CLINICAL REVIEW

Orthodontic

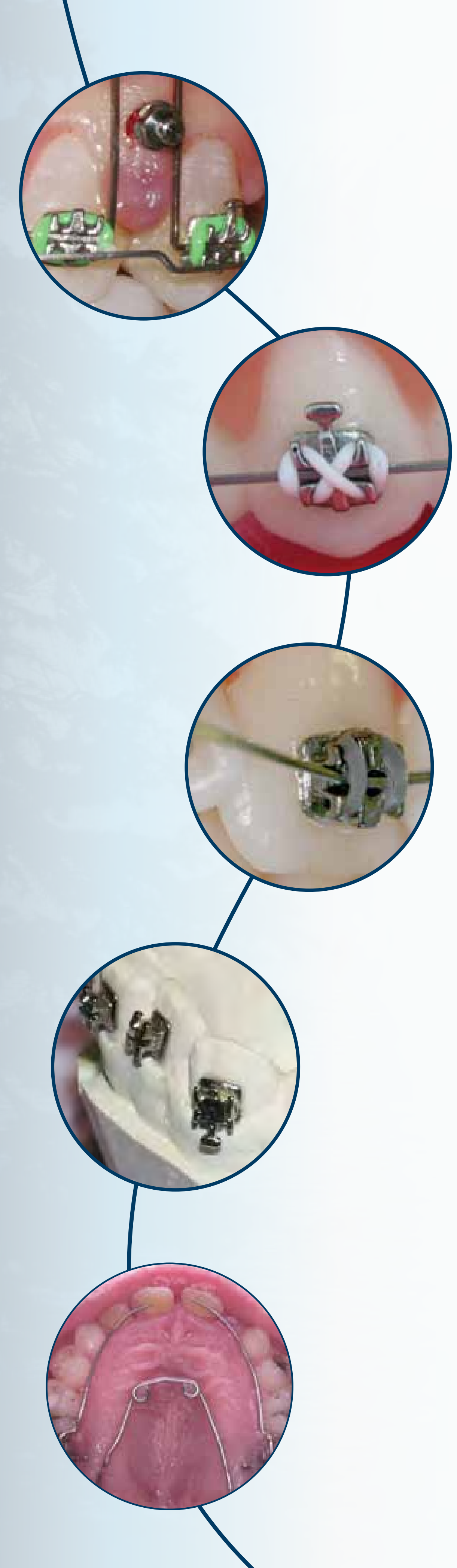
2007-2008

RMO®'s **NEW**
SWLF Synergy R™
Bracket System

Molar Intrusion with TADs

Indirect Bonding REVEALED

Early Treatment:
Wilson® 3D® Quad-Helix & Maxillary Expansion



2007-2008
Articles and Highlights

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* Indirect Bonding System will not be available from RMO® until early 2008.

SWLF SYNERGY R *bracket*

By Robert T. Rudman
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BEFORE

AFTER

“After” images represent first scheduled retie appointment at only 10 weeks

All of us as orthodontists are experiencing vast changes in our profession. The speed at which technological and market demands sweep the globe touch every aspect of our practice. These changes include a move towards low force/low friction bracket systems that hold the promise of treating patients in reduced time and less visits. Demands from our patients for an efficient and effective orthodontic experience with outstanding results leaves little room for missteps along the way. All these changes are occurring amongst the backdrop of a generalization of orthodontics, a competitive orthodontic landscape, and a changing economy. The 2003 JCO survey indicated that median case starts have declined for the first time since the survey began in 1981. With the vast array of clinical systems we have at our disposal and the effect that these choices will have on our day to day practice experience, clinical results, profitability, and ultimately the patient’s experience, the impact of the decisions we make are far reaching.

In my practice, any decisions to implement a new system, whether brackets, software or equipment, must meet three distinct criteria. The system must be synergistic, efficient, and effective.

Synergy is defined as the interaction of two or more agents or forces so that their combined effect is greater than the sum of their individual effects.

Efficient is defined as performing or functioning in the best possible manner with the least waste of time, effort, skill, or resources.

Effective is defined as the ability to accomplish a purpose; producing the intended or expected result.

With this in mind I would like to discuss the implementation of two new systems from RMO that I have incorporated into my practice: the SWLF Synergy R bracket system, and Indirect Bonding.

REVIEW OF SELF-LIGATION

Although the idea of self-ligating brackets dates back to the 1930’s with the Russel Lock edgewise attachment , it is only within the last decade that self-ligating brackets are attracting more interest. There have been many journal articles defining what an ideal self-ligation system might look like. Harradine described these properties as:

- Secure and robust
- Ensure full bracket engagement of the arch wire
- Exhibit low friction between the bracket and arch wire
- Be quick and easy to use
- Permit high friction when desired
- Permit easy attachment of elastic chain
- Be comfortable for the patient

SELF-LIGATING BRACKETS

• Faster Arch Wire Changes: Maijer and Smith found a four-fold reduction in ligation time compared to wire ligation of conventional brackets[3] , but when compared to elastomeric ligatures, arch wire change time savings are less dramatic at approximately 1 minute faster per arch wire[4].

• Expense: Self-ligating brackets are reported to cost anywhere from two to four times the cost of a quality conventional bracket. For the practice that starts 250 cases per year, for every two dollar increase per bracket expenditure, the clinician will realize over a 2.6 million dollar impact to the bottom line over a 30 year career* (assuming savings are invested and compounded @ a 10% return).

• Moving Parts: Moving parts in a bracket system introduce unique challenges. The literature has reported breakage, inadvertent opening, difficulty in opening, difficulty in visualizing the spring clips due to gingival overgrowth and/or excess composite around the bracket pad,[5,6] brackets that close inadvertently before the arch wire is in position causing difficulty seating the arch wire, retention of flexible clips can be overcome by larger rectangular wires, difficulty in removing thicker archwires[5], contraindicated on patients with calculus forming tendencies making clips difficult to open, removal of calculus on clips risking debond[6].

• Active Clip: An active clip effectively reduces slot depth. The claims that active clips act passively only holds true if the teeth are aligned. Harradine accurately described if the tooth (or part of the tooth is rotated) is sufficiently lingually placed, a higher total force will be applied in comparison to the passive clip. Another misunderstanding explained by Harradine is the fact that an active clip places a diagonal force on the wire which does not contribute to third order (torque) interaction. The depth of one side (occlusal or gingival) of an active clip slot is reduced which means the rectangular wire is not fully engaged. This increases the slop between the rectangular wire and the slot. Harradine stated that “these factors probably explain the reported additional difficulties in finishing cases with some examples of this bracket type. In a thick working arch wire an active clip would create more friction.5”

• Passive Clip: It has been reported that passive clips may have the advantage of reduced friction in the initial stages of treatment but at the expense of three dimensional control. It has been suggested that the passivity of these brackets acts like a buccal tube and unless a full size S.S. arch wire is used, which might be too stiff to insert, undesirable torque may result. Kusy and Thorstenson have stated that although a low value of resistance to sliding may be beneficial during the early stages of treatment, a higher value might be optimal for later stages .

SWLF SYNERGY R BRACKET SYSTEM

RMO’s first self-ligating bracket (“Snap Channel”) was developed in the 1930’s. Over the years RMO became aware of the advantages and disadvantages of self-ligation and incorporated their latest technological developments to create SWLF Synergy R, a bracket system that delivers the benefits of self-ligating while eliminating the majority of limitations associated with self-ligating.

