Possibilities of Transverse Expansion

Many different strategies exist to realize transverse expansion under a variety of conditions. Some orthodontists think that whether the appliance is fixed or removable, it must inevitably have screws. Others disagree about whether continuous or interrupted forces are optimal. Despite these issues, one should never forget that the most important aim in transverse tooth movements, as in any other step in treatment, is a fully controlled movement with determined force systems. In addition, there often is a need for more expansion in the anterior segment of the arch than in the posterior. The appliance should be as flexible as possible and ideally, treatment results must not depend on the patient’s cooperation. Lastly, since not every appliance works in every patient as well as it should, especially with the complex biomechanics needed in the transverse dimension, the doctor must be free to easily react to changing conditions. One ideal system to use to manage all the above mentioned variables, is the Unitek MIA Mobile Intraoral Arch Quad Helix System.

Why a Quad Helix ...

... and not a transpalatal arch? Obviously, there is more wire in a quad helix, which means increased elasticity. This elasticity produces the lower load/deflection ratio (Figure 1). In addition, the generated forces become more constant during the course of tooth movement and most of the activation bends remain in the appliance after insertion and are not bent out again.

And Why the Removable Unitek™ MIA Quad Helix System...

...and not a soldered fixed quad helix? A soldered quad helix, of course, is useful if a custom shape appliance is needed. For example, if a second premolar is blocked out lingually, insertion of the double end into a MIA lingual sheath becomes impossible. Every other condition can easily be managed with either direct adaptation of the appliance or at least by use of the MIA transfer system.

The disadvantage of a soldered appliance is the need to remove and reinsert bands and archwires for each adjustment. Much more comfortable, effective and time saving is the use of the Unitek MIA System. Bands with pre-attached MIA lingual sheaths, straight or curved, can be cemented at the usual bonding appointment whether or not a quad helix will be used then or later. In my office, I use prewelded straight MIA lingual sheaths on every upper first molar band, regardless of the treatment technique used (Figure 2), even for patients treated with lingual technique. In adults, one can also use these sheaths on second molars to reinforce cortical anchorage by use of expansion forces.

In the mandible, it makes sense to have molar bands with seating lugs only on the lingual side. Since anchorage reinforcements can easily be done with a utility alone (due to the very short distance between buccal root surface and cortical bone) lingual attachments are only indicated for extreme changes in the shape of the arch form or for correction of asymmetries. If needed, a banana-shaped curved MIA lingual sheath is welded onto the lower first molar bands during the bonding appointment. If one is not very familiar with using quad helices in the lower, it may be easier to first seat the fully activated lower quad helix into both bands and then cement them to the teeth together as one unit. This is the same handling as used with a welded appliance. Usually no securing ligatures are necessary, since chewing forces push the frame of the quad helix downward, and the special shape of the lower sheaths plus this downward pushing force always seats the appliance into the sheaths.

Figure 1: The quad helix has by far a lower load/deflection ratio than a transpalatal arch due to the greater length of wire in the appliance.
In both arches, the double end of the Unitek™ MIA Transverse Body is stable enough to withstand the necessary activation needed for totally controlled tooth movement. The amount of activation moments to the arms is normally much greater than usually thought of. This is due to the fact that the double ends function at crown level and the desired tooth movement has to be realized at the center of resistance. To simplify biomechanical thinking, one could think of the point of force application being at the level of the sheaths, even if that’s not exactly the case. The double end and seated lingual sheath act as a fixed connection just as if they were soldered together or manufactured in one piece. That is why insertion force can never be determined to be at one special point in a continuous and joint free system like the “quad helix double end-sheath-band-tooth” (similar to the “head-gear-buccal tube-band-tooth”, with which many are more familiar). Actually the force insertion takes place nearly all over the frame of the quad helix due to its elasticity, which therefore can only be calculated with the finite element method. Nevertheless, to overcome the elasticity of the appliance, activation moments of 45° buccal root torque for maximum cortical anchorage and up to 40° of distal rotation are quite usual.

The Unitek™ MIA System and quad helices may be used in any treatment technique. Figure 2a: Victory Series™ Brackets. Figure 2b: Conceal Lingual Brackets.

**General Problems in More Complex Situations**

Bilateral transversal expansion with various appliances is not very difficult to realize from the biomechanical point of view because unwanted equilibrium forces will cancel out in symmetric conditions and pure transverse forces will remain. Controlling tooth movements in the transverse dimension becomes more difficult if an asymmetric maxilla is involved. Real problems will often occur if a situation only seems to be symmetric at first. Especially in those cases where the asymmetry can only be diagnosed by a three-dimensional biomechanical analysis, which can only be done on casts and never in the patient’s mouth.

