# Occlusal Vertical Dimension: Alteration Concerns

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**Abstract:** *This article exposes common myths supported by restorative dentists that serve to limit our potential for achieving more favorable results. The need to alter occlusal vertical dimension (OVD) signifies a number of concerns that include: bite force measurements, rest vertical dimension, effect on temporomandibular joint loading, effect on tooth loading, and neuromuscular adaptation/stability. There appears to be sufficient scientific support to conclude that alteration of OVD can provide a biologically compatible adjunct to treatment. These alterations can improve dentofacial esthetics, create improved visual proportions in facial height, and provide an important treatment modality for force management of the masticatory system.*

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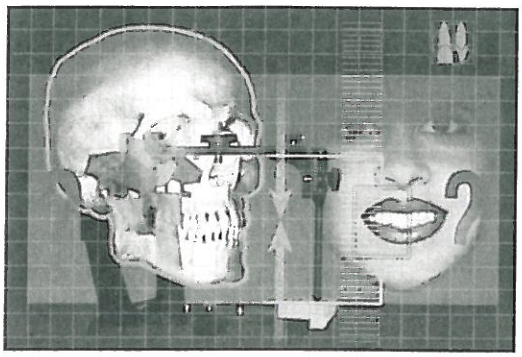
**Learning Objectives:**

*After reading this article, the reader should be able to:*

- describe how vertical relationships change during the growth process.
- determine that changes in occlusal vertical dimension are stable with certain precautions.
- understand that new paradigms which represent a logical clinical assessment will be provided to obtain the most desired treatment outcome.



If we alter occlusal vertical dimension (OVD), we must rely on the patient's adaptive response. Then why ever change it? Controversy exists about whether OVD, the distance measured between two points when the occluding members are in contact,* can ever be lost. The following common myths[1] continue to be supported by restorative dentists even without sufficient scientific support:

1. the neuromuscular system has an optimal vertical dimension;
2. the vertical relationship and rest position cannot be altered permanently;
3. alteration of vertical relationships will lead to masticatory pain and/or dysfunction;
4. rest position is established before the teeth have erupted; and
5. rest position is stable even after the teeth have been lost.

Previous long-term follow-ups documenting changes in adult face height as a result of aging, wear, and loss of teeth have been reported by Tallgren.[2] This study indicated that the rate of wear affects changes in face height, and that severe wear did, in fact, result in a loss of face height. Even though our dentition is capable of adaptations to functional and parafunctional attrition through compensatory eruption of teeth, mesial drift, and changes in occlusal patterns,[3] it appears that the rate in some patients can be too severe for this process to maintain proper physiologic balance throughout one's lifetime.

We must also consider that problems can occur during the normal growth and development of intermaxillary relationships, which can create less-than-ideal circumstances. The form of the face is largely dependent on the anteroposterior position and vertical relationship of the jaws in relation to the cranial base.[4,5] The most important factor in the vertical development of the face is the direction of growth of the condyle. Normal vertical growth patterns are downward and anterior (Figure 1). Bilateral problems can result in overclosure of the

*The Glossary of Prosthodontic Terms, ed. 6. The Editorial Council of The Journal of Prosthetic Dentistry, 1994.

mandible within the maxilla, seen as deep vertical overbite, or excessive opening, seen commonly as an anterior open bite. Unilateral discrepancies develop as mandibular asymmetries. In addition to concerns with craniofacial growth, many habits affect dental and maxillofacial growth and development. Numerous possibilities include: early oral function, nonnutritive sucking, tongue habits, mouth breathing, bruxism, and lip habits. Altered oral function or rest position can have a significant influence on the developing orofacial region.[6,7]

Considering the magnitude of what could go wrong during growth and development, it seems unlikely that the patient has developed some predestined optimal vertical relationship that is incapable of being altered. We, therefore, can be on an elusive quest for an improbable, precise, ideal vertical relationship.

The need to alter OVD signifies a number of concerns, including: bite force measurements, rest vertical dimension, effect on temporomandibular joint (TMJ) loading, effect on tooth loading, and neuromuscular adaptation/stability.

