Maxillary transverse deficiency

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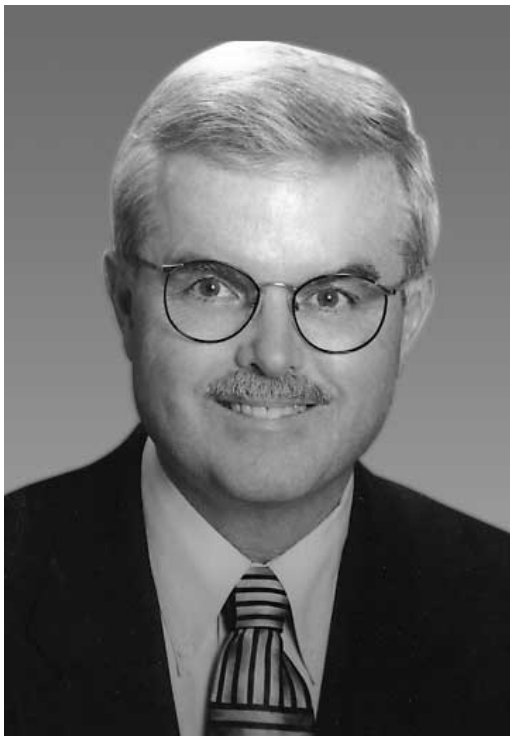
It is a pleasure for me to contribute a few thoughts to this issue honoring the illustrious career of Dr Thomas M. Graber, retiring Editor-in-Chief of the *American Journal of Orthodontics and Dentofacial Orthopedics*. I have known Tom (perhaps first as "Lee's dad") for over 30 years, and my career has been influenced and enhanced on numerous occasions by our interactions, spanning the time from his introducing me to Rolf Fränkel in the very early 1970s to his establishing the Graber Professorship at the University of Michigan in 1998. I am deeply indebted to Tom for his friendship and support over the years.

One of the continuing themes of Tom Graber's career has been growth modification. My own career has taken a similar course. After having been involved in experimental and clinical studies for over 30 years, some general themes have emerged that have influenced the way in which my partners and I practice orthodontics and dentofacial orthopedics on a day-to-day basis.

My initial research efforts were focused on modifying the growth of the mandible, with particular emphasis on adaptations within the temporomandibular joint. Today, there is no question that short-term and long-term condylar adaptations can be produced in a variety of animal species. There also appears to be general agreement among those who have studied this question that the growth of the mandible can be increased in human beings over the short-term, perhaps 2 to 4 mm more than that which occurs normally. The long-term effects of orthopedic intervention, however, remain controversial and open to question. For example, long-term investigations of the Herbst appliance[1,2] demonstrate minimal skeletal increases over what would occur during normal growth, whereas long-term studies of the FR-2 of Fränkel[3] are more encouraging.



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In the patient with Class III malocclusion, the length of the mandible also can be affected by therapeutic intervention (eg, chincup, facial mask) over the short-term, particularly with regard to altering the direction of its growth (usually downward and backward), but there is little evidence to date to support the concept that the length of the mandible can be reduced over the long-term by Class III mechanics.

I am much more enthusiastic today about treatment possibilities within the maxilla, particularly with regard to the management of the transverse dimension. Maxillary transverse deficiency, in fact, may be one of the most pervasive skeletal problems in the craniofacial region. Its

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many manifestations are encountered by the orthodontist on a daily basis but usually are not quantified. As part of an initial evaluation of a patient, I recommend that the distance between the closest points of the upper first molars (ie, transpalatal width) be measured. Typically a maxillary arch with a transpalatal width of 36 to 39 mm can accommodate a dentition of average size without crowding or spacing, whereas maxillary arches less than 31 mm in width may be crowded and thus in need of orthopedic or surgically assisted expansion.[4] Obviously other factors, such as facial type, soft tissue profile, and level of muscle tonus, also must be taken into consideration when making the extraction/expansion decision.

Further, I am impressed with the treatment effects produced by rapid maxillary expansion (RME) in patients without crossbite. Orthodontists traditionally have used RME to correct crossbites, but little else. In contrast to the aggressive approaches often taken in treating skeletally based anteroposterior and vertical problems, many orthodontists have been reluctant to change arch dimensions transversely. Yet, the transverse dimension of the maxilla may be the most adaptable of all the regions of the craniofacial complex. It is my opinion that many, if not most, transverse skeletal imbalances in the maxilla are ignored or simply not recognized, and thus the treatment options for such patients of necessity are more limited than if these imbalances were recognized.