**Unitek™ MIA Transfer System is an Optimal Way to Handle Difficult Situations**

With the MIA transfer system the exact position of the sheaths in the patient’s mouth can be transferred to metal auxiliary sheaths placed on a cast. Special transfer angles are available to transfer the exact position of the cemented Unitek MIA lingual sheaths to the study casts (Figure 7). Different transfer angles are available for the left and right side, as well as in straight and banana-shaped curves.
Figure 7: Unitek™ MIA Transfer Angle inserted into the lingual sheath in the patient’s mouth.

First, bands with Unitek™ MIA Lingual Sheaths are cemented in the patient’s mouth, usually during the full banding. Next, the MIA transfer angles are inserted into the palatal and/or lingual MIA sheaths. Then a standard alginate impression is made. In this impression, one can see the mold of the MIA transfer angle and lingual sheath. The transfer angle can then be removed from the patient’s mouth.

Before pouring the cast, a transfer angle is seated into an auxiliary sheath. Take care to match the sheath and angle shape. Seat the transfer angle into the sheath; then using pliers; seat both into the impression (Figure 8).

Figures 8a, 8b: Unitek™ MIA Transfer Angle and auxiliary sheath are seated into the impression.

After pouring the impression, one receives a cast with the MIA auxiliary sheaths exactly representing the position of the lingual sheaths in the patient’s mouth (Figure 9). On these MIA casts the exact biomechanical situation can be diagnosed and all necessary preactivations of the quad helix can be made at the doctor’s convenience with the patient not present.

Figure 9: Cast with Unitek™ MIA Transfer Angle and auxiliary sheath representing the precise lingual sheath position in the mouth.

Biomechanics Made Easy

The first step in activation of a quad helix or any other transverse mechanical device is to adjust the double ends until they are passive in the MIA auxiliary sheaths. (When I do this, the appliance can look a little bit asymmetric to me. If so, this has nothing to do with asymmetric mechanics; it only indicates that the slot position on both sides is not equal.) From this passive situation we can begin to activate the sheaths.

In case of symmetric bilateral expansion we need about 45° of active buccal root torque since the force insertion is far away from the center of resistance of the teeth. This is the most important activation for transverse expansion. In addition to this, an expansion of up to 8-10mm can also be activated, but not more. The reason why the buccal root torque is so important, and why the activation for expansion is actually incremental, can be demonstrated by trial activation.

Trial activation refers to the position of the arms with the activation bends in place. If buccal root torque is activated and you take the quad helix with two pliers, one at each sheath, and you carefully bow the double ends into position as if they were to be inserted into the sheaths, you will see that the buccal root torque itself already expresses a certain amount of transverse expansion. This is due to the geometry of the appliance. Adding an overly strong transverse expansion activation would only result in the teeth tipping towards the buccal.

Planning the Total Amount of Transverse Expansion

At the very least, the total amount of transverse expansion that will remain stable after treatment should be pre-planned by calculation on a PA head film. As long as the teeth stay in the neutral zone, one can expect the result to be stable. The neutral zone is determined by the width of the apical base, and the equilibrium of forces from tongue and cheek muscles (Figure 10). This drawing of the functional neutral zone cannot fully illustrate this complex theme. Complete determination would require analyzing the EMG-potential of the chewing muscles, a PA head film, a TMJ evaluation, and an examination of tongue posture. Nevertheless, if you move out of this zone towards the buccal or the lingual, you will have to develop a special retention appliance, since biological laws cannot be overcome even by the best mechanical system.

Figure 10: Determining the functional neutral zone. 1) Using a PA headfilm, determine the maxillary-mandibular relation (green arrows, measured from lower first molar to frontal denture plane), which has a normal value of 10 mm ± 2 mm. 2) Determine the molar relation (yellow arrows), which is 6 mm ± 2 in normal conditions. These two parameters with their
clinical deviation determine the skeletal basis for the functional neutral zone (gray area). The functional neutral zone is a modification of this skeletally-determined zone taking into account additional functional parameters.