CHARACTERISTICS OF SWLF SYNERGY R IN CLINICAL USE

- Faster arch wire changes (38% less time in my office)
- No moving parts to deform or break
- No doors or clips
- No need for crimpable stops on the arch wire or dimpled wires
- No need for posted arch wires due to Energy Chain not binding wire (Figures 1a & 1b)
- Offset bicuspids available
- No need to use hybrid or rounded arch wires to avoid sensitivity caused by clip engagement/disengagement forces on incisors
- Benefit of a passive ligation in the early and middle stages of treatment for rapid alignment, leveling, and sliding mechanics
- The option of easily converting the bracket to full 3D control in the detailing phase
- After conversion, elastomerics can still be employed in a reduced friction configuration (Fig “FSC”)
- A true rectangular slot size available in both .018” and .022” – Flexibility of bidimensional technique if desired
- Extended treatment appointment intervals
- Respect for the patient’s desire for colors as part of the system keeps the fun in treatment
- No ‘double ligation’ of closing doors and then ligating colors cutting into the time efficiency of arch wire changes
- Patients want colors on the incisors
- 60% less ligation - 8 (incisor) brackets vs. 20
- RMO ConverTechnology assures easy conversion only when desired
- Convertible cap insures integrity of the slot dimensions when debonding and repositioning by adding a fourth wall to the slot
- No special tools needed for ligation
- Familiar mechanics

SWLF Synergy R Bracket

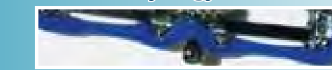


Figure 1a

Conventional Twin Bracket

Figure 1b
Note the space between the arch wire and the Energy Chain

Figure “FSC”

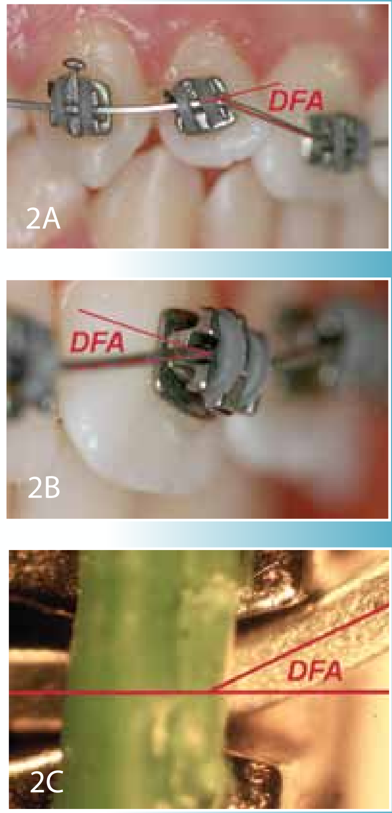
REDUCED FRICTION

MODERATE ROTATION

MAXIMUM ROTATION

CONVENTIONAL CONTROL

MAXIMUM CONTROL



The Dynamic Friction Angle (DFA) between slot and archwire is very important in sliding in the initial phases of treatment.

- It is easier to place detail bends on incisors with SWLF Synergy R because ligatures allow the arch wire to be pulled to the base of the slot on incisors for optimal activation and alignment of contacts
- Familiar technique - no implementation headaches
- Bracket costs in line with quality traditional twin brackets
- Detailing of the occlusion with familiar/traditional 3D control
- SWLF prescription option of 0 or -6 degree lower anteriors

THE SWLF SYNERGY R BRACKET

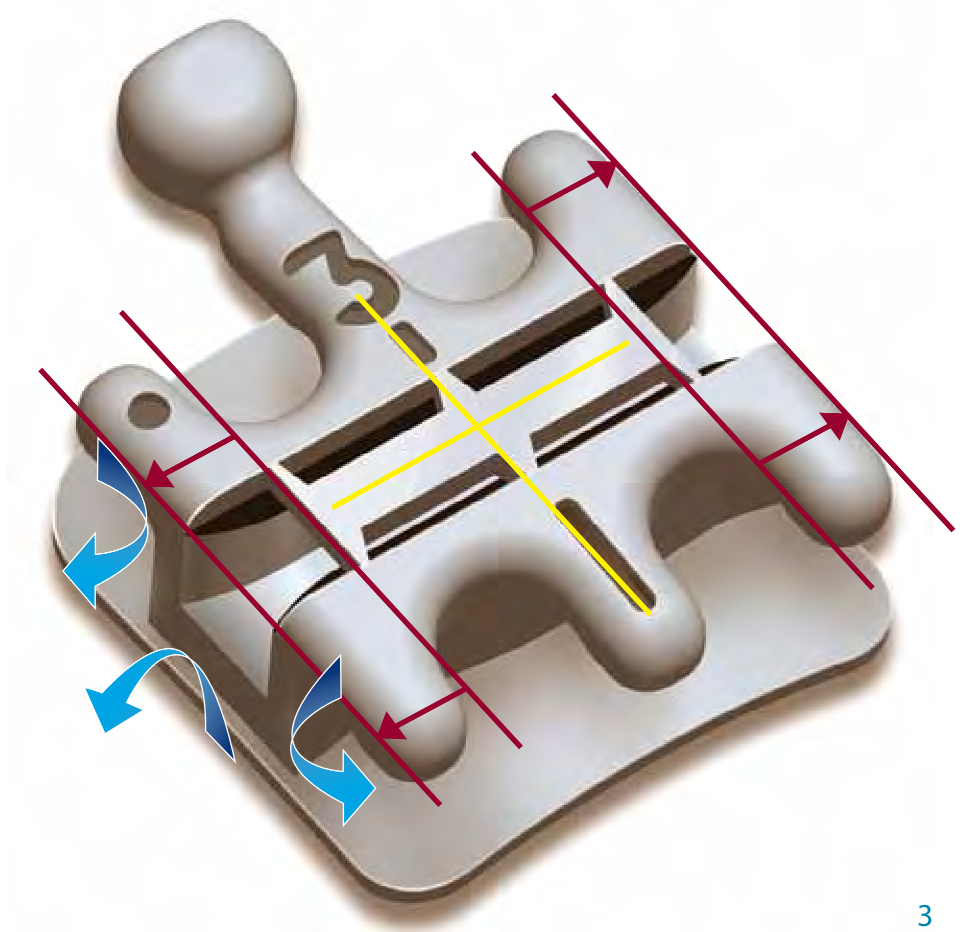
The SWLF Synergy R bracket builds on the long established success of RMO's Synergy series brackets. The slot design of SWLF Synergy R incorporates rounded arch slot walls both occlusal/gingivally and buccal/lingually, allowing for an increased effective interbracket distance as well as the reduction of binding forces that arch wire slots ending in 90 degree angles may introduce in the initial leveling and aligning phase of treatment. Suarez refers to this effect as the Dynamic Friction Angle.[11] (Fig. 3a, 3b, 3c) The unique arch wire slot design also allows for easier insertion of arch wires due to the inherent funneling effect the entry and exit path of the slot exhibits on the wire (Fig 3-blue arrows).

Mesial distal width of the convertible cover is similar in dimension to a twin bracket for excellent rotational control (Fig 3 - red). For even more control, the orthodontist can utilize the full dimension of the synergy outer wings when ligated traditionally.

Positioning of the bracket is simplified with engineered visual cues. The scribe mark is built into the face of the center wing and its junction with the convertible cap, forming a marksman's like cross-hair for proper crown and root angulation (Fig 3 - yellow).

The three sets of wings have been reconfigured for ease of the various ligation options that SWLF Synergy R offers the orthodontist.