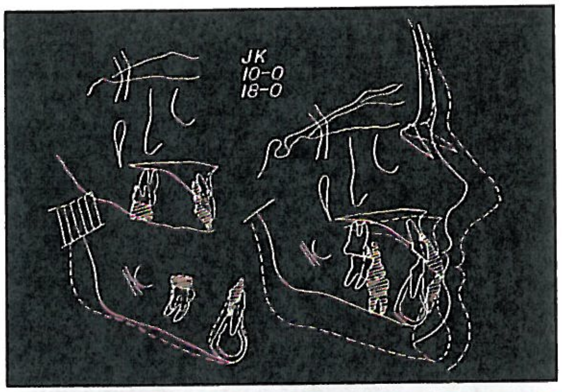



**Figure 1**—Normal direction of vertical change in the growing face is downward and anterior.

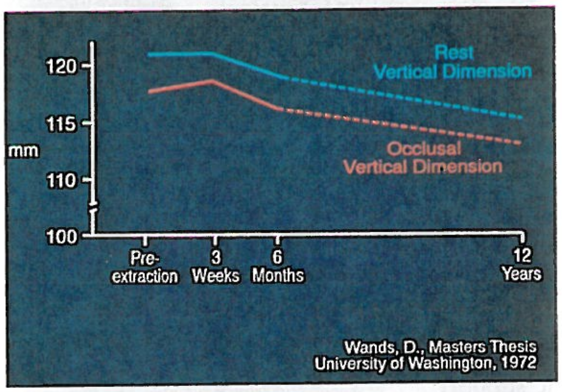



**Figure 2**—Reduction in rest vertical dimension and OVD during a 12-year longitudinal study.[20]

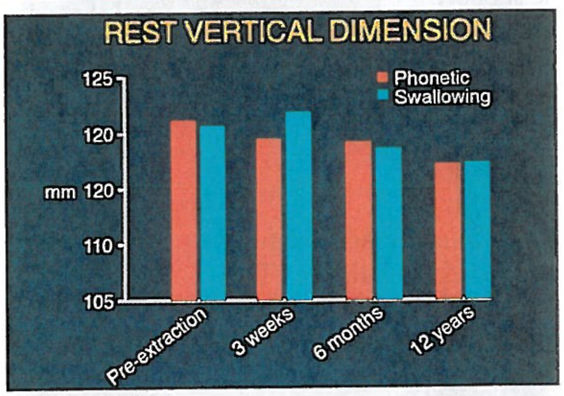



**Figure 3**—Reduction in rest vertical dimension determined phonetically and through swallowing.

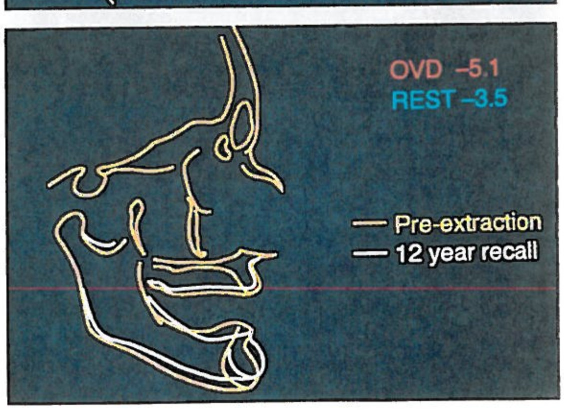



**Figure 4**—Cephalometric comparison of preextraction and 12-year recall data.

### *Bite Force Measurements*

It is not known whether the muscle forces are the primary factor deciding the facial form, or if the shape of the face secondarily gives rise to strong or weak muscle forces. Historically, it was believed that each muscle had a critical length at which it could exert the greatest bite force. Complete denture concepts were attempted to develop OVD at this optimal position to create more efficient chewing with dentures. In 1940, Boos developed a bimeter to measure this.[8] It was not until 1959, however, that Boucher determined there was no point of maximal bite force, and that the bimeter was not objective.[9]

Gibbs et al evaluated the limits of human bite strength and determined dentures to be only 20% of natural teeth and bruxer clenchers to be as much as 6 times that of the nonbruxer.[10] Varying relationships to OVD and bite force have also been established. Surgically altered decreases in OVD, as well as pathologic attrition, have shown no alteration in maximal bite force.[11] Additional research has found that maximum bite forces, recorded along with the optimal working length of the muscles at the most efficient electromyograph (EMG) activity, are 10 mm to 21 mm beyond the existing OVD.[12,13]