The functional neutral zone is the area where the pressure of muscles from the buccal and from the lingual side are equal over a period of time. For example, a hypotonic tongue will make it difficult to establish a stable transverse expansion, because the functional neutral zone is closer to the facial midline (blue arrows), as does a low tongue posture which cannot create buccal forces on the upper molars. While tongue activation potential is very difficult to measure on a routine basis, EMG measurements of m. masseter and m. buccinator can easily be done. Any activation potential on the EMG monitor of more than 20 mV at rest will indicate these muscles are hypertonic. This means that the functional neutral zone for each side is closer to the midline. If transverse expansion is important under these conditions, the doctor has to take care to ensure enhanced retention. If the masseter-buccinator complex is maintained in equilibrium, it will bring the functional neutral zone more to the lateral side, thus improving stability after expansion. This equilibration can be done by means of special physiotherapy or by EMG feedback training.

Figure 11: In symmetric activation, the intrusive and extrusive equilibrium forces of both moments cancel each other out.
Figure 12: If an asymmetric activation is present, vertical equilibrium forces will remain.
Figure 13: Shows an asymmetrically activated Unitek™ MIA Quad.

Figure 14: Distal rotation is easy with a Unitek™ MIA Quad Helix.
Figure 15: Asymmetrical activation moments in the transverse plane will generate sagittal equilibrium forces.
Figure 16: Distal rotation on one side and mesial rotation on the other will enhance mesiodistal movements, but can be difficult to handle intraorally.

Figure 17: Notice the mesial rotation activation on the one arm and the distal rotation activation on the other, to generate a mesial force at the side of distal rotation activation and vice versa.

Figures 18-21: Notice the full segmentation of the arch with utility mechanics. To reduce unwanted rotation, .016" Unitek™ Flexiloy Wire segments are built bilaterally from 7 to 3. The activation on the left side is distal rotation without buccal root torque. The right side activation is mesial rotation and 45° buccal root torque, in order to generate cortical anchorage so that this molar will not move distally.
**Biomechanics of Asymmetric Corrections**

In order to discuss asymmetric corrections, we have to simplify our way of looking at the appliance. At first we assume the point of force insertion to be at the Unitek™ MIA Lingual Sheaths. Second we only want to look at a bidimensional system in the frontal plane. With these preconditions it becomes quite easy to understand unwanted vertical side effects during expansion:

Symmetric buccal root torque is achieved, if the angle of activation between lingual sheath and double ends is the same on both sides (Figure 10). At both sides, a moment of a couple (MC) is activated which produces an intrusive equilibrium force at the same side and an extrusive equilibrium force at the other. Since both of the moments are equal, their equilibrium forces are equal, too and cancel out.

As soon as the angle of activation becomes greater on one side, some vertical equilibrium forces will remain in place and will produce vertical tooth movements, which are usually unwanted (Figure 11). This situation can occur in the mouth if one molar is more upright than the other. Use a MIA cast to recognize these asymmetric conditions and to prevent vertical side effects.

In very few cases, these vertical forces may be what we want, for example in lateral open bites. While the MIA's vertical equilibrium forces can be used to help bite closure, the quad helix should never be used as the sole mechanism. Since there are always equilibrium forces present from both arch arm activations, we have to know whether the resultant equilibrium is intrusive or extrusive at one side. The bigger activation moment will determine the direction of the resultant equilibrium. Thus for extrusion of the right molar, maximum buccal root torque has to be activated at the left molar. But, never try to enhance the extrusive forces by activating palatal root torque at the extrusion site. The only movement you will get is somewhat of a tipping and shifting of molars, and conversely, no extrusion will result at all.

**How about Distal Rotation?**

Distal rotation of the upper molars is often a very pleasing tooth movement that helps correct a Class II occlusion. With symmetric activations, (i.e., symmetric angles of activation between sheaths and double ends), distal rotation of the molars can more easily be realized with a Unitek MIA quad helix (Figure 13) than via continuous wires.

Asymmetrical activation moments generate sagittal equilibrium forces (Figure 14). This can be helpful in unilateral space closure.

Activating distal rotation on one side and mesial rotation on the other (Figure 15) can even enhance sagittal forces. But normally this system is very difficult to handle in the mouth. The arches must be fully segmented in order for these mesiodistal movements to really take place.

**Summary**

With the Unitek™ MIA Quad Helix System, a system for quick transverse mechanics exists, which is very easy and time saving to handle. An inventory of molar bands can be prepared with MIA lingual sheaths on a routine basis to allow the insertion of a MIA quad helix whenever necessary. More complex situations or asymmetric conditions can be managed by use of the MIA transfer system and MIA casts.

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