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Occlusal Vertical Dimension: Best Evidence Consensus Statement

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Keywords
Rest vertical dimension; occlusal vertical dimension; inter occlusal distance; freeway space; changes; aging; restoration.

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Accepted September 27, 2020

doi: 10.1111/jopr.13315

Abstract

Purpose: Patients in need of extensive prosthodontic treatment may need restoration of their occlusal vertical dimension (OVD) due to tooth wear, tooth loss, or changes that have occurred to existing prostheses over time. Prosthodontic treatment is based on the clinical application of the available evidence regarding interocclusal distance (IOD), the positional stability of rest vertical dimension (RVD), and the effect of altering the OVD. Hence, the purpose of this consensus document is to examine available data related to IOD, RVD, and alteration of the OVD.

Materials and Methods: The search was limited to Clinical trials, Randomized Controlled Trials, Systematic Reviews and Meta-analyses. Key words were *healthy patient, mean, range, interocclusal rest distance*; *healthy patient, mean, range, freeway space*; and *dentistry, interocclusal gap*, and no citations appeared. *Dentistry, interocclusal distance*, revealed 5 not relevant citations. *Dentistry, inter occlusal rest space*, and *dentistry, interocclusal rest distance*, both had the same single not relevant citation. *Dentistry, freeway space* revealed over 7,000 citations. *Dentistry, occlusal vertical dimension*, revealed 253 citations, 7 of which were related to the search question but only 1 which was different from the previous search. *Mandible, rest vertical dimension*, *age changes*, found 7 citations, none relative to the question. Expanding the search to include *journal article* found 260 citations with only one relevant to the question. *Mandible, rest vertical dimension, alteration, harm* revealed no citations; *mandible, occlusal vertical dimension, alteration*, revealed 15 citations, 1 of which was relevant; *mandible, occlusal vertical dimension, changes*, revealed 75 citations, none of which were relevant; *mandible, occlusal vertical dimension, rehabilitation* revealed 10 citations, none of which were relevant. Expanding the search strategy to include *Journal article*, *mandible, occlusal vertical dimension*, *alteration*, received 159 citations, 4 of which were relevant; *mandible, occlusal vertical dimension, restoration* revealed 208 citations, 1 of which was relevant. Numerous other articles were culled by going through the reference lists of the aforementioned articles.

Results: For IOD, 27 articles were found relevant to the search question, which confirmed a mean of 3.0 mm with ranges from 1 to 9 mm. Five articles revealed little evidence as to whether the RVD changes during life. For OVD, 20 articles, including 4 systematic reviews, revealed some evidence that skeletal growth continues from mid adolescence into mid adulthood; strong anecdotal evidence that some unopposed teeth will continue to erupt; no clinical evidence to support the concept that abraded teeth in occlusion in a patient with bruxism will undergo continuous eruption; and some evidence from clinical case reports that restoring OVD in patients with severe abrasion is a successful treatment.

Conclusions: There is a range of dimensions for the interocclusal distance (IOD) with many normal dental patients functioning with a higher or lower IOD than the commonly used 3.0 mm average dimension. The resting vertical dimension (RVD) is a 3-dimensional range with little evidence related to changes in the RVD during life. However, aging can cause a decrease in muscle tone which could affect the RVD. The restoration of the OVD can be successfully accomplished if proper diagnosis and treatment planning are performed.

Patients in need of extensive prosthodontic treatment may need restoration of their occlusal vertical dimension (OVD) due to tooth wear, tooth loss, or changes that have occurred to existing prostheses over time. The process of altering the OVD is not an exact science and it is best described as treatment based on clinical assessment of facial and dental esthetics along with dimensional guidance provided by the dental literature. Use of this guidance requires understanding the numerical difference between the rest vertical dimension (RVD) and the OVD, a distance known as the interocclusal distance (IOD). Prosthodontic treatment is based on the clinical application of the available evidence regarding (IOD), the positional stability of rest RVD, and the effect of altering the OVD. Hence, the purpose of this consensus document is to examine available data related to IOD, RVD, and alteration of the OVD.

Focus question 1: In a healthy patient, what is the mean and range for the interocclusal distance?

