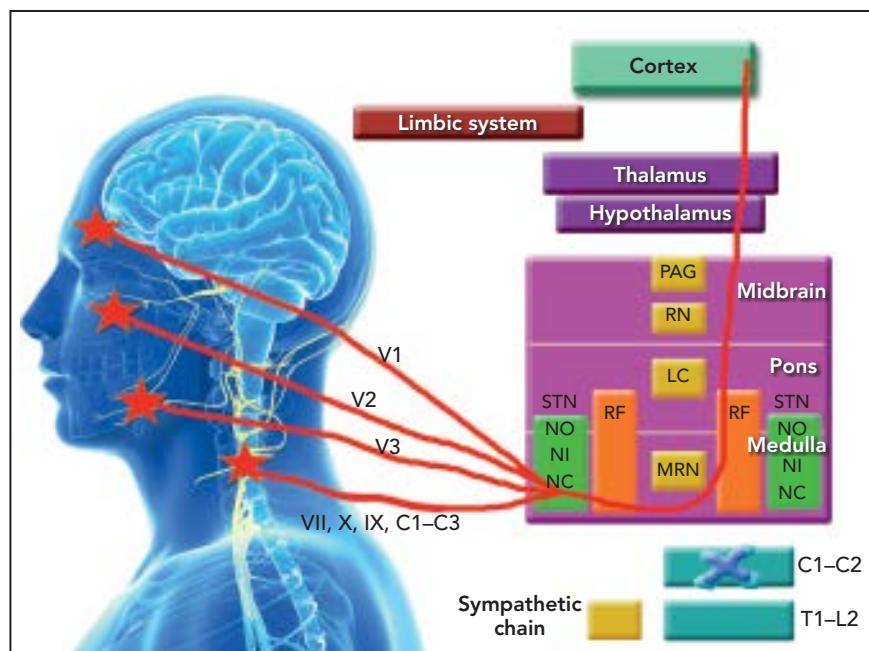
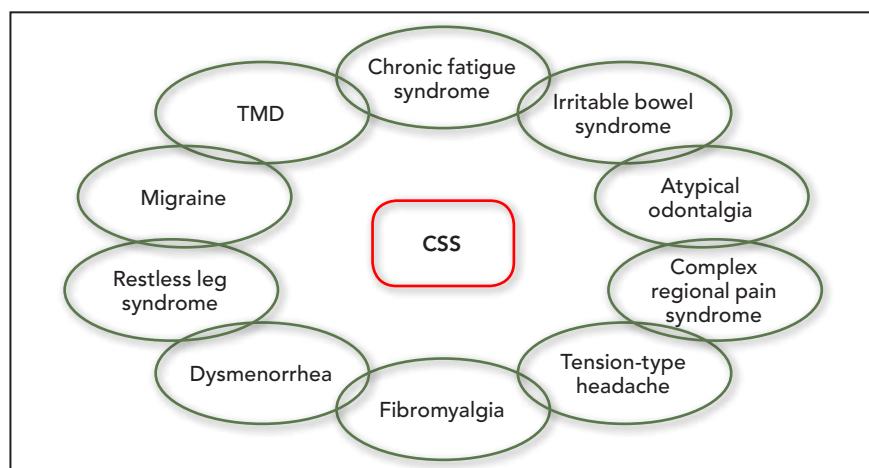


Fig 2b Increased response to stimulation mediated by amplification of signaling in the CNS (central sensitization [CSS]) is the common pathophysiologic mechanism of numerous pain conditions, with comorbidity frequent. It is prudent, therefore, for practitioners to take a "go low, go slow" approach when treating patients (eg, in restorative dentistry/prosthodontics), to minimize any aberrant input into the CNS and the stimulation or extension of any unwanted sequelae (ie, comorbid conditions).¹⁶⁻¹⁹



