Introduction:

Understanding the past often helps us to see the future more clearly, but in some instances, our past experiences can inhibit our ability to discern the possibility for change. Transverse development of the mandibular arch is considered an obstacle that limits success in some non-extraction treatment protocols. (1) With previous techniques and materials available, many clinicians have decided that these movements were either impossible or undesirable. This has become a barrier to innovative treatment and, unfortunately, a paradigm for the orthodontic profession. (2) With advances in biomaterials, especially the introduction of “superelastic” arch wires, these previously held beliefs are being challenged. Understanding the biology of osteoblastic recruitment has also influenced our concepts of orthodontic movements and dentofacial orthopedics. (3) Starting with the premises that a “normal” anterior-posterior mandibular incisor position is inviolate and stable, (4) and that transverse development of the maxillary arch is known to have long-term stability. (5) A natural corollary would suggest that transverse development of the mandibular arch should not be attempted in isolation but should be closely linked to that of the maxilla and the new operating environmental functional matrix dynamics created. Also that mandibular arch
development should not advance mandibular incisors excessively. These concepts have led to the development of this family of orthodontic/orthopedic appliance designs known as Series 2000®.

Appliance Description:

The MSX 2000® appliance (FIG.1) is a combination of rods and tubes that are soldered to either bands or stainless steel crowns and makes efficient use of the special properties of nickel titanium coil springs. (6) At first glance it might appear that these appliances were intended for lower molar distalization. However, the appliance has actually been constructed to take advantage of transverse arch development in the mandibular first bicuspid area. This is achieved in an active manner that is similar to the passive manner advocated with Frankel’s Functional Regulator. (7,8)

Figure 1: MSX 2000® appliance for transverse mandibular development

The MSX 2000® is a fixed lower expander with an unobtrusive low profile that facilitates hygiene maintenance and is easily tolerated by patients of any age. In some respects this design can be described as an adjustable lingual holding arch as prescribed by those advocates of leeway space maintenance. (9,10) The rods
and tubes allow the unloading of the compressed nickel titanium springs to express a constant linear force and promotes higher efficiency with a continuous light force system. This rod and tube sliding design is well suited for the mandibular arch as any deformation of the exposed rod elements will not affect the internal workings nor increase friction of the sliding elements that are at work within the protected lumen. These tubular components on the mandibular molars have two other advantages. First they facilitate initial seating of the appliance and repositioning of a loose segment without the removal of the entire appliance. A second advantage is that the archial movement in the molar area allows the mandibular dentition to respond to alterations of the maxillary dentition thus reducing the discomfort often found when patients develop hyper-occlusion of individual teeth.

The Max 2000® (FIG.2) appliance is a banded appliance designed with an acrylic and metal framework similar to that of the Haas palatal expander (11) with one major difference. A dual rod/tube spring mechanism has been substituted for the original expansion screw. The dual rod/tube spring mechanism allows for a low continuous force of 300 grams promoting efficient expansion.

Figure 2: Max 2000® appliance
The concept of dual arch development is often difficult for clinicians to conceive. Arch length discrepancies often are not recognized in the maxillary arch until the space required for the maxillary canine eruption is deficient and many clinicians still are reluctant to expand the maxillary arch in the absence of a buccal cross bite. The Series 2000® system as presented is a matched and mated system which allows for similar force systems to be applied across both the mandibular and maxillary arches simultaneously. The advantages of these designs are in patient comfort and treatment efficiency. They do not require patient activation and answer requirements of a modern day practice with the present challenges placed on the clinician by a non-compliant patient population. When there is a need for both maxillary expansion and molar distalization then the DMAX 2000® (Fig.3) should be substituted for the MAX 2000® design.

Figure 3: the DMAX 2000® for distalization and expansion

Case Report: Each clinician has their preferences in the extraction non-extraction debate. It has been suggested that less than three millimeters of crowding is routinely considered a non-extraction treatment decision, that 4-9 millimeters is debatable and that ten millimeter or more of crowding is usually an extraction case. (12) The
case presented is one where a majority of clinicians would select an extraction method of treatment. The patient is an Asian female of 13 years 4 months in age with a Class I molar relationship and a Class II canine relationship. She has an excessive overbite and over jet with severe mandibular crowding. (Fig. 4) Lateral cephalometric analysis indicates a mild maxillary retrusion and moderate mandibular retrusion with a resulting Class II anterior-posterior skeletal tendency. Transverse analysis also indicates a maxillary deficiency. (Fig. 5)

![Figure 4: facial and intra-oral photographs indicative of a Class I crowded malocclusion](image)

A non-extraction treatment plan was initiated with simultaneous transverse development of both the mandible and maxilla utilizing a MSX 2000® and MAX 2000® appliances. In conjunction a full bonded edgewise appliance was placed. The “straight-wire” brackets consisted of a .018 slot with a Roth prescription. The
exception to this prescription was in the molar areas where a Ricketts Bioprogressive philosophy with zero degree torque was employed.

Figure 5: Lateral and PA cephalometric analysis illustrates AP and transverse maxillary deficiency

Once the brackets and Series 2000® appliances are in place the initial leveling process is the same as with any full bonded strap-up. Each clinician has their own preferred method and sequence of leveling depending on materials, slot size and experience. The one used in this case consisted of a series of three arch wires, 16-nickel titanium followed by a 16x22 nickel titanium and finished with a 16x25 stainless. (Fig. 6) The selected arch wire sequence, size and material however are of little value without a discussion of the arch perimeter or form desired. When the initial clinical determination is made as to whether mandibular incisor crowding can be alleviated by mandibular transverse development the transverse dimension of the opposing arch is evaluated, in particular the distance from the cemento-enamel junction of right to the left maxillary permanent first molars. (13) Our arch form preference is related to having a finished treatment
result with increased bicuspid prominence and maxillary first molar width of a minimum of thirty-six millimeters.