**Key Principle: Determination of maximal bite force offers no precise location.**

### *Rest Vertical Dimension*

Rest position has been considered a reference position for assessment of OVD. Clinical

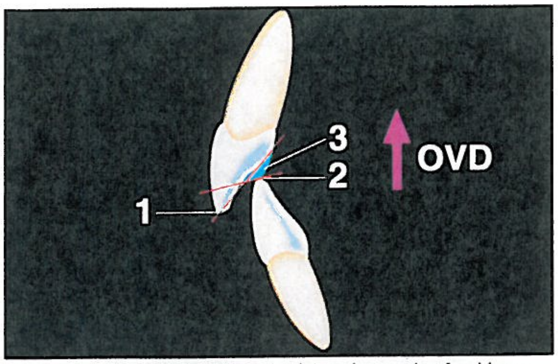
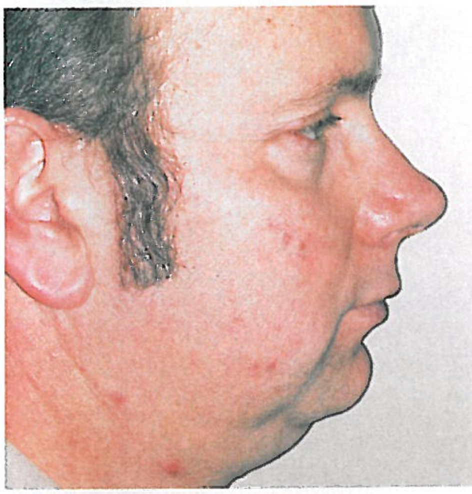



**Figure 5**—Diagram of the keys to determine angle of guidance. Note: Exact sequence must be followed.

**Figure 6A**—Pretreatment frontal view.

**Figure 6B**—Pretreatment lateral profile.



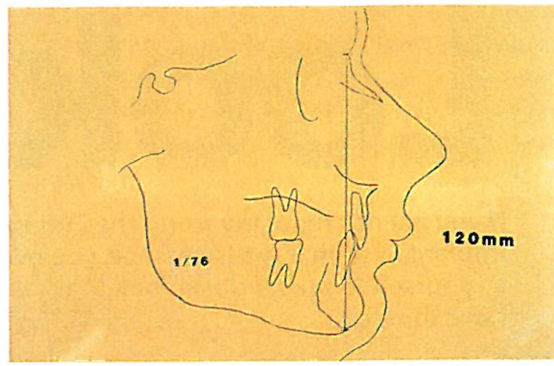
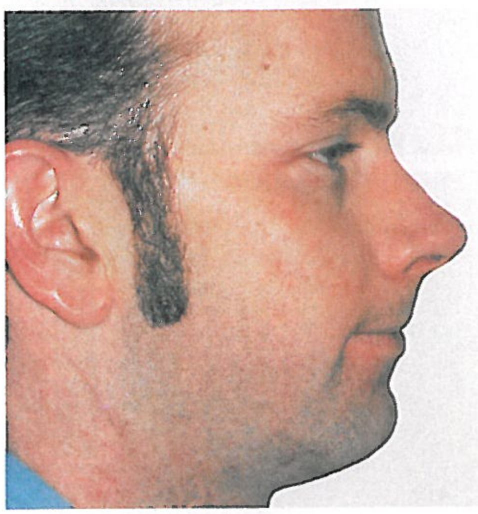



**Figure 6C**—Pretreatment lateral cephalometric tracing.

**Figure 7A**—Post orthodontics and orthognathic surgery lateral profile.



rest position, which is controlled by tonic muscle activity,[14] has been determined to be 1 mm to 3 mm greater than OVD. The reproducibility of clinical rest is questionable at best. In fact, research has shown that rest position is highly variable and influenced by airway posture, emotional factors, medication, and even a 10-degree difference in head posture.[15-18]