Central sensitization is another aspect of gnathologic care that is of day-to-day importance for the dental team. Central sensitization is loosely defined as an increased response to stimulation (eg, afferent input from the periphery [teeth]) that is mediated by amplification of signaling in the central nervous system. It is the common pathophysiologic

mechanism of numerous pain conditions, such as temporomandibular disorders (TMD), with frequent comorbidity (Figs 2a and 2b).¹⁶

Decreasing aberrant input from the stomatognathic system is no doubt beneficial for patients and directly or indirectly attenuates noxious input, for example, excessive tooth overload.¹⁷ Comorbid condi-

tions should also be noted by dental teams, and allowances made to mitigate untoward intraoral events and procedures to which these patients are more susceptible to adverse responses (Fig 2b).¹⁸ In other words, a "go low, go slow" approach to oral care is advised with ample preemptive analgesia (eg, nonsteroidal anti-inflammatory medications).¹⁹

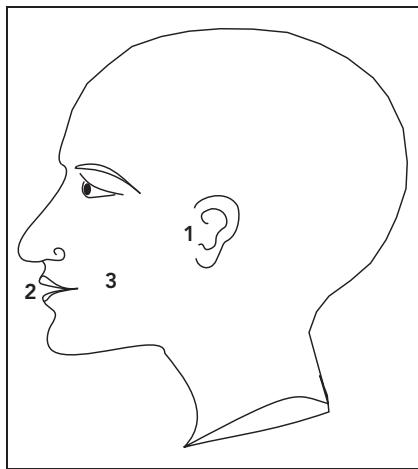


Fig 3 (left) *The 123s of Dentistry. The starting point, the anterior parameter, and the finishing touches.^{15,20}*

Fig 4 (below) *Establishing vertical dimension with direct composite in a simple manner for diagnostic evaluation.^{15,20,22}*



Occlusal design

Time and evidence-based methodology have distilled the various design concepts for occlusion (eg, centric relation occlusion, neuromuscular therapy) into practical, workable basic rules for daily application.^{1,4,15,17} Therefore, when a dental practitioner is considering rehabilitating or maintaining a dentition, sequential logical approaches are available to be followed, such as the 123s of Dentistry.²⁰ The 123s of Dentistry defines the starting point, the anterior parameter, and the finishing touches (Fig 3).

The 1 is the starting point. It is the relationship of the mandible to the maxilla, where occlusal therapy will be done. This point is not only the position of the condyle relative to the glenoid fossa, but also the vertical dimension of occlusion (VDO).¹ For the former, classic centric relation (ie, the mandibular condyle within the glenoid fossa)

is usually chosen, but some practitioners opt for a neuromuscular position (ie, a condylar glenoid fossa-articular eminence relationship).^{3,4} Practically speaking, the relationship of the mandibular condyle to the glenoid fossa and articular eminence is a consistently reproducible (CR) position.¹⁵ It is, after all, the consistency of this position that must be held throughout treatment and during the maintenance years. Therefore, the precision of the CR position is more important than the actual position, as noted by Celenza.²¹ Practitioners routinely and successfully treat in a CR position that they prefer and not necessarily in a vogue CR position (ie, a trendy, highly promoted and marketed condylar-glenoid fossa concept). Stated differently, practitioners will rely on a CR that works for them. The other concept that needs to be clarified is VDO, "the distance measured between two points when the occluding mem-

bers are in contact."¹ In general, it is practical for practitioners to plan occlusal therapy at the patient's existing VDO. However, when situations such as reduced lower facial height, deep overbites, or reduced posterior or crown height arise, clearly indicating that opening of the VDO would be beneficial, modest increases should be entertained and a significant provisional or prototype phase should be planned (validating free-way space accommodation and stabilization).^{1,2,22} If orthotics will not be used to facilitate VDO changes, provisional restorations for this phase can be created from diagnostic wax-ups, or direct composite restorations can be employed, for example, bonded to the occlusal surfaces of existing restorations (Fig 4).