RMO ConverTechnology: RMO's patented ConverTechnology is at the heart of the SWLF Synergy R bracket system. This tried and true proprietary technology utilizes a cutting edge Metal Injection Molding (MIM) process that molds the cap directly into the bracket, thereby eliminating the manual soldering of traditional convertible tubes that is riddled with problems introduced by human variation. This means that manufacturing tolerances can be tightly controlled, ending premature conversion as well as eliminating caps that are too hard to convert and that can compromise the bonded bracket. This gives the orthodontist the option of going from a friction free mode to traditional mechanics in seconds.



3

ARCH WIRE INSERTION

There are no special tools or training to place arch wires. In fact, you and your staff have been utilizing this technique as long as you've been threading arch wires through molar tubes. Since the SWLF Synergy R system is a low friction system, depending upon the irregularity index of the teeth the initial arch wire is a .013" or a .015" Orthonol. These initial wires have been specifically designed by RMO for the SWLF Synergy R system. The initial arch wire form is 15% larger than the natural form that will be utilized once rectangular wires are introduced. The rounded walls of the arch wire slot provide an easy entry and exit path for the arch wire threading.

The arch wire is cut to length *(TIP: We use the indirect bonding tray of each arch as a template to determine initial arch wire length - Fig 4)* and placed in the right and left canine brackets (Fig 5). The wire is then threaded through to the terminal molar on one side and then the other. Midlines are lined up with the arch wire and the 2-2 brackets are ligated in usual fashion with the color of our patient's choice. In our office this method has reduced arch wire change time an average of 38% over standard elastomeric ligation. The operator has the flexibility to utilize all the ligation options SWLF Synergy R affords. We tend to ligate the incisors around all the wings initially for full rotational control. Ligation of the incisors only does away with time consuming stops and the guess work of where to place them. There is no need for the additional inventory of dimpled wires since arch wire creep is controlled and the variety of ligation modes can be employed when indicated (Fig "FSC").

Generally at the second or third appointment (12 or 24 weeks in our office) we insert a .016" x .022" Thermaloy arch wire. *TIP: In rectangular arch wire insertion, utilizing the initial round arch wire as a template, use a distal end cutter to cut the rectangular wire at a distal lingual bias forming a point and enhancing the ease of arch wire threading (Fig 6).*

APPOINTMENT INTERVALS

After experience with the system I have found 12 week intervals in the initial leveling and aligning phases to be ideal. I have moved initial intervals from 6 to 8 to 10 to now 12 weeks. I find that the light forces inherent in the system do not over power the occlusion and oral musculature, allowing these extended intervals without loss of control over the case. I have realized a huge benefit by allowing the adaptation of the oral environment to the physiological tooth moving forces over these extended intervals vs. one's natural predilection to jumping in and forcing things to happen. Depending upon the irregularity index of the teeth, I typically begin a case with RMO's specially designed SWLF Synergy R .013" or .015" Orthonol (15% larger than the natural form). This wire generally serves for the first 12-24 weeks, at which point I shift to a .016" x .022" Thermaloy (natural form) for the following 12-24 weeks. Depending upon the needs of the case, up to a .017" x .025" Bendaloy wire can be placed without converting the system. When jumping up to .017" x .025" steel wire and above, it is advisable to convert only the canines using the RMO cap converting instrument (Fig 7a, 7b, & 7c).

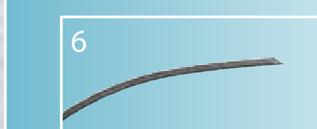
REPOSITIONING OF BRACKETS

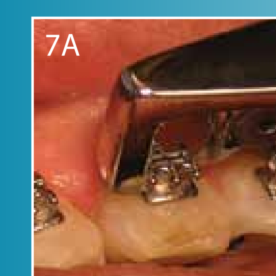
Although indirect bonding has greatly reduced the need, there is little argument for the efficiency of repositioning brackets vs. arch wire bends for error in bracket position. After a progress panorex has been taken, the integrated convertible cap adds a fourth wall to the bracket slot, thereby minimizing arch slot distortion when brackets are debonded for repositioning.

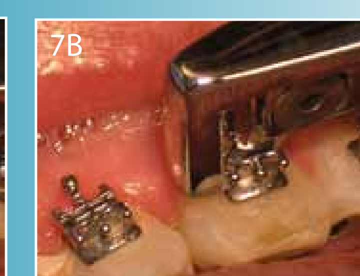
The elegance of the system gives clinicians the option of repositioning or converting all the brackets to standard straight wire for detailing bends.

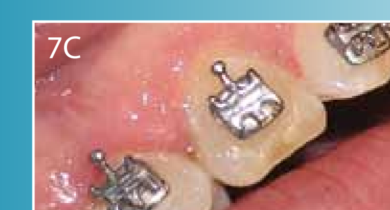
ENERGY CHAIN

Because of SWLF Synergy R's unique design, the Energy Chain does not touch the arch wire and soldered posted wires are not needed to avoid binding of the Energy Chain as in all other systems (Fig 1a, 1b). With the drastic reduction in friction by ligating around the center wings only, closed Energy Chain is generally contraindicated and open chain keeps the forces in a physiological realm. A good example of this is indicated in Fig 8a and Fig 8b where open chain was stretched and released, the rebound shows friction free effect (Fig 8a) for SWLF Synergy R vs. frictional elastomeric binding (Fig 8b) for competitor's brackets. The well documented long acting forces of RMO Energy Chain are an integral part of lengthened appointment intervals, and the product allows patients a variety of color choices (or clear for ceramics) also.









Case 1

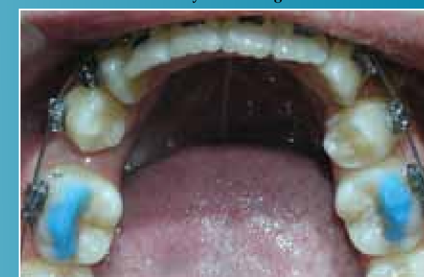
Patient treatment planned for asymmetrical 4 bicuspid extraction due to Class III left Class II right occlusal relationship. Upper and lower arch were indirect bonded (note initial position of maxillary lateral). Lower cuspid was left unligated to allow lateral to move freely and to act as a reference tooth. .014" Thermaloy maxillary arch/.013" Thermaloy mandibular arch inserted at bonding appointment. Patient was instructed to wear very light class II elastics while sleeping. At 10 weeks after initial bonding, photos were taken and .016" Thermaloys were placed.

Of particular interest is the lack of incisor flaring due to the low force wires not overpowering the oral musculature. Rapid space closure occurred with no Energy Chain due to the ability of teeth to drift under the lack of binding forces normally found in traditional ligation.

Day of Bonding

Day of Bonding

1st scheduled retie appointment at only 10 weeks



1st scheduled retie appointment at only 10 weeks

1st scheduled retie appointment at only 10 weeks

1st scheduled retie appointment at only 10 weeks

1st scheduled retie appointment at only 10 weeks

Before and after with total treatment time of 16 months

After treatment - total of 16 months

Before and after with total treatment time of 16 months

Before and after with total treatment time of 16 months

Before and after with total treatment time of 16 months

Before and after with total treatment time of 16 months

Note: All cases were indirect bonded with RMO's RMbond indirect bonding system

Case 2

Patient indirect bonded with posterior turbo's and .016" Orthonol wires placed. Follow up photos taken at 11 weeks after initial bonding when .016" x .022" Orthonol wires were placed. Of particular note is the uprighting of the lower arch allowing rapid alignment and nice arch form on a very light wire. Upper left central was not ligated around all wings because of it's seemingly good initial position. This has lead to ligating all wings of the incisors on the majority of our cases.