The following terms have been used for the vertical distance between the intercuspal position and the rest vertical dimension: the freeway space; the interocclusal rest distance; interocclusal distance, interocclusal clearance; interocclusal gap; and the interocclusal rest space. The 9th Edition of the Glossary of Prosthodontic Terms has listed interocclusal distance, interocclusal rest space and interocclusal rest distance as accepted terms.[1]

For this Best Evidence Consensus Statement the authors have chosen to use the term "interocclusal distance" (IOD) and eliminate the word "rest" since Rugh and Drago, using a kinesiograph, found that the vertical dimension of minimal muscle activity ranged from 4.5 to 12.6 mm with an average of 8.6 mm and was never found to be at or near the clinical rest position.[2]

Search strategy

The following searches were performed: *healthy patient, mean, range, interocclusal rest distance*; *healthy patient, mean, range, freeway space*; and *dentistry, interocclusal gap*, and no citations appeared. *Dentistry, interocclusal distance*, revealed 5 not relevant citations. *Dentistry, inter occlusal rest space*, and *dentistry, interocclusal rest distance*, both returned the same single irrelevant citation. *Dentistry, freeway space* revealed over 7,000 citations. Limiting the search to Clinical trials, Randomized Controlled Trials, Systematic Reviews and Meta Analyses revealed 255 citations, 12 of which were related to the question.[3–14] *Dentistry, occlusal vertical dimension*, with the same filters, revealed 253 citations, 7 of which were related to the search question but only 1 which was different from the previous search.[15] Numerous other articles were culled by going through the reference lists of the aforementioned articles.[16–28]

The seminal work on IOD was performed by Niswonger [16] in 1934 who reported that 4/32nd of an inch (~3.0 mm) was recorded for 87% of 100 subjects with natural teeth, with a range from 1/32 to 11/32nd of an inch. It was also 4/32nd of an inch for 83% of 100 subjects with worn natural teeth, with a range from 1/32 to 7/32nd of an inch. This measurement was recorded between a dot on the middle of the chin and another where the philtrum meets the nasal septum and reported as the mode, not the mean. If the data were reported using the mean, that average would have been affected by the number of subjects who were outliers, especially the ones close to, or at, 11/32 inch, and most likely would have revealed a larger number. Since then the 3.0 mm IOD has been an accepted standard.

One of the problems in most of the subsequent studies on IOD is the tendency to report the mean (average) and not the median, which is the true midpoint or even the mode, which is the number that occurs most often in the data set. If the mean and median are similar then the data distribution is homogeneous. Outliers affect the mean, but not the median. In addition, the tendency of statisticians to eliminate outliers so the data falls into a more homogenous data set is a controversial issue for biomedical studies. If there is a significant spread to the data, the median is a better indicator of central tendency and is the standard in medical studies.[29–31] Additional variables that make comparisons among the studies difficult is the lack of consensus on how to achieve the rest vertical dimension, and how and where to measure it.[17,18,22,23]

Tingey et al[17] used electromyographic recordings of 24 young male subjects (age range 23-35) with intact healthy dentitions at 4 independent postural positions "based on minimal electromyographic and verbal instructions to swallow, lick the lips and say 'Mississippi.'" They reported medians of 2.3 to 5.6 mm depending on the postural position. What is important to note is that each subject had a rigid body attached to the mandibular incisors to help track mandibular movement. Babu et al[8] in a study of 20 dentulous and 20 edentulous subjects compared the RVD utilizing phonetics and swallowing to that determined by electromyographic methods and found that differences were not statistically different. They did find that determining the RVD in subjects with dentures was more accurate than in patients without their dentures. The authors used the mean of the three readings to determine the RVD. By only utilizing the average of those three readings it eliminated incorporating the range of the readings which would have been helpful. In addition, the electromyographic recordings were obtained with the usual facial recording devices attached.