The stability of clinical rest is also a concern. The reduction in face height of edentulous and partially edentulous patients during long-term denture wear has been evaluated.[19,20] It appears that wearing complete dentures can cause a marked reduction of the morphologic face height as a result of resorptive changes of the alveolar processes. This apparent loss of face height is accompanied by a loss of clinical rest position (Figures 2 through 4). In addition, opening OVD with the use of maxillary occlusal splints has been shown to obliterate "freeway space" in most patients, with adaptation beyond the presenting clinical rest position and reestablishing to a more open OVD and increased face height. It also appears that jaw muscle motor behavior is more adaptable than previously believed.[21,22]

**Key Principle: Clinical rest position cannot be considered a stable reference position.**

## *Effect on TMJ Loading*

OVD as an etiologic factor in temporomandibular disorders has never been proven.[23] Previous research has demonstrated that the TMJ is capable of extensive remodeling throughout adult life.[24,25] The degree of remodeling is related to changes in the dentition and mechanical stresses. In fact, remodeling can be considered a functional adaptation, rather than a disease process.

The specific response on the TMJ after an increase of OVD has also been studied. These changes represent only a rotational change in the joint as anterior face height is altered. The findings support that altering OVD can create some TMJ remodeling, which also can be considered a functional adaptation.

The most important concern, however, after changes in OVD for TMJ loading, is equal bilateral loading and posterior vertical support. Understanding concerns of mandibular flexure[26] when reestablishing posterior tooth contacts is critical for TMJ support. If the contact is "light" on one side, the patient may activate the muscles on the same side, which will deform the mandible and establish contact forcibly. This patient may experience discomfort on the affected side, but the clinician can falsely assume the problem is the altered OVD. Correctly establishing perfectly simultaneous bilateral vertical posterior contacts will eliminate this problem. This concern is fundamental for all aspects of prosthodontics: crown and bridge, partial dentures, complete dentures, implant supported prosthesis, and appliance therapy.

Altering OVD can create an even more significant additional component. Established procedures that decrease OVD can allow the patient to move apically along the lingual concavity of the maxillary anterior teeth. This can drive the mandible more distal and create unfavorable TMJ loading on retrodiscal tissue—not the optimal condylar position.[27-30]

**Key Principle: Alterations of OVD accomplished in the optimum condylar position are well-tolerated by the TMJ. The problems often encountered are uneven bilateral loading or adversely managing anterior guidance when reducing OVD.**

## *Effect on Tooth Loading*

Altering the OVD can affect how forces are distributed to the masticatory system. Changing tooth length restoratively can influence the crown-to-root ratio, relative mobility, sensory feedback from the periodontal ligament, and the biomechanics of anterior guidance.

Increasing OVD with prosthodontics will create longer teeth, which may adversely affect the crown-to-root ratio. These changes seldom create a tooth length significantly greater than the original anatomic possibilities, and are, therefore, not usually a concern. More commonly, however, these changes are done commensurate with crown-lengthening procedures or removal of supporting bone, and subsequent permanent relative tooth mobility can then compromise the ultimate stability of tooth position. In addition, perceived changes can alarm the patient. It is also possible that individuals with loss of attachment can have impaired sensory function, resulting in reduced control over bite force discrimination.[31]

These alterations can be essential with structurally compromised teeth. When the teeth are severely worn or destroyed by caries, it can be less invasive to increase the OVD.

**Figure 7B**—Post-orthodontics and orthognathic surgery frontal view.

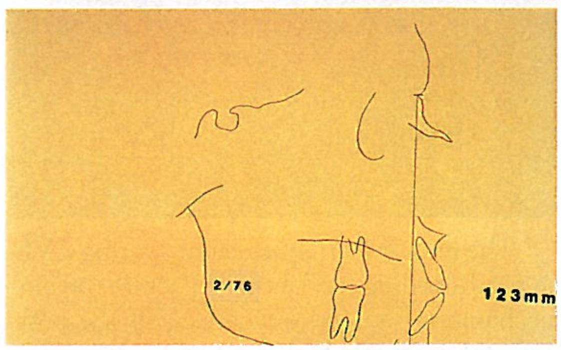



**Figure 7C**—Posttreatment lateral cephalometric tracing. Note: 3-mm increase in anterior facial height.

**Figure 8A**—13-year follow-up, frontal view. Note: Tooth destruction compensatory eruption with commensurate alterations in the free gingival margin.