1st scheduled retie appointment at only 11 weeks

1st scheduled retie appointment at only 11 weeks

Case 3

Transfer patient treatment planned for 4 bicuspid extraction to address bi-maxillary protrusion, dolichocephalic skeletal pattern and the patient's chief complaint of fullness of profile. Patient indirect bonded, .016" Thermaloy wires placed, scheduled to be back in 6 weeks to remove arch wire for 4-bicuspid extractions by referring dentist. Of particular note is that this patient did not come back to our office for 24 weeks, so the progress photos are of this first appointment. Upon examination of the photographs (a new ceph in 24 weeks would not be in the patient's best interest), there appears to be no increase in flaring compared to the initial photos. No mechanics for vertical control of the open bite tendency were employed. Patience with not overpowering the teeth and time (although inadvertent in this case) allowed significant leveling, decrowding, and alignment while the teeth and musculature adapted to keep a difficult case in good control. Patient was sent for the extractions.

1st appointment at 24 weeks - patient disappeared and did not return until these photos

1st appointment at 24 weeks - patient disappeared and did not return until these photos

1st appointment at 24 weeks - patient disappeared and did not return until these photos

Note: All cases were indirect bonded with RMO's RMbond indirect bonding system

Case 4

Patient presented with high cuspid and right buccal segments in cross bite. .013" SWLF Synergy R wire in .018" slot at 9 week follow up.

1st scheduled retie appointment at only 9 weeks

CASES

In this article, I have included the very first cases using the SWLF Synergy R prototype brackets. You will notice an array of arch wire sizes and appointment intervals, degrees of difficulty, and treatment plans prior to familiarity with how the system performs. The commonality is the speed of alignment, leveling, and uprighting in very light wires that the SWLF Synergy R accomplished. Since finishing employs the familiar mechanics of traditional straight wire brackets, leveling, aligning and space closure will be discussed.

CLINICAL TIPS

Clinical situations vary immensely between patients, and although SWLF Synergy R is an easy system to implement there may be situations where bracket engagement is a challenge (Fig 9). The uniqueness of the SWLF Synergy R design gives the clinician versatility to overcome these clinical obstacles.

1. Make sure that you anneal the last 5 mm of the .013" wire before inserting, as this allows you to control the bias of the wire. Use a weingart or a scaler between the brackets when interbracket distance is an issue in order to guide/bend the dead soft wire to the next entrance of the following bracket. This is a built in design attribute of why the ConverTechnology convertible cap does not fully cover the width of the bracket (so you can access the wire). Most of the time on a difficult rotation, once you get a part of the annealed wire directed into the next bracket entrance you can push the wire through. Many times it is easier to push from a vantage point away from the mesial of the bracket in question, in order to thread the wire through. Sometimes you have to push vs. pull or pull vs. push, because the wire almost wants to find the path of least resistance. Otherwise, if you grab the wire just mesial of where you are threading it through it can be difficult and put an awkward vector of force on it.

I have had brackets that are touching due to rotations and this annealing works well as you can orient the wire by the permanent deformation ability of the annealed wire. (Obviously you will cut off the annealed part as the annealed aspect will be totally distal of the last molar tube so you have active wire working).

2. Just like a conventional bracket, if things are severely rotated you will only be able to partially engage the bracket. In this instance, take a steel quick tie or elastomeric and piggy back the wire across the slot cover and engage the wings. Because of SWLF Synergy R's 6 wing advantage, I will usually try to only engage 4 of the 6 wings (the middle and the wings closest to the rotation) (Fig 10a, 10b, & 10c).

3. You can also take a steel ligature and thread it though the arch wire slot (under the convertible cover) and lasso the wire to the bracket cover and tighten it down (think of this as a vertical auxiliary slot except it is horizontal). You can also do this for very high cuspids where you run a regular steel lig in the slot and lasso the wire and bring it up to the cuspid (wire underneath occlusal tie wings). Very lingually displaced teeth can be pulled towards the buccal. You can re-tighten the ligature or thread it through depending on the displacement (Fig 11).

4. Another thoughtful design attribute is the malleable centered hook. Run the wire under the hook in the middle of the bracket (skipping the slot). Because the hook is in the center it allows easy access and pulls the center of the tooth buccally, aligning the teeth. The bracket hook is very malleable, so you can orient it in towards the gingival to better hold the arch wire (Fig 12). Adding Energy Chain will provide de-rotational movement if desired (Fig 13). By combining these two techniques the clinician can align the bracket buccal/lingually and also rotate the misaligned tooth in a reduced friction environment. You can then typically thread the arch wire through the arch slot during the next appointment. (I will usually schedule patients back in 2-4 weeks depending on the severity of rotation and then put them on a regular 10-12 week schedule after the wire is threaded through the slot.)

5. Converting: In our office it is extremely rare to convert anything but the canine brackets once in heavy wires. Place a piece of orthodontic wax on the RMO converting pliers to catch the integrated cap, making sure the instrument is seated in the mesial entrance of the arch wire slot underneath the cover and the blunt end of the instrument is resting on the distal. Squeeze lightly and you will feel three distinct clicks, this is the patented RMO ConverTechnology cap releasing the cover at the proper force (Fig 14a & 14b).

6. The Interaction of the SWLF Synergy R bracket system with RMO's RMbond indirect bonding system synergizes the efficiency and effectiveness of treatment.

9

10A

10B

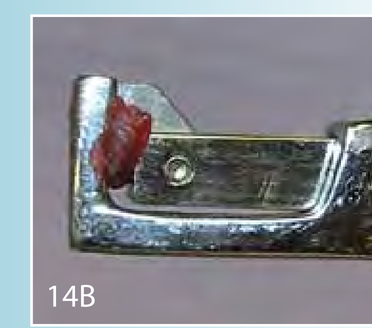
10C

11

12

13

14A



14B

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INDIRECT *bonding*

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Have you ever asked yourself while seemingly standing on your head, fighting saliva, cheeks, tongues, and time to get to the next patient that there has to be an easier way to bond?

There are many seemingly undisputed advantages to various indirect bonding techniques:

• Precise bracket placement via the ability of the clinician to fully visualize and access the teeth to be bonded on a model.

• Patient is more comfortable due to the minimum amount of time spent with the mouth open.

• Clinician is ergonomically and physically more comfortable vs. awkward contortions of direct access.

The usual disadvantages to implementing indirect bonding are:

• In many indirect bonding systems there are issues with technique sensitivity, adhesive flash, bond failures when removing trays, and time intensive lab procedures.

RMO's RMbond Indirect Bonding System has been developed to maximize the advantages of indirect bonding while utilizing products specifically formulated to minimize the problems associated with implementation:

• RMO's RMbond Inner Tray Material is a transparent PVS material that fully encapsulates each bracket for precise transfer and minimizing of flash. The intimate fit of the trays does not allow the bracket to be inadvertently displaced by the curing light bumping the bracket, which can occur routinely with direct bonding. The transparency of the material allows for rapid light curing and visual assurance of seating the tray properly. Its consistency and handling qualities allow for rapid in-house lab tray fabrication with no time consuming block out of undercuts or hooks. It has a low tear strength so that when the tray is pealed from the bonded brackets, the material gives, ensuring the brackets remain on the teeth.

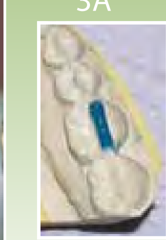
• The RMO RMbond LC Flowable Adhesive is a light cured flowable composite in a precision delivery system. This allows for maximum control, no working time constraints, minimal flash and minimal chair time. The RMbond LC Flowable Adhesive material also has a curing booster to cut light curing time in half as well as fluoride for added protection.