Burnett,[20] in a comprehensive study of 60 healthy young individuals and 30 subjects with severe tooth wear, reported a 1.8 mm mean, range 0.5 to 9.0 mm, for the normal cohort and 1.7 mm, range 0.7 to 2.7 mm, for the tooth wear cohort. An electromagnetic device was used to track movement, but the author was unclear exactly where the measurements were made from. Preiskel,[22] using electromyographic recordings reported a mean of 3.1 mm when the subjects head was positioned horizontally, 2.7 mm with the head down and 4.2 mm with the head up. Gillings[25] reported a mean of 2.5 mm with a range from 1.0 to 6.0 mm when using a photoelectric mandibulograph. The opening was measured at the incisor teeth after the subjects were instructed to swallow and then relax their jaw muscles.

A cephalometric radiograph study on 75 dental students at the University of Helsinki, reported a 2.7 mm mean, with a range from 0.8 to 7.2 mm, on measurements made from radiographic images of lead pellets located at the canine areas of the maxilla and mandible.[26] Another study on 100 subjects,

using four measurement techniques, including radiographs, reported a 3.07 to 3.67 mm IOD with those measurements being in the premolar and molar areas and concluded that the IOD is never absolutely static.[27] Swerdlow,[19] in another study using cephalometric radiographs, with measurements taken from nasion to menton, reported a 3.7 mm mean distance as determined by phonetics and a 2.6 mm mean as determined by swallowing. The interocclusal distance ranged from 1.0 to 9.5 mm.

The included references show no consistency in how and where the measurements were made. They all included ranges of some substance and are difficult to compare. While sophisticated methods are available to track and record the mandibular position, when the patient returns home and is chewing, reclining, walking, sleeping, etc., it would be difficult to relate those numbers to what is clinically relevant.

There are numerous techniques that clinicians utilize in establishing the RVD and from that reduce 3.0 mm to achieve the OVD for the occlusal rehabilitation. Unlike centric relation, RVD is considered a 3-dimensional (3D) range, affected by a number of factors.[19–22,24,28] At a typical trial placement appointment the standard approach is verification of the OVD and RVD by evaluating the esthetics and phonetics. Phonetics is also affected by the horizontal and vertical overlap of the incisors, the arch form as well as possible tongue and neurologic issues. Esthetics is a multi-factorial olio. Is the lower third of the face, measured between the nasion and the gonion, a realistic ideal for every patient? The clinician ends up with a rigid adherence to a "Mean" 3.0 mm space dictated by an artistically arrived at RVD. The conundrum, as concluded by Turrell, in his classic article, is "When no accurate pre-extraction records exist, the dentist must rely upon esthetic appearance supplemented by aids which are often misleading."

Evidence-based conclusion

It appears that Niswonger's classic work has been validated by subsequent studies and that an average fully dentate patient will have an IOD of around 3.0 mm. He also showed that in the worn dentition 3.0 mm was still the mode, with a significant reduction in the upper range. That is similar to the findings of Burnett.[20] What is also obvious, viewing the ranges, when reported, is that many normal dental patients function with a higher or lower IOD than the commonly used 3.0 mm dimension. Care should be taken in applying this data to a patient with a pathologic occlusion in need of a full occlusal rehabilitation.

Focus question 2: Does the rest vertical dimension change during life?

What has been shown is that RVD is a 3D range, affected by a number of factors.[19–22,24,28] While early publications hypothesized that the RVD was constant throughout life, by the 1940s it was believed that the RVD was completely dependent on the tonicity of the muscles.[32–34]

In normal aging there is some wear on the occlusal surfaces of teeth and some loss of tonicity in the head and neck musculature. As a patient ages, especially one with a mutilated dentition, muscles undergo sarcopenia, which is the loss of muscle mass combined with the loss of muscle function.[35–37] Calamita et al,[38] in their Narrative Review (NR), stated that "In elderly patients, the effect of cellular aging causes loss of support and texture of the skin and lips, impairing the visualization of the maxillary worn teeth."

The above articles indicate there could be changes in the RVS over time due to changes in muscle tone. Therefore, a literature search was initiated to identify evidence-based studies related to RVD changes over time.