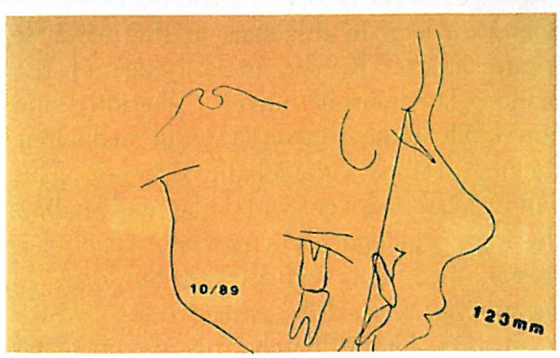



**Figure 8B**—Lateral cephalometric tracing, 13-year post-treatment. Note: OVD unchanged, even though clinical appearance was misleading. Stability evident.

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This approach minimizes the need to apically position the bone to establish adequate preparation length, which could also be an esthetic compromise and result in permanent tooth mobility. In addition, not having to further reduce tooth structure may eliminate the need for root canal treatment and foundation restorations.

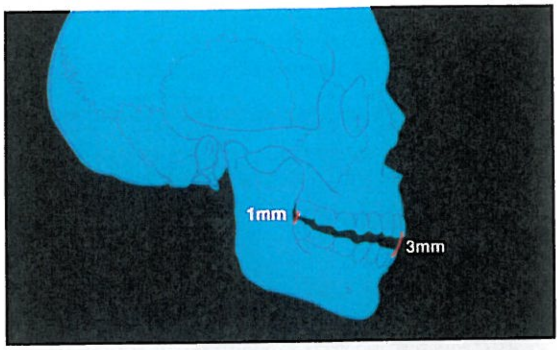


**Figure 9**—Rotational change only. Patient positioned in CR. Note: Ratio varies based on the length of mandible. Stability expected.

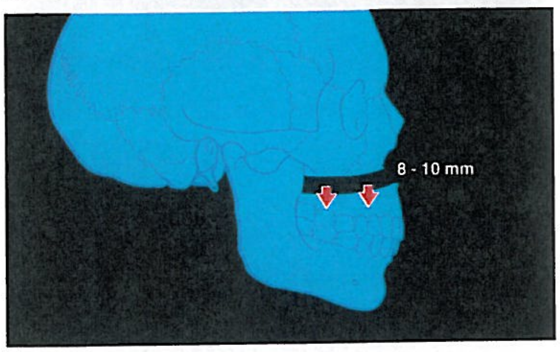


**Figure 10**—Diagram illustrates LeFort I osteotomy. May create increase in posterior facial height. Stability not expected.

The most important effect of altering OVD on tooth-loading can be the impact on the biomechanics of anterior guidance.[32] If the position of the mandibular incisors is correct, or not changed relative to the lower lip, the changes in OVD will create a different angle of guidance. Reducing OVD in centric relation (CR) positions the mandibular incisors more anteriorly and further apically along the lingual slope of the maxillary incisors. This increases the vertical overlap of the anterior teeth, which steepens the angle of guidance and potentially increases the forces to the teeth if the patient bruxes. Conversely, opening the OVD has the opposite effect. In this case, as the mandible rotates from CR, the incisal edge of the mandibular incisors moves posteriorly and potentially more superiorly positioned along the lingual slope of the maxillary incisors. This will decrease the vertical overlap and shallow the angle of guidance when anterior coupling is reestablished. This will decrease the forces to the anterior teeth if the patient bruxes, which is an asset. Unfortunately, this also increases the risk of posterior interferences and adds lingual thickness.

The relationship between OVD and angle of guidance is an important treatment consideration to minimize the forces to the teeth when treating patients with bruxism. The process involves a 3-step approach (Figure 5): (1) determine the maxillary incisal edge position (see article by Dr. Robert Mack in this issue); (2) determine the mandibular incisal edge position in CR; (3) develop the "Blue Zone" (ie, the amount of vertical change critical to control the angle of guidance [which is only necessary if the patient exhibits excessive forces]). This is determined by rotating the mandible until the maxillary and mandibular occlusal plane are level. Concerns about speech alterations also are addressed in this issue (see article by Drs. Warren C. Rivera-Morales and Barry M. Goldman).