• RMbond LC Bonding Resin has been proven to create the ideal sealed surface and interpenetrated network of the polymerized primers and unfilled resin, resulting in a high bond with a low film thickness of only 8μm to ensure ideal intimate fit of the custom pad to the tooth.

LABORATORY STEPS

1. Start with an excellent alginate impression poured in a high quality dental stone (orthodontic plaster is not recommended) and trimmed so that the model allows clear access to all surfaces of the teeth. Because of the RMbond Inner Tray Material's unique qualities, the records model can serve as the indirect model (a second set of indirect models is not needed). *TIP: Do not pick off any bubbles or alter the anatomy of the model as this will potentially cause a negative in the model that can cause the Indirect Bonding Tray to fit improperly in the mouth.*


2

3A


3B


3C


2. Allow the models to dry completely (over night). Apply two liberal coats of tinted separating medium or tinfoil substitute to teeth and allow to dry to the touch (min 10 minutes). *TIP: The tint in the separating medium distinguishes the separated model from one that is not.*

3. RMbond LC Model Adhesive (or clinician's choice) is fully worked into the bracket mesh and the brackets are placed on the model and stored in the patient model storage box (light insensitive) supplied with the RMO RMbond Indirect Bonding Kit before final positioning adjustments by the doctor. *TIP: Articulate the models together before final positioning to determine bracket interferences. This gives the opportunity to reposition brackets or introduce the use of posterior "bite turbo's" utilizing RMbond LC Turbo Material to temporarily open the bite. (These turbo's are placed on the patient's model and are included in the indirect set-up tray). (See step 4 below)*

4. Once all brackets are in their final position with all excess flash removed, the light cure adhesive is activated using a light source. *TIP: An alternate color dental stone material provides excellent contrast to the RMbond LC Model Adhesive, allowing for easy flash clean up (Fig 2). A light curing unit, having a bulb positioned above a rotating table is recommended; the table is set to rotate 8-10 minutes. A light gun will work as well. Be aware that the stone is dense, and thorough curing must occur to reach the adhesive center of the bracket pad. After all brackets are fully cured, the turbo's can be placed. Models are then replaced in the patient model storage box.*

Turbo construction: Place a small amount of RMbond LC Turbo Material on the buccal cusps of the lower molars where you want turbo's located (Fig 3a). Light cure. Place another small amount on RMbond LC Turbo Material on the top of the cured material and flatten with a wet microbrush, (this creates undercuts for the RMbond Inner Tray Material to secure the buildups). (Fig 3b & 3c) Light cure.

5. The models are returned to the lab where the border of the tray is defined by red utility rope wax (RMbond Round Rope Wax). The wax is applied very simply by starting at the most distal tooth to be bonded and wrapping around to the opposite most distal tooth (Fig 4). From the buccal view it is important to place the rope wax so there is 1 mm of clearance above the most gingival aspect of the bracket (including hooks). This allows the uniquely formulated RMbond Inner Tray Material to fully encapsulate the entire bracket.

6. The RMbond Inner Tray Material should be stored in a refrigerator prior to use to extend its working time. It is applied with the RMbond Dispensing Gun delivery system starting at the distal buccal with the mixing tip at a slight gingival bias expressing the translucent material in a single bead with a deliberate and continuous motion. The rope wax will act as a stop for the material, further enhancing its ability to fully encapsulate the gingival aspect of the brackets. The specific thickness of the rope wax also gives a visual cue to the thickness of the Inner Tray Material. Now that the buccal is covered, the same motion is used to apply a bead to the entire occlusal and lingual surfaces (Fig 4a & 4b)

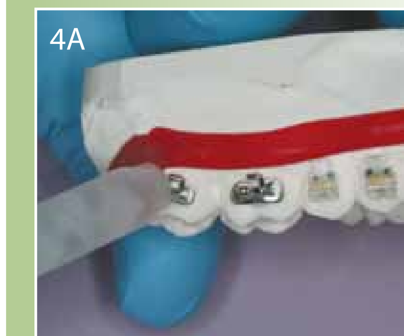
7. A wet paper towel is then used to intimately adapt the material to the teeth and brackets and shape the tray. Before the material sets up, a liberal amount of RMO separating medium should be placed on a finger and rubbed across the facial and occlusal aspect of the Inner Tray Material in a mesial-distal motion giving these surfaces a uniform flat surface parallel to the brackets and occlusal surfaces. Doing this gives a crystal clear finish to the tray. *TIP: use enough separating medium so that it acts as a lubricant and doesn't allow the material to stick to your finger (Fig 5). Remember to use the red rope wax border as the visual cue, as well as a tactile cue, for thickness of the tray as well as the gingival border. RMbond Inner Tray Material should be allowed to harden (2-4 min). Rinse off any residual separating medium from the outside of the tray and then remove the rope wax, revealing a tray that is well defined and not in need of trimming.*

8. Take a sharp scalpel and section the tray on the model between the lateral and canine from the lingual to the buccal aspect of the tray. If access does not allow this, section the tray between the canine and the first bicuspid (Fig 6).

9. Apply a 1mm thick clear thermal forming suck down material using a vacuum forming machine. This forms a hard outer tray. Trim excess material away from the model with scissors and use a wheel saw to trim the hard outer tray at the gingival border of the soft inner tray (Fig 7).

10. Soak the model in a pan of warm water for 15 minutes. To remove the tray from the model place a finger under each bracket starting at the distal to make sure each bracket is free to move with the tray, then slowly remove the tray. The tray should release very easily. Blow any excess water from the tray.


4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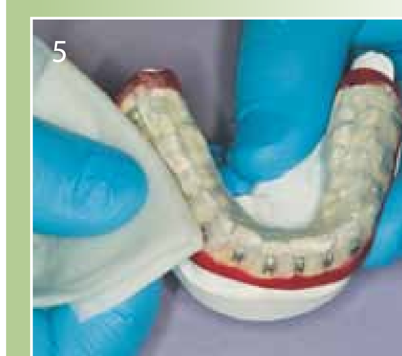
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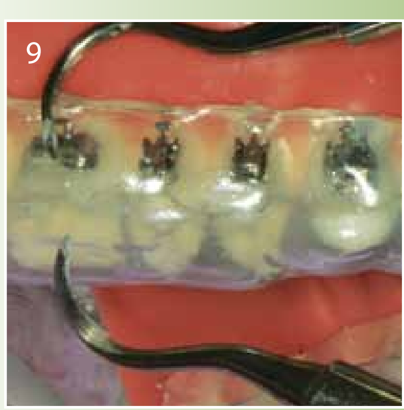
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11. Place the tray back in a light curing apparatus (or use a light gun) to ensure that all adhesive on custom pads is cured.

12. Using 50 micron white aluminum oxide, lightly (1 second per pad) etch the custom adhesive pad being careful to only remove any residual stone and leave the adhesive pad intact. The adhesive pad should have a frosty look and be free of stone. Blow air on the inside of the tray to remove any oxide particles. Return the trays to the patient model storage box for delivery on bonding day. Finished trays can also be stored in a labeled zip lock bag.

CLINICAL PROCEDURES:

1. Proper cleaning of the surfaces of all teeth, especially the first and second molars, is imperative for success. After preparation of teeth via a non oil containing pumice, the assistant places a NOLA dry field system and dry angles. Upper and lower arch are acid etched with 37% phosphoric acid for a minimum of 20 seconds. *TIP: Make sure the assistant examines the indirect trays to verify what surfaces should be etched, including OCCLUSAL SURFACES of teeth with bite turbo's in the tray.*

2. The assistant rubs a very light layer of RMbond LC Bonding Resin to the custom pad of each custom bracket base and turbo's if used (there should be no pooling of the liquid) and replaces the tray in the patient model storage box (Figure 8a). The doctor is called to the patient where close inspection of all etched surfaces takes place (it is nearly impossible to tell whether a tooth is sealed or wet - using this technique, contamination risks are minimized).