Search strategy

Limiting the strategy to Clinical Trials, Randomized Controlled Trials, Systematic Reviews and Meta Analyses the following searches were performed: *Mandible, rest vertical dimension, age changes*, found 7 citations, none relevant to the question. Expanding the search to include *journal article* found 260 citations with only one relevant to the question.[39] Additional related articles were culled from reference lists in the articles found in the PubMed searches.[40,41]

While the search did not provide data specific to changes in the RVD, there were studies related to facial soft tissue changes, muscle adaptation, and the effect of exercise and nutrition on muscles changes over time. These studies relate to muscle tone and as a result may have a peripheral relationship to changes in the RVD during aging.

Pecora et al[39] in a recall study of 39 subjects (19 male, 20 female) who had lateral cephalograms taken during late adolescence, mid adulthood, and late adulthood reported on aging changes in the craniofacial complex. Skeletal changes were significant only from late adolescence to mid adulthood while soft-tissue changes continued to mid and late adulthood. Soft tissue changes, thinning and elongation of the maxillary lip and drooping of the nasal tip and columella of the nose, were the most pronounced.

Grünheid et al,[40] in their NR on the adaptive response of jaw muscles, concluded that the muscles of mastication are "versatile and capable of changing their size, cross-sectional area, and fiber properties to adapt to altered functional demands." A good portion of the data they presented were in orthodontics as well as orthognathic, plastic, and trauma surgery, where large changes in the OVD occur as part of the treatment.

McCormick and Vasilaki[37] in their NR on skeletal muscle age changes and therapy concluded that "The contrast in the results from these studies suggests that the responsiveness of individuals to exercise and changes in nutritional intake may depend on the individual and stage of sarcopenia that is occurring." A study of 43 men concluded that high intensity resistance training was a safe and efficient method for combating sarcopenia.[35] Vlietstra[41] in an SR to determine the effects of exercise in older adults with sarcopenia, concluded that exercise improved strength, balance and muscle mass.

Evidence-based conclusion

There is little evidence relative to the question, "Does the dental RVD change during life", as it would require a long-term prospective observational study that would take many years to complete with an enormous cost. What is present is a

temporal relationship, in that aging does cause a decrease in muscle tone which could affect the RVD and that RVD is a 3D range, affected by numerous factors.

Focus question 3: In a patient in need of occlusal rehabilitation, will an alteration in the OVD cause harm?

Harm is the evidence based term used to describe any adverse effect to a patient in clinical care or research projects. There are many forms of harm, both physical and mental, with death, morbidity, and adverse drug reactions being significant examples. But it also includes any undesirable consequences of health care, which in this section would be failure to adapt to occlusal changes, TMD, muscle problems, chipped teeth, and phonetics to mention a few examples.

There are many questions that arise when a change in the OVD is being considered since the process is not based upon scientifically rigorous guidelines. The conundrum as previously presented in focus question 1 and concluded by Turrell[18] in his classic article, is "When no accurate pre-extraction records exist, the dentist must rely upon esthetic appearance supplemented by aids which are often misleading." Consider a typical trial placement appointment where the standard esthetic and phonetic approach is used to determine the OVD and the resting vertical dimension (RVD). Since facial esthetics is a multi-factorial olio, is the lower third of the face, as measured between the nasion and gonion, a realistic ideal for every patient? Do patients with square, tapering or ovoid facial forms all have a nasion-gonion measurement that is 1/3rd that of the overall facial height? Does rigid adherence to a "Mean" 3.0 mm for the IOD result in an artistically determined RVD?

When one or more teeth in a quadrant are missing, it is common to see eruption of the now unopposed teeth often accompanied by their supporting alveolar bone. However, consider a patient that is a bruxer, will the teeth with severe occlusal wear, and in occlusion, continue to erupt to maintain the patient's previous OVD? The premise for such continuous eruption is based upon a quote from Sicher's 1949 Oral Anatomy text[42] and Turner and Missirlian's[43] article, where the unreferenced and unproven statement is made that the OVD is maintained in patients with excessive wear by continuous eruption. These and other questions deserve exploration when discussing the main concern about potential harm from altering the OVD.