**Key Principle: Altering OVD creates an important influence on tooth loading and may provide a valuable adjunct in force management.**

### *Neuromuscular Adaptation Stability*

It appears that physiologic adaptation after alteration of OVD is highly individual and does have definite limits. Opening OVD beyond rest vertical dimension can be unstable as a result of increased muscle activity, compromised muscle length, increased trauma to teeth, or the reestablishment of original vertical relationships.[33] Alternatively, however, physiologic acceptability of the muscles can be achieved by structural reordering occurring in the contractile protein elements of the sarcomeres[34] and from satellite cells.[35,36]

The influence of altering OVD on EMG activity has been evaluated. Surgically altering OVD with LeFort I osteotomy procedures has confirmed adaptation of EMG rest vertical dimension.[37] Increases in lower anterior facial height through mandibular procedures have shown to be stable up to 12.5 years posttreatment,[38] and closing anterior open bites have also proved to be stable.[39] Prosthetically altered OVD has also supported stability.[40] Opening OVD with splint therapy has been shown to both increase and decrease EMG activity.

Restorative dentists seem to be concerned with changes in tenths of millimeters of OVD and would prefer to pretest the patient's adap-

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tation to change with the use of appliances. However, oral and maxillofacial surgeons, as well as orthodontists, are comfortable making significant changes in OVD instantaneously with anticipated adaptation, some relapse, and stability (Figures 6 through 8). Why does this significant difference exist both from a management standpoint and a conceptual one? We all agree there are definite limits.

**Figure 11A**—Pretreatment frontal view.

**Figure 11B**—Posttreatment frontal view, 1-year follow-up.

The confusion revolves around what is actually meant when OVD is opened. The literature refers to significant changes in anterior facial height, nasion to menton, which is usually accompanied by a rotational change in the posterior only. These rotational alterations have previously been shown to be well-tolerated by the TMJ and create little or no change in posterior facial height. These adjustments also produce little or no change in posterior muscle length, especially when evaluated from the more open position of the CR contact position (Figure 9). Instability is more likely when the necessary procedures involve alteration in posterior facial height, which may adversely affect muscle length (Figure 10). These surgical procedures often compensate these concerns by altering the muscle insertion position to ensure long-term stability. (See article by Dr. Stephen Rimer in this issue.) Alterations in OVD must always be accompanied by equal bilateral posterior vertical support and appropriate angle of anterior guidance (Figures 11A through 12B). Distal extension removable partial dentures that are tissue-supported are not acceptable to support changes in OVD because of resorptive changes in the alveolar process. Even metal occlusal surfaces are inadequate, although they can minimize loss in OVD resulting from occlusal attrition of the denture teeth. Redesigned anterior teeth with lingual horizontal platforms are essential to support the altered OVD.

**Key Principle: If increasing OVD changes anterior facial height with primarily rotational condylar movement, it is not accompanied by posterior facial height or muscle length. An adaptive muscle response in these instances is anticipated with long-term stability. Vertical support and anterior guidance are essential.**

## Conclusion

Alteration of OVD can provide a biologically compatible adjunct to treatment. These alterations can improve dentofacial esthetics, create improved visual proportions in facial height, and provide an important treatment modality for force management of the masticatory system. Predictable stability is more easily obtained from corrections to problems from growth and development rather than neuromuscular concerns. Muscles will always win to some degree. It appears that the prosthodontic guidelines for determining OVD (rest position and speech) are adaptive and can be altered.

The time for a more enlightened approach that incorporates all the disciplines of dentistry and the scientific evidence has arrived. It does appear prudent that when altering OVD, the minimum amount necessary to achieve all objectives should be considered. It does not matter which discipline provides the direction for change, as long as the best logical clinical assessment is used.

## Acknowledgment

Special thanks to Gary Nunokawa, CDT, of LeBeau Dental Laboratory, and Steve McGowan, CDT, of Arcus Dental Laboratory for their laboratory support shown in Figures 11B and 14B. For additional information about teaching programs available from Dr. Kois, contact Creating Restorative Excellence Center for Advanced Dental Learning: (800) 457-9165.

**Figure 12A**—Initial patient facial view. Note the facial proportions, irregular maxillary occlusal plane, and gingival display.

**Figure 12B**—Post-treatment facial view, 1-year follow-up. Note the correction of facial proportions and maxillary occlusal plane, with only restorative intervention.

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