Let me explain further. Other than crossbite, two of the most common problems encountered by the orthodontist are crowding and protrusion of the teeth, both of which derive from discrepancies between the size of the teeth and the size of the bony bases. Howe et al[4] have shown that dental crowding, at least in individuals of European ancestry, appears to be related more to a deficiency in arch perimeter than to teeth that are too large. A primary factor in dental crowding often is maxillary transverse or sagittal deficiency. If the position of the maxillary dentition reflects the skeletal discrepancy, crossbite results; on the other hand, if maxillary constriction is camouflaged by the dentition, and both dental arches are constricted, crowding in the absence of crossbite is observed.

It is well recognized that one of the limiting factors in the management of tooth-size/arch-size problems is available space in the mandibular dental arch. Unfortunately, true orthopedic expansion of the lower arch is unlikely unless recently developed distraction osteogenesis techniques are used. Interestingly, however, it has been our observation that the position of the lower dentition may be influenced more by maxillary skeletal morphology than by the size and shape of the mandible.[5] Following RME, not only is there expansion of the maxillary dental arch, but the lower dental arch as well. The lower arch widening is due primarily to "decompensation," an uprighting of the lower posterior teeth, which often have erupted into occlusion in a more lingual orientation because of the associated constricted maxilla.

Crossbite and dental crowding, therefore, are two easily recognizable clinical signs that could be the result of maxillary deficiency. Other effects of maxillary deficiency, however, are not as easily identifiable and often not detected. For example, laterally flared maxillary posterior teeth may camouflage a maxillary transverse deficiency. These patients have what appears to be a normal posterior occlusion, although on closer inspection the maxilla is narrow (eg, intermolar width <31 mm), and the curve of Wilson is accentuated. The lingual cusps of the upper posterior teeth are tipped below the occlusal plane, often leading to balancing interferences during function. Even though there is no crossbite, such patients are candidates for RME before comprehensive edgewise therapy.

Another clinical manifestation of maxillary deficiency is dark spaces at the corner of the mouth. Vanarsdall has used the term *negative space* to refer to the shadows that occur in the corners of the mouth during smiling in some patients who have a narrow, tapered maxilla and a mesofacial or brachyfacial skeletal pattern (RL Vanarsdall, Jr, Personal communication, 1992.) Regardless of whether teeth are extracted, the maxilla can be widened by means of RME, increasing transpalatal width and eliminating or reducing the dark spaces in the "buccal corridors." This type of orthopedic intervention results in what many consider a more pleasing frontal facial appearance. It is my opinion that RME for esthetic purposes (eg, broadening the smile) in the future will become an increasingly recognized indication for RME in patients with narrow dental arches.

It is not surprising that certain types of sagittal malocclusions also are associated with maxillary deficiency. One of the major components of Class III malocclusion is maxillary skeletal retrusion, a condition that occurs in nearly half of all Class III patients.[6] In my opinion, the most efficient and effective treatment for Class III problems in the early mixed dentition is RME combined with the orthopedic facial mask. In some mixed dentition patients with only mild skeletal imbalances, however, simply widening the maxilla without initiating facial mask treatment may lead to a spontaneous correction of an anterior crossbite and the resolution of the Class III molar relationship.[7] In patients with more severe problems, modest maxillary skeletal advancement combined with a similar amount of maxillary dentoalveolar advancement can be

induced by RME combined with facial mask therapy.[8] The most common surgical treatment for this condition in the mature patient today is the LeFort I osteotomy, a procedure during which the maxilla can be both advanced and widened, instead of reliance on surgical procedures that involve the mandible.

Counterintuitively, certain Class II malocclusions also may be associated with maxillary deficiency. From a sagittal perspective, maxillary skeletal protrusion occurs only in about 10% to 15% of Class II patients, whereas as many as 30% of Class II patients may have maxillary skeletal retrusion, often associated with an obtuse nasolabial angle and a steep mandibular plane angle.[9] Further, many Class II malocclusions, when evaluated clinically, have no obvious maxillary transverse constriction. When the study models of the patient are "hand-articulated" into a Class I canine relationship, however, a unilateral or bilateral crossbite is produced. In fact, Tollaro et al[10] have shown that a Class II patient with what appears to be a normal buccolingual relationship of the posterior dentition usually has a 3 to 5 mm transverse discrepancy between the maxilla and mandible.