To begin answering questions, there is moderate agreement that the RVD is a 3D range, affected by a number of factors,[19–22,24,28] and that muscle changes and aging have a significant effect on its position.[32–34,39,40] Therefore, a closer look at the Turner Classification is in order. Category No. 2 was defined as "excessive wear without loss of occlusal vertical dimension but with space available." But later in the article the authors state "In these patients continuous eruption has maintained occlusal vertical dimension, but there is seemingly insufficient interocclusal space for restorative materials unless occlusal vertical dimension is increased."[43] In addition, there is some data exploring the wear of teeth and associated tooth movement. Dahl and Krogstad[44,45] reported on 2 studies of 20 participants with "gross pathological wear" on their anterior teeth but not on their posterior teeth. Orthodontic removable devices were fabricated to cover the maxillary anterior teeth to bring the posterior teeth out of occlusion. Reference Tantalum implants were placed in the midline of the basal portions of the maxilla and mandible. Patients had cephalometric radiographs taken at 2-month intervals until measurements between the reference implants "showed no or hardly any difference in the distance between the implants on two corresponding exposures," a range of 6 to 14 months. The authors concluded that participants demonstrated a combined effect of extrusion of the posterior teeth and intrusion of the anterior teeth, with eruption 40% greater than intrusion. They stated that "unless space is provided by reduction or removal of the functional load on the teeth, this potential cannot be turned to account. The eruption of teeth therefore appears to be mainly a filling in process between the jaws when antagonistic forces permit." In the data presented the teeth extruded into a created space that would allow movement to occur. Dahl[46] in a 6 to 67 months follow up on the participants, after the anterior teeth received full coverage restorations, found 12 out of the 19 patients (1 drop out) did not have a stable vertical relation. This may be because the causative factor in the pathologic wear of the anterior teeth was never ascertained or accounted for in the treatment. Murphy[47] in his commonly quoted 1959 study, concluded that "The controversial concept of continuous tooth eruption in adult life is thus given quantitative support." His study was performed on 337 Australian aboriginal skulls and measurements were taken with the skull being "held with the jaws centrally occluded." Given that this was a cross sectional study of skulls with disarticulated mandibles, it is difficult to understand how he came to the aforementioned conclusion.

If a patient has a 10 mm+ IOD then reestablishing a correct OVD is not difficult. But what if the patient has an obvious collapsed OVD with 0 to 3 mm of IOD and that distance does not allow sufficient interocclusal space for an adequate restoration? What dimension should be used when performing occlusal rehabilitation? Did the RVD accommodate to the OVD with a stable IOD or did the teeth erupt?

To provide further insight into the above challenging questions, a literature search was initiated to identify available evidence regarding alterations in the OVD.

Search strategy

Limiting the search to Clinical trials, Randomized Controlled Trials, Systematic Reviews and Meta-analyses, *mandible, rest vertical dimension, alteration, harm revealed* no citations; *mandible, occlusal vertical dimension, alteration*, revealed 15 citations, 1 of which was relevant[3]; *mandible, occlusal vertical dimension, changes*, revealed 75 citations, none of which were relevant; *mandible, occlusal vertical dimension, rehabilitation* revealed 10 citations, none of which were relevant. Expanding the search strategy to include *Journal article*, *mandible, occlusal vertical dimension, alteration*, received 159 citations, 4 of which were relevant[3,17,38,62]; *mandible, occlusal vertical dimension, restoration* revealed 208 citations, 1 of which was relevant.[50] Additional related articles were culled from reference lists in the articles found in the PubMed searches.[48–52]

Carlsson et al[48] increased the OVD 4 mm in the incisor region, which was greater than the individuals IOD, in 6 healthy

participants who had natural teeth and no history of pain or dysfunction of the masticatory system. Acrylic resin occlusal devices were cemented for a 7-day period. Numerous symptoms were reported which diminished within 1 or 2 days. One participant was unable to adapt and "felt a severe discomfort and psychic stress during the whole experimental period." A second participant had speech issues during the 7-day test period. It was concluded that a moderate increase in the OVD "does not seem to be a hazardous procedure, provided that occlusal stability is established."