3. After verification Dr. then seals the lower arch only with RMbond LC Bonding Resin. A light air dry to thin any pooling of the sealant may be necessary. At the same time the Dr. is sealing the lower arch the assistant is applying the RMO RMbond LC Flowable Adhesive to the lower arch bracket pads. Apply a small amount of LC Flowable Adhesive on the entire gingival edge of the 7's and 6's to cover the lower 50% of the pad. Apply a small amount of LC Flowable Adhesive to the gingival center of 5-5 brackets. This allows the adhesive to flow as the tray is seated in a gingival to occlusal direction (Fig 8b). Apply Flowable Adhesive to posterior bite turbo's if in tray also.

4. Tray is handed to Dr. for insertion. It is very important to make sure the distal and lingual aspects of the tray are under and/or not interfering with the NOLA tongue crib. Line up the midline and seat the tray. One of the valuable aspects of a clear tray is the ability to visually verify the tray is properly seated. Verify tray does not rock and is fully seated around all teeth.

5. We have found that having a uniform curing sequence is invaluable. In our office when bonding 7-7 we start on the LL7 working our way forward to the LL1, then repeat the process for the LR7 forward to the LR1. *TIP: If any area of the mouth is an isolation problem, cure that area first.*

6. Using two scalers the Dr. places a finger rest on the occlusal of the anterior aspect of the tray, a scaler on the occlusal aspect of the tray and a scaler on the buccal aspect of the bracket to be light cured (Fig 9). Only light pressure is used with the scalers as this assures intimate contact with the tooth/adhesive/bracket interface. The assistant then light cures the bracket from the occlusal/buccal aspect through the transparent tray for the appropriate time. In my office we use a plasma arc light and cure molar bonds for 6 seconds and brackets for 3 seconds before moving on to the next bracket to be cured. This time will vary depending upon the light utilized (led/halogen/plasma) (Fig 10). *TIP: Placement of the scalers gives a visual cue to the assistant on proper placement of light curing tip.*

7. When the lower Arch is complete the clinician air dries the previously etched upper arch, verifies the frosty appearance, and steps 3 through 7 are repeated for the upper arch. Doctor is done! *TIP: In my office upper and lower 7-7 including turbo's takes 6 minutes of Dr. time.*

FINAL STEPS

8. Assistant then re-cure's upper and lower arch from a gingival/occlusal aspect for appropriate time (again depending upon light utilized).

9. The hard outer plastic tray is removed first. The soft inner trays that were sectioned are removed by starting with the posterior section in a peeling motion from the lingual/gingival edge of the tray and continuing in a rolling motion towards the buccal/gingival (Fig 11a, 11b, & 11c). The RMbond Inner Tray Material is specially formulated to shear if caught in an undercut, leaving the bracket bond intact. This same motion applies to the rest of the inner tray sections.

10. Since the RMbond LC Flowable Adhesive syringe applies a precise amount of adhesive, we have minimal to no flash on our bondings (Fig 12). *TIP: On your initial indirect bondings, inspect for flash and floss each tooth to calibrate the amount of LC Flowable Adhesive placed on the custom pads. This step will not be necessary once your assistants are familiar with the system and a learning curve has been established.*

11. Turbo's should be adjusted for even occlusion. Arch wires are ready for immediate insertion. *TIP: Although it is not necessary for me to be involved in the clinical bonding process (I have checked final positions of all the brackets on the model already), I find that the 6 minutes I am at the chair gives me a chance to talk with the patient. And since I am not standing on my head fighting moisture and visual impossibilities, I find it to be quality time spent with my patients building the relationships upon which the growth of the practice depends.*

CLINICAL TIPS

Because the indirect bonding happens so quickly it is advisable to have the arch wire selected prior to bonding so the orthodontist doesn't have to return to the chair.

Prior to having the Dr. over to insert the tray, the assistant will cut the arch wire using the indirect trays as a guide (Figure 13) and anneal the wire for easier insertion through RMO's SWLF Synergy R bracket system (cuspids, bicuspids, and tubes) - (leave an additional 5mm length to allow for annealing).

Since hooks are great when you need them and a discomfort when not, we bend the very pliable SWLF Synergy R bracket hooks in towards the buccal surface (Fig 14a & 14b). Prior to arch wire insertion, this verifies bond strength and ensures patient comfort.

The RMbond LC Flowable Adhesive is excellent to place on the distal of the arch wire if the wire is to be left long for unraveling of crowding, and ensures the very light wires used in the SWLF Synergy R system do not slip through the terminal molar tube preventing emergency appointments (Fig 15a & 15b).


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11A 11B 11C


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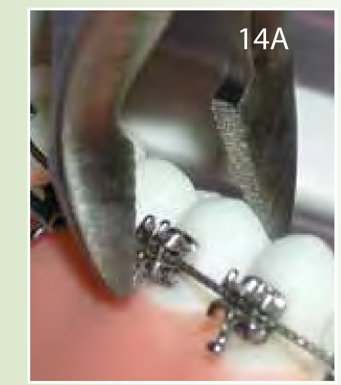
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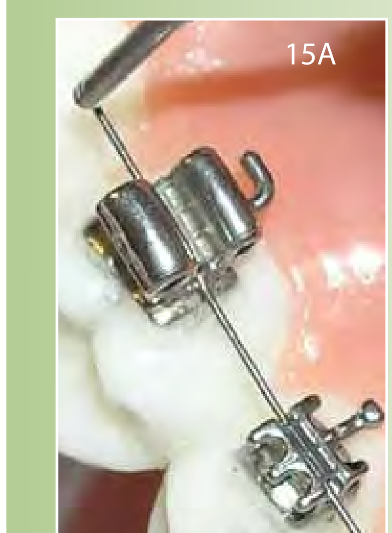
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The use of Temporary Anchorage Devices *for Molar Intrusion*

By Neal D. Kravitz, DMD; Budi Kusnoto, DDS, MS; T. Peter Tsay, DDS, PhD; William F. Hohlt, DDS

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ABSTRACT

Image courtesy of RMO Inc./ Did not appear in original JADA article.

Background. This article reviews the use of temporary anchorage devices (TADs) for maxillary molar intrusion.

Types of Studies Reviewed. The authors reviewed clinical, radiographic and histologic studies and case reports. The studies provided information regarding the application, placement and biological response of orthodontic TADs.

Results. TAD-supported molar intrusion is controlled and timely and may be accomplished without the need for full-arch brackets and wires. Supraerupted maxillary first molars can be intruded 3 to 8 millimeters in 7.5 months (approximately 0.5 - 1.0 mm per month), without loss of tooth vitality, adverse periodontal response or radiographically evident root resorption.

Clinical Implications. True molar intrusion can be achieved successfully with orthodontic TADs, re-establishing a functional posterior occlusion and reducing the need for prosthetic crown reduction.

Key Words. Temporary Anchorage Device; intrusion.