Once the starting position, or CR, is established, the anterior parameter, or 2, is set for speech and esthetics.²³ Tools such as cephalometrics can be employed, for example, via McNamara Plane utilization

Fig 5 Cephalometrics allow practitioners to analyze tooth relationships, especially incisor position, and assess accuracy of position. Useful guides such as the McNamara Plane (a perpendicular plumb line to Frankfort Horizontal at nasion) can be employed quickly and effortlessly. Maxillary central incisors are preferably on the line or slightly anterior, while the mandibular incisors are slightly posterior.^{15,20}

Fig 6 The envelope of motion and function.²⁴ The envelope of motion defines the borders of mandibular movement while the envelope of function defines the functional region during mastication and phonation (green region). Respect for the envelope of function minimizes fremitus and optimizes stomatognathic physiologic harmony.

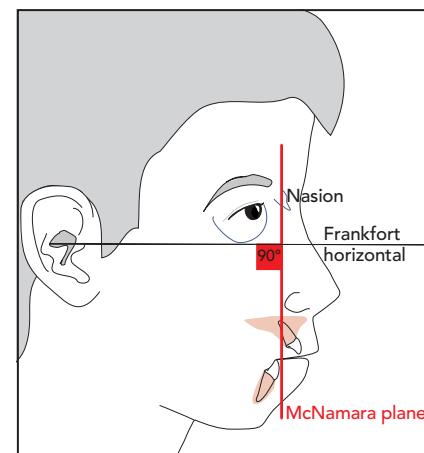


Fig 7 (left) A stabilized 1 position (flat plane lingualized occlusal scheme) and provisionalization phase for the anterior teeth. (right) Finalization of the posterior dentition, or 3 (buccalized occlusal scheme).^{14,15,20,22}

(Fig 5).^{15,20} The McNamara Plane is a plumb line from the nasion in which the maxillary central incisors are preferably on the line or anterior, and the mandibular incisors are on the line or slightly posterior. The distilled message with central incisor positioning is that the dental team should be respectful of the envelope of function and minimize fremitus (Fig 6).^{1,24}

Central incisors also are to be esthetically pleasing in repose, in normal conversation, and in laughter, and must function properly during speech and chewing.^{5,23} The anterior parameter, therefore, con-

cerns itself primarily with achieving incisor positioning, especially the position of the incisal edges of the central incisors, that is comfortable for the patient and esthetically unobtrusive. The 2 is completed with smile design, when all the anterior teeth are added in, and it also preferentially provides for a cuspid/incisor protected occlusion.^{1,2,23}

The 3, or the finishing touches, details the posterior occlusion in harmony with the average posterior determinants of occlusion (ie, progressive side shift 7.5 degrees, immediate side shift 1.5 mm, protrusive

25 degrees) and protects the anterior dentition.^{1,5} Exquisite tooth anatomy is the result. Occlusal planes with minimal or little Curve of Spee that are parallel to the horizon and sharp crisp anatomy that is easy to equilibrate and that maximizes function are desired. All the while, CR and the established occlusal vertical dimension (1) are honored (Fig 7).

Following the 123s of Dentistry in occlusal planning and therapy results in a mutually protected occlusion for the natural dentition. This relationship should be as equalized and stress-free as possible at



Fig 8 Occlusal equilibration before (left) and after (right). Note the buccalization of the occlusal scheme.^{1,15,17,24,25}

an acceptable VDO.^{1,22} It is generally accepted that the goals are to obtain even intensity with axially directed posterior contacts when vertical pressure is applied, and to allow for ease of movement with horizontal excursions via the anterior teeth most capable of enduring the load.^{1,2,15,25} One contact per posterior tooth provides adequate support, either buccalizing or linguinalizing the occlusion with a cusp tip occluding a flat plane, preferably in the central fossa of the opposing tooth (Fig 8).^{1,15,17,25,26} With vertical loading, molars and premolars take the majority of the burden, with light or no contact and fremitus relief for the anterior teeth.^{5,24–26} With horizontal loading and function, working-side canines are usually best suited in lateral excursions, and central incisors in protrusive function, although anterior group function in these movements is commonly employed (premolars if

anterior teeth are weak or unavailable).^{1,2} Nonworking contacts are to be avoided.²⁷ Ideally, an equipoised occlusion is in harmony with the temporomandibular joints, providing for optimal orthopedic stability.^{1,4,5,15,25} This occurs naturally only a small percentage of the time, but it is the objective when extensive oral rehabilitation is required (CR).²⁸ In function, such as mastication, allotment should be made for mandibular range of motion that is noninterfering; the so-called envelope of function should be respected (Fig 6).^{1,24}