Amorim[49] analyzed the condylar position of 12 patients, who presented with a maxillary CD and no mandibular posterior teeth, who were restored with a new maxillary CD and a Kennedy Class I mandibular RPD. Changes in the condylar position were measured using corrected lateral tomography. The authors reported that the prosthetic restoration "caused changes in the condyle/fossa relationship, reducing the incidence of posterior condylar positions and increasing the incidence of concentric condylar positions." No mention was made of the amount of change in the OVD in the patients treated.

Ormianer and Gross[50] compared 2 cohorts, a test cohort that consisted of 8 subjects, 6 with severe occlusal wear, one with excessive anterior vertical overlap, and one with an anterior reverse occlusion and a control cohort that consisted of 8 dental students with intact dentitions. A healthy temporomandibular joint (TMJ) was an inclusion criteria for both groups. While much of the discussion revolved around differences between a "physiologic rest position" and a "clinical rest position," what is important to this Best Evidence Consensus Statement is that the "resting face height adapted to the increased OVD and remained consistent over 1 and 2 years."

Ormianer[51] reported on a retrospective study examining the clinical outcome of increasing OVD in 30 patients who needed either implant or tooth-supported fixed partial dentures (FPDs). Group 1, with an n = 10 participants were restored with tooth-supported FPDs in both the maxilla and mandible and were followed for a mean of 7 years (range 4-11 years). Group 2, with an n = 10 participants, were restored with implant-supported restorations in the maxilla opposing tooth-supported restorations in the mandible and followed for a mean of 4.5 years (range 3-6 years). Group 3, with an n = 10 participants, were restored with implant-supported FPD restorations in the maxilla and "fixed implant-supported restorations" in the mandible and followed for a mean of 5.1 years (range 3-8 years). No TMJ issues were reported in Group 1, while Group 2 had 2, and Group 3 had 4. They concluded that the alteration of the OVD was acceptable in patients with implant retained restorations. No information was provided relative to how much of an increase in each patients OVD was supplied and whether or not the increase was greater than the existing IOD.

An important factor to remember when describing changes in the OVD is to identify where the measurements are made. A recent study showed that a 1.0 mm vertical opening between the maxillary and mandibular central incisors resulted in 0.73 mm opening in the first molar region.[52] If a measurement was made from the tip of the nose to the chin, a 1mm opening would result in a smaller opening between the molars. Typically, clinical determinations are made by adjusting the incisal pin, which is even more anterior.

Systematic reviews

Abduo[3] in an SR of 9 articles that met the inclusion criteria, concluded that, where indicated, a 5 mm increase in the OVD "is a safe and predictable procedure without detrimental consequences." His concern over the heterogeneity of the experimental design, the inclusion of healthy participants that typically would have no treatment and participants with worn dentitions, combined with the small number of participants necessitated more high-quality clinical studies.

Calamita et al,[38] in a 2019 NR, concluded that the OVD is not an "immutable reference, but rather a dynamic dimension within a zone of physiological tolerance that can be altered as long as the dentist respects the envelope of function." They also advised that there needs to be a clinical demand that warrants a change in the OVD and gave guidelines for determining the risks, the amount of change and methods to enact the change.

In their 2015 review of the literature, Moreno-Hay and Okeson[53] questioned the validity of the available studies. Their concern was the lack of controls, randomization, adequate sample size and long term follow up. Despite these validity issues, they concluded "there is no indication that permanent alteration in the OVD will produce long-lasting TMD symptoms." Interestingly, 2 articles by Riise[54,55] were not included. In Riise's 1982[54] study they reported that in 11 healthy young males there was postural activity in the anterior temporal and in the masseter muscles sometimes as early as one hour after the insertion of an occlusal interference which persisted until the interference was removed one week later. In their 1984[55] study, experimental interference in the intercuspal position significantly changed the timing and the level of muscular activity during mastication. In addition, 4 of the 11 subjects withdrew from the study due of pain in the muscles of mastication and/or temporomandibular joints. Both studies were of short duration.

Muts et al[4] in an SR of minimally invasive treatments for generalized tooth wear concluded that "the present evidence is not strong enough to form conclusions." They looked at 11 studies and found that an increase in OVD was tested in 8 studies, centric relation was the reference position in 5 studies and 7 studies prescribed an intra-oral device post treatment.