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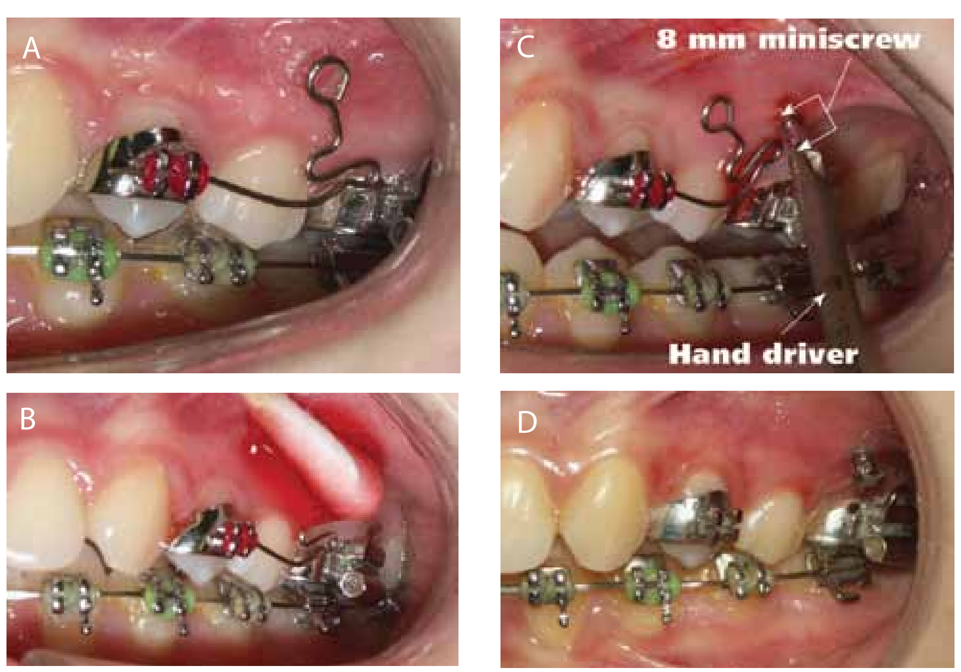

Figure 1. A. Surgical guide marks the site of temporary anchorage device (TAD) insertion based on a periapical radiograph. B. Tetracaine, lidocaine and phenylephinerine 20 percent topical anesthetic applied for five minutes. C. Direct insertion of a self-drilling TAD with a hand driver at the mucogingival junction. Angulation 45 degrees from occlusal plane greatly minimizes the risk of root approximation. D. Insertion complete and ready for immediate loading (Dual-Top Miniscrews, Rocky Mountain Orthodontics, Denver). Image of Dual-Top orthodontic miniscrew reproduced with permission of Rocky Mountain Orthodontics.

Supraerupted maxillary molars are a common clinical finding in dental practice. Early loss of the mandibular first molar often leads to extrusion of the opposing maxillary first molar into the edentulous space. Reestablishing a functional posterior occlusion requires a comprehensive dental treatment plan involving full-arch braces, headgear, surgical impaction or iatrogenic root canal therapy with significant occlusal equilibration.[1,2] Orthodontic temporary anchorage devices (TADs) provide a minimally invasive treatment alternative, one that does not require the patient's compliance, for molar intrusion.

This article focuses on orthodontic TADs with specific emphasis on their application in molar intrusion.

TEMPORARY ANCHORAGE DEVICES

A TAD is a titanium-alloy miniscrew, ranging from 6 to 12 millimeters in length and 1.2 to 2 mm in diameter, that is fixed to bone temporarily to enhance orthodontic anchorage.[3] Placement is minimally invasive and often completed using only topical anesthetic (Figure 1). They can be inserted directly through the gingival tissue into bone with a hand driver. In regions of thick soft tissue and dense cortical bone, a mucosal punch and pilot hole may be placed to help guide insertion. Stationary anchorage is achieved by gripping mechanically to cortical bone, rather than by osseointegration.[4] Therefore, the orthodontist is able to load the TAD immediately, as well as remove it with a simple twist of the hand driver. Stationary anchorage failure of TADs under orthodontic loading varies between 9 and 30 percent.[5-8]

Self-tapping versus self-drilling TADs. TADs are either self-tapping or self-drilling in design. Self-tapping TADs feature a conical design with a threaded shaft and a tapered furrow at the tip. These miniscrews often require a pilot hole before being inserted with a hand driver. Self-drilling TADs feature a corkscrew design with a threaded shaft and a sharp tip.[9] The shaft is designed to work like a cutting flute, expelling bone debris onto the surface during insertion.[9] Self-drilling TADs are placed directly with a hand driver without the need for a pilot hole.

TREATMENT CONSIDERATIONS

Patient selection. TADs are approved by the U.S. Food and Drug Administration for use in patients 12 years and older.[10] Juvenile patients who have not completed skeletal growth, as determined by a hand-wrist radiograph, should not undergo TAD placement directly into the maxillary palatal midline suture.[10] Ossification of the palatal suture will continue through the late 20s.[11] TADs are contraindicated in heavy smokers and patients with bone metabolic disorders.[12]

Proper location for TAD insertion. TADs should be inserted into a region with high bone density and thin keratinized tissue. The location chosen should be the optimal one in terms of both the patient's safety and biomechanical tooth movement. Bone density and soft-tissue health are the key determinants that affect stationary anchorage and miniscrew success.[6]

Bone density and Misch classifications. Stationary anchorage failure often occurs because the TAD was placed in a region of low bone density with inadequate cortical thickness.[13] Misch[14] classified bone density into four groups—D1, D2, D3 and D4—based on the number of Hounsfield units (HU)—units of measurement used in computed tomographic scanning to characterize tissue density. D1 (> 1,250 HU) is dense cortical bone primarily found in the anterior mandible, buccal shelf and midpalatal region. D1 bone has the tactile analogue of oak. D2 (850-1,250 HU) is porous cortical bone with coarse trabeculae found primarily in the anterior maxilla, the midpalatal region and the posterior mandible. D2 bone has the tactile analogue of pine. D3 (350-850 HU) is thin (1 mm), porous cortical bone with fine trabeculae, found primarily in the posterior maxilla and mandible. D3 has the tactile analogue of balsa wood. D4 (150-350 HU) is fine trabecular bone, found primarily in the tuberosity region (Figure 2). D4 has the tactile analogue of polystyrene foam.[14]

Regions of D1 to D3 bone are adequate for TAD insertion. TADs placed in D1 bone may require a drilled purchase point to perfetrate the thick outer cortical plate. TADs placed

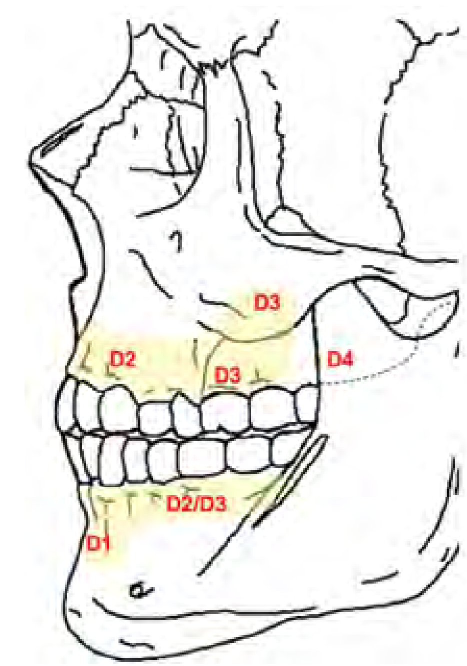

Figure 2. Regions of bone density (as classified in Misch.[14]) D1 bone has the highest density. D4 bone has the lowest density and is not recommended for placement. Temporary anchorage devices (TADs) can be placed in D1 to D3 bone (yellow region) with a 70 to 90 percent success rate. The maxillary midpalatal region (not shown) contains D1 and D2 bone. TADs placed in the retromolar pad or zygomatic region may require a flap; patients requiring such placement should be referred to a surgeon.

in D1 and D2 bone exhibit lower stress at the screw-bone interface and may provide greater stationary anchorage during loading.[15] Placement in D4 bone is not recommended owing to the high failure rate associated with it (35-50 percent).[16,17]

Soft-tissue health. Inflammation of the surrounding soft tissue is directly associated with stationary anchorage failure.[6,7] TADs placed in nonkeratinized alveolar tissue have a greater failure rate than those inserted into attached tissue.[6] The loose alveolar tissue is irritated easily, leading to gingival inflammation and overgrowth of the miniscrew head. In the buccal posterior region where the mucogingival junction is shorter, the clinician may choose to place the TAD in alveolar mucosa to avoid root proximity.