Several proposals for occlusal restoration for prosthetics, dental implant-supported or not, have been advanced in the literature. Generally, the rules for the natural dentition are followed with a few added considerations.²⁹ Narrowing the occlusal table, prosthetic splinting, and cantilever minimization are entertained, as is an implant-

protected occlusion for segmental implant restorations/prostheses.^{30,31} With an implant-protected occlusion, the natural teeth, not the implant-borne restorations/prostheses, hold thin shim stock (8 µm) on light biting pressure in maximum intercuspal position.³⁰ Under heavy occlusal forces, the implant-borne restorations/prosthetics and the natural teeth hold shim stock equally. In lateral excursions, the same rules apply: the natural teeth hold shim stock on light contact, and under heavy occlusal forces both the implant-borne restorations/prostheses and natural teeth hold shim stock equally. As for the posterior occlusal anatomy, when immediate anterior disclusion is present it is recommended that the design at least follow the average posterior determinants of occlusion (ie, progressive side shift 7.5 degrees, immediate side shift 1.5 mm, protrusive 25 degrees) with a fossa depth of at least

Table 1 Occlusal design recommendations

1. Patients are educated regarding minimizing tooth contact.
2. Patients are educated regarding orthotic use while sleeping, especially for bruxers.
3. Maxillary/mandibular relationship is consistently reproducible at an acceptable vertical dimension of occlusion, minimizing overbite.
4. Envelope of function is respected (ie, fremitus free).
5. Neutral zone is allotted for.
6. Tooth anatomy is physiologic (sharp, crisp).
7. Occlusal schemes are implant protected when indicated.
8. Mutually protected occlusions are developed for all cases (natural dentition, fixed or removable prostheses, implant related) with posterior contacts linguinalized or buccalized.



Fig 9 Anatomic, physiologic occlusion can be optimized regardless of materials used or supporting structures (molars: implant/crowns; premolars: crowns; anteriors: laminates).

one-quarter the depth of the clinical crown height.^{1,5,20,25,26,29} As shown by Gibbs and Lundein, chewing programming and masticatory efficiency are optimized when the occlusal anatomical scheme is sharp rather than flat; therefore, an occlusal anatomical scheme that follows gnathological principles for the natural dentition should be entertained for all patients (restoratively/prosthetically rehabilitated [implant borne or not, fixed or removable], bruxers/clenchers or not).^{5,29} For segmental implant-borne restorations/prostheses, the intaglio of full-coverage hard acrylic orthotics require relief about these devices due to lack of mobility when loaded.⁶

Concluding remarks and recommendations

When embarking on occlusal therapy for patients, the dental prac-

tioner must appreciate that the endpoints are the static relationship of the opposing arches and that the destructive parafunctional bruxing and clenching forces must be considered in the design. Hence, a mutually protected occlusal design in a CR mandibular position at an acceptable VDO (which minimizes overbite) stabilizes the stomatognathic system when teeth are in contact. Patients are encouraged to keep their teeth apart during waking hours and wear hard acrylic full coverage dental orthotics while sleeping; tooth and restorative/prosthetic material wear is thus minimized and practitioner/patient material choices become more varied and creative. For segmental implant-related cases, an implant-protected occlusal scheme is devised. Basic occlusal contact schemes, regardless of the dental discipline or materials employed, are kept simple and efficient via

buccalizing or linguinalizing the occlusion. Anterior fremitus is always eliminated (Table 1 and Fig 9).

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