Numerous case reports have demonstrated successful treatment of patients with severely worn dentitions,[38,56–63] all with the caveat that there needs to be a compelling reason to do so. Patients are often given an intra-oral "occlusal device" post treatment to minimize damage from parafunctional habits. While the cited articles indicate that patients tolerate these devices with few problems reported, some compelling questions remain. Given the concern of many practitioners about modifying a patient's OVD, why doesn't the device frequently create problems? If a patient with "severely" worn teeth that presented with minimal OVD is restored to a "normal" OVD, will the thickness of the post-treatment "occlusal device" interfere with the adaptability of the stomatognathic system? If the patient is having symptoms post-treatment, it is due to the restorations or the presence of the device?

There is a subtle philosophical difference between restoring lost OVD and increasing OVD. In a patient with an intact posterior occlusion that distinction is obvious, but in the severely worn posterior dentition it is controversial. There is

substantial literature that supports the restoration of "lost OVD" in a patient with severe wear. However, this data may not be applicable to a patient who has intact posterior teeth.

What is commonly agreed upon is that the cause of severe occlusal wear is typically parafunctional habits. However, what has never been proven, is whether the teeth extruded, or the muscles contracted. In a bruxer is there continuous eruption to maintain the OVD or are the hyperactive muscles adapting to the lost OVD? If one accepts the premise that the muscles can adapt to an increase in OVD, why wouldn't the muscles adapt to a decrease in OVD?

Going back to the Turner Classification,[43] the construct that if a patient has excessive occlusal wear and a +3.0 mm IOD there is no continuous eruption and a loss of OVD, but if they have −3.0 mm IOD the teeth erupted and the OVD was stable does not fulfil the Evidence Based requirement for a Temporal Relationship. Given the possible ranges of IOD and RVD, without knowing what the IOD was before the patient started bruxing or having high quality before and after CAT or Cephalometric radiographs to evaluate bone height, it is difficult to make that assumption.

In a patient showing severe abrasion of the anterior teeth with little or no wear on the posterior teeth, the treatment plan is more difficult to ascertain. These patients typically have tilted mandibular molars which are in contact with their antagonists as the patient moves into protrusive.[38,56,58–63] This relationship will allow greater force to be exerted on the anterior teeth and more time in contact due to the tripod effect. Regardless of whether the treatment included an increase in the OVD, the experienced clinician will flatten the occlusal plane to make sure that protrusive posterior contacts will not occur. Treatment options for this type of patient can include: crown lengthening with a reduction in alveolar bone, always a concern in a bruxer, a Dahl occlusal splint, with the increase time and the reported unstable VD in 12 of the 19 patients studied,[46] or altering the OVD. Goodacre et al[64] have shown that the stomatognathic system has the ability to adapt to changes in occlusion. Another factor to consider is the relationship between maximum intercuspation and centric occlusion. If the patient is guided back into Centric Relation there is usually a prematurity on the tilted molars. Will more anterior space be available and is it possible that some of the issue is resolved by a slight vertical movement combined by rotation of the condyle as demonstrated by Amorim?[49]

This review has answered some questions, but many questions remain unanswered related to alterations in the OVD. However, the following conclusions are offered to provide guidance related to this challenging topic.

Evidence-based conclusion

There is strong clinical evidence that the RVD and IOD are a range. There is also strong clinical evidence the Stomatognathic system can adapt. There is some evidence that skeletal growth continues from mid adolescence into mid adulthood but at a much slower pace than childhood to mid adolescence.

There is strong anecdotal evidence that some unopposed teeth will continue to erupt, but there is no clinical evidence to support the concept that abraded teeth in occlusion, in a patient with bruxism, will undergo continuous eruption. There is also some evidence from clinical case reports that restoring OVD in patients with severe abrasion is a successful treatment.

Consensus conclusions

There is a range of dimensions for the IOD with many normal dental patients functioning with a higher or lower IOD than the commonly used 3.0 mm average dimension. The RVD is a 3-dimensional range with little evidence related to changes in the RVD during life. However, aging can cause a decrease in muscle tone which could affect the RVD. The restoration of the OVD can be successfully accomplished if proper diagnosis and treatment planning are performed.

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