It is my opinion that most Class II malocclusions in mixed dentition patients are associated with maxillary constriction. When one is treating in the mixed dentition, the first step in the treatment of mild-to-moderate Class II malocclusions, characterized, at least in part, by mild mandibular skeletal retrusion and maxillary constriction (eg, intermolar width <30 mm in the early mixed dentition), should be orthopedic expansion of the maxilla. The maxillary posterior teeth can be left in an overexpanded position, with contact still being maintained between the upper lingual cusps and the buccal cusps of the lower posterior teeth. The occlusion subsequently is stabilized using a removable palatal plate in the mixed dentition or alternatively full orthodontic appliances combined with a transpalatal arch in the permanent dentition.

A most interesting (and somewhat surprising) observation following our initial efforts to expand Class II patients in the early mixed dentition was the occurrence of a spontaneous correction of the Class II malocclusion during the retention period. Such patients had either an end-to-end or full cusp Class II molar relationship. Generally, these patients did not have severe skeletal imbalances but typically were characterized clinically as having either mild-to-moderate mandibular skeletal retrusion or an orthognathic facial profile. At the time of expander removal, these patients had a buccal crossbite with only the lingual cusps of the upper posterior teeth contacting the buccal cusps of the lower posterior teeth. Following expander removal, a maxillary maintenance plate was used for stabilization. Several appointments later, the tendency toward a buccal crossbite often disappeared, and some of the patient now had a solid Class I occlusal relationship. It should be noted that the shift in molar relationship in these patients occurred before the transition from the lower second deciduous molars to the lower second premolars, the point at which an improvement in Angle classification sometimes occurs in untreated subjects due to the forward movement of the lower first molars into the leeway space.

This phenomenon has forced me to rethink my concept of Class II molar correction. Traditionally, clinicians have viewed a Class II malocclusion as primarily a sagittal and vertical problem. Our experience with the post-RME correction of the Class II problem in growing patients indicates that many Class II malocclusions have a strong transverse component. The overexpansion of the maxilla, which subsequently is stabilized with a removable palatal plate, disrupts the occlusion. It appears that the patient becomes more inclined to posture his or her jaw slightly forward, thus eliminating the tendency toward a buccal crossbite and at the same time improving the sagittal occlusal relationship. Presumably, subsequent mandibular growth makes this initial postural change permanent.

Spontaneous Class II correction, if it is going to occur, usually happens during the first 6 to 12 months of the post-RME period. The Class II correction can be enhanced further at the end of the mixed dentition period by way of a transpalatal arch that not only maintains the maxillary leeway space but also can be activated sequentially to produce molar rotation and uprighting.[11] At this point, if the occlusion still has a Class II component, additional treatment approaches (eg, extraoral traction, functional jaw orthopedics) may be indicated. The phenomenon of the spontaneous correction after RME treatment combined with the routine use of a transpalatal arch now are components of our mixed dentition treatment protocol, and we have found that the need for subsequent functional jaw orthopedics has dropped substantially in our practice during the last 10 years.[12]

I have covered a wide variety of orthodontic problems in this essay, all linked to maxillary deficiency in the transverse or sagittal dimension or both. Signs of maxillary deficiency include far more than just anterior and posterior crossbite as well as crowding of the maxillary dentition. In fact, the signs of maxillary deficiency are such that they often appear together, as in what might be termed *maxillary deficiency syndrome*. We are fortunate to have at our disposal a proven orthopedic appliance, the rapid maxillary expander, that can be incorporated easily into treatment plans directed toward a variety of orthodontic conditions. RME is useful in correcting both Class II and Class III problems as

well as in resolving mild-to-moderate tooth-size/arch perimeter discrepancies. In addition, RME can be used to "broaden the smile," while at the same time possibly improving nasal airway function. Many or most of these signs appear in the same patient with maxillary deficiency, with RME available as an adjunct to fixed appliance treatment, a procedure that I suggest will be incorporated into orthodontic treatment protocols at a greater frequency in the next century than is seen today.

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