Figure 6: Leveling with nickel titanium ("superelastic") arch wires.

In evaluating the effect of the Series 2000® appliances, it is important to note that the appliances are designed purposefully to have the greatest vectors of force on the first bicuspid area. The mandibular canine area is the least stable area for expansion and the first bicuspid area has been determined to have a greater potential for successful transverse development and stability.\(^{(14,15)}\) This is the exact area that these appliances have been designed to influence.

Figure 7: MSX 2000® and MAX 2000® appliances utilized for transverse development.
It is important to notice that the spacing is developing in the bicuspid area distal to the canines. (Fig. 7) Paradoxically the first bicuspid extraction regimen is the most common orthodontic treatment plan for facilitating correction of a Class I crowded malocclusion. The decision to extract the first bicuspids or even the deciduous first molars in an early serial extraction regimen can stymie the possibilities of non-extraction mandibular arch development. (16) Although non-extraction therapy in and of itself is not a goal of treatment, it is significant to note that there are often overall facial proportional improvements that occur with the development of the transverse dimension. (Fig. 8)

It is this aspect of non-extraction treatment that is facilitated with the proper use of the Series 2000® appliances. Clinicians who are looking for this cosmetic result will notice the disappearance of “dark buccal corridors” and experience the pleasure of a bicuspid prominence in their patient’s smile. Class I crowded

Figure 8: Facial changes possible with simultaneous transverse arch development.
malocclusions can be successfully treated through several means, distalization of molars, advancement of lower incisors or expansion distal to the canines.\textsuperscript{(17)}

Distalization of first molars in all four quadrants is most feasible for those who prefer second molar extraction to first bicuspid extraction. Simply bracketing with “straight wire” appliances and leveling and alignment with continuous arch wires will routinely advance the lower incisors to an unacceptable position. One of the most promising attributes found when treating the permanent dentition with a combination of the MSX 2000\textsuperscript{®} expander and a full bonded bracketed setup is that the cases are finishing without crowding and without advancing the lower incisor as would happen normally with a straight wire setup alone. (Fig. 9)

![Figure 9: Initial and final dental superimpositions illustrate maintenance of lower incisor position.](image)

**Discussion:**

Diagnosis and treatment planning are the keys to success. Each clinician defines the problem areas and then plans a treatment that address for the most part each of the determined problems. Likewise, in designing a new mandibular appliance past treatment philosophies or techniques must be examined as well as the level of success that has been achieved through these methods. When
identifying mandibular arch crowding it is important to determine where the
crowding routinely exists. It is noted that the mandibular first molar rarely erupts
ectopically and is guided by the position of the distal surface of the deciduous
second molar. Since the mesial-distal dimension of the mandibular second
bicuspud is significantly smaller than that of the deciduous second molar, this
advantage in arch length has led many to maintain that the mere preserving of
this “leeway space” can prevent the need for bicuspid extraction. Due to a
perceived inability to develop the mandibular arch and the success in those
cases where “leeway space” has been preserved, there are many who have
maintained that lower arch development is unnecessary.\(^{(18)}\) Early crowding of the
mandibular dentition is not found in the first molar area nor in the area of the
deciduous second molar, it appears that it is located between the mesial contacts
of the deciduous second molars until the permanent second molar erupts.
Therefore the stable areas to choose for transverse development are the first
bicuspids.\(^{(19)}\) By developing more space for the natural eruption of the lower
incisors adequate interproximal alveolar bone is developed and normal
periodontal ligament attachment patterns are supported. Overlapping root
proximity due to anterior arch constriction in conjunction with abnormal
periodontal ligament attachment positions in them is adequate justification for
early treatment. Understanding where crowding truly exists in the mandibular
arch and where potential areas for mandibular arch development are have
influenced the mandibular expansion designs presented with the Series 2000®
family of appliances.
Figure 10: Facial and dental proportions as our patient grows out of adolescents.
Conclusion:

Today's criterion for a well-treated orthodontic case requires far more than basic tooth movement mechanics. It is critical that the modern orthodontist understand the mechanisms of cranial-facial development, facial growth and aging. (20) It is imperative for the clinician to be able to build smiles that will be right for the adult face and that they be able to individually growth forecast into late adulthood for results that will last a lifetime. (Fig. 10) Orthodontists will no longer be asked to create smiles that are satisfactory for the late adolescent face. This need will best be served by visiting the often neglected third dimension in orthodontics through developing transverse dimension on our young patients so that they have smiles to grow into instead of building smiles that fit the adolescent face but often become deficient as the patient enters adult maturity and continues into the geriatric generation. (21) Series 2000® appliances were designed with this futuristic understanding in mind. It is now possible to give more than mere lip service to these new challenges.

*Series 2000® is a registered Trademark and the appliance designs are protected by U. S. patent numbers: #5645422, #5769631, #5919042, #6036488, #6241517, #6402510, #6520722, and #6719557. All patent and Trademark rights are reserved by Michael O, Williams, D.D.S.
REFERENCES:


Am J Orthod Dentofacial Orthop. 1990 Nov;98(5);437-45.


19. Weinber M, Sadowsky C. Resolution of mandibular arch crowding in growing patients with Class I malocclusions treated nonextraction. 
Am J Orthod Dentofacial Orthop. 1996 Oct;110(4);359-64.

20. Behrents RG. Looking at the adult face. Orthod Fr. 1997;68(1);35-40.