Bone availability. In the maxillary posterior dentoalveolus, the greatest amount of interradicular bone is located between the second premolar and first molar, 5 to 8 mm from the alveolar crest.[18,19] In the mandibular posterior dentoalveolus, the greatest amount of interradicular bone is on either side of the first molar, approximately 11 mm from the alveolar crest. In the anterior region of the maxilla and mandible, the greatest amount of interradicular bone is located between the canine and lateral incisor.[18,19] If inadequate interradicular bone is available, the clinician can place the TAD palatally or diverge the roots before inserting it.

PLACEMENT OF TEMPORARY ANCHORAGE DEVICES

Insertion technique. Proper angle of insertion is important for cortical anchorage, the patient's safety and biomechanical control. In the posterior maxilla, the angle of insertion should be 30 to 45 degrees to the occlusal plane.[20] Steeper angulation (< 30 degrees) minimizes the risk of root perforation but may increase the risk of miniscrew slippage. In the anterior maxilla and posterior edentulous maxilla, the angle of insertion should approximate 90 degrees to the occlusal plane (parallel to the paranasal sinus floor) to minimize perforation of the sinus.[21] This allows for a more gingival position of the TAD head, which is biomechanically advantageous during molar intrusion. In the mandible, the angle of insertion should be

Figure 3. Surgical stents. **A.** Before insertion in the posterior region, a 16 round stainless steel wire is placed at the level of the mucogingival junction. **B.** Radiographic confirmation of adequate interradicular bone thickness and proper insertion site. **C.** Before insertion in the anterior region, 16 x 16 stainless steel wires are placed outlining the outer margins of the roots (technique was introduced by W.F.H.). **D.** Postoperative radiograph confirming accurate interradicular placement.

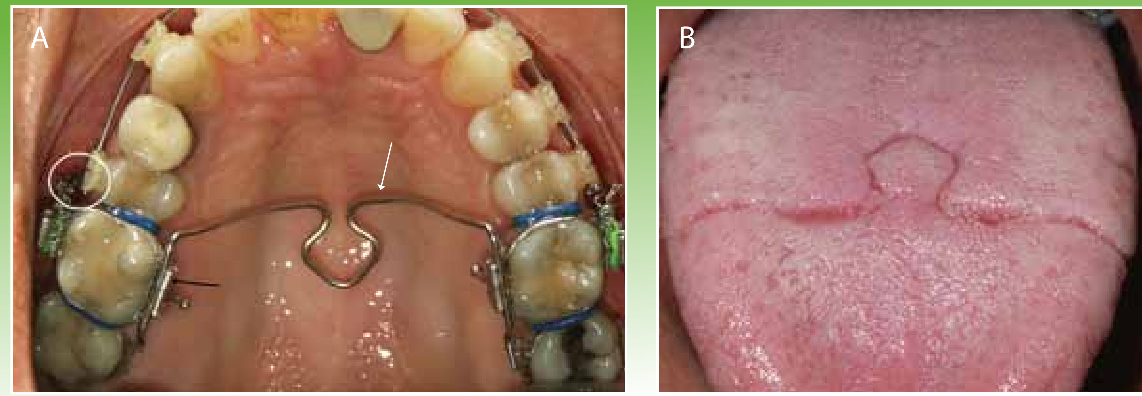

Figure 4. Molar intrusion with a single temporary anchorage device (TAD) and a transpalatal bar. **A.** Placement of the TAD between the second premolar and first molar (white circle). Buccal root activation is applied to the transpalatal bar (black arrow). The transpalatal arch is raised 3 to 5 millimeters away from the palate. (White Arrow)

B. Resting tongue pressure against the transpalatal bar aids with intrusive forces.

30 to 45 degrees to the occlusal plane to increase the surface area contact between the miniscrew and the thicker cortical bone.[20] A surgical stent made of orthodontic wire can be used to guide insertion (Figure 3).

Force load. In regard to stationary anchorage, numerous articles have recommended loading forces of 300g of force or less.[5,6,22-27] Dalstra and colleagues[28] suggested loading forces of 50g in regions of thin cortical bone and fine trabecula. Buchter and colleagues[22] reported that TADs inserted into dense mandibular bone remained clinically stable at forces up to 900g. In regions of poor bone density, simply placing a longer screw or applying lighter force does not ensure stationary anchorage.[6,29]

Intrusive force should be light and continuous to produce the appropriate pressure within the periodontal ligament and minimize the risk of root resorption.[30] Kalra and collagues[31] used 90g of force to intrude maxillary molars in children; Melsen and Fiorelli[32] used 50g of force to intrude maxillary molars in adults. Park and colleagues[33] used 200g of force for miniscrew-supported maxillary molar intrusion, and Umermori and colleagues[34] used 500g of initial force for miniplatesupported mandibular molar intrusion. The recommended force for miniscrew-supported maxillary molar intrusion is 100 to 200g. En-masse intrusion of the second premolar and the first and second molar requires greater force, approximately 200 to 400 g per side.[35,36]

Chlorhexidine rinse. Chlorhexidine (0.12 percent, 10 milliliters) should be used a minimum of twice daily during the first week after placement and continued throughout the course of treatment if needed to minimize soft-tissue inflammation. Chlorhexidine is a cationic, bacteristatic and bacteriocidal rinse that works via sustantivity within the oral cavity. It has the added benefit of slowing down epithelialization, which may limit soft-tissue overgrowth. After rinsing with chlorhexidine, patients should wait 30 minutes before brushing with fluoridated toothpaste. The anionic agents in fluoridated toothpaste will reduce the activity of the rinse, and the surface contact of the toothbrush will remove the chlorhexidine coating.[37]

MAXILLARY MOLAR INTRUSION WITH TEMPORARY ANCHORAGE DEVICES

Protocol. For maxillary molar intrusion using a single TAD, the miniscrew should be placed in the buccal dentoalveolus between the second premolar and first molar at the mucogingival junction. To prevent the intruding molar crown from tipping buccally, the clinician can place a transpalatal arch with buccal root activation. The transpalatal arch should be raised 3 to 5 mm away from the palate to allow resting tongue pressure to aid with intrusion (Figure 4).

For maxillary molar intrusion using two TADs, one miniscrew should be placed in the buccal region between the first and second molar; the other in the palatal slope between the second premolar and first molar just medial to the greater palatine nerve. This will allow the elastic chain or nickel-titanium coil to pass diagonally across the occlusal table. Owing to the angulation of the palatal slope, there is a tendency for the molar to tip palatally during intrusion. Partial braces may be needed during or after intrusion to prevent the molar from moving into crossbite (Figure 5).

In the absence of adequate interradicular space, TADs can be placed in the palate, either in the midline region or on the palatal slope. TADs placed in the midline region often require an extension arm reaching up the palatal slope (Figure 6). Partial braces from the first premolar to the second molar can be placed to counterbalance palatal crown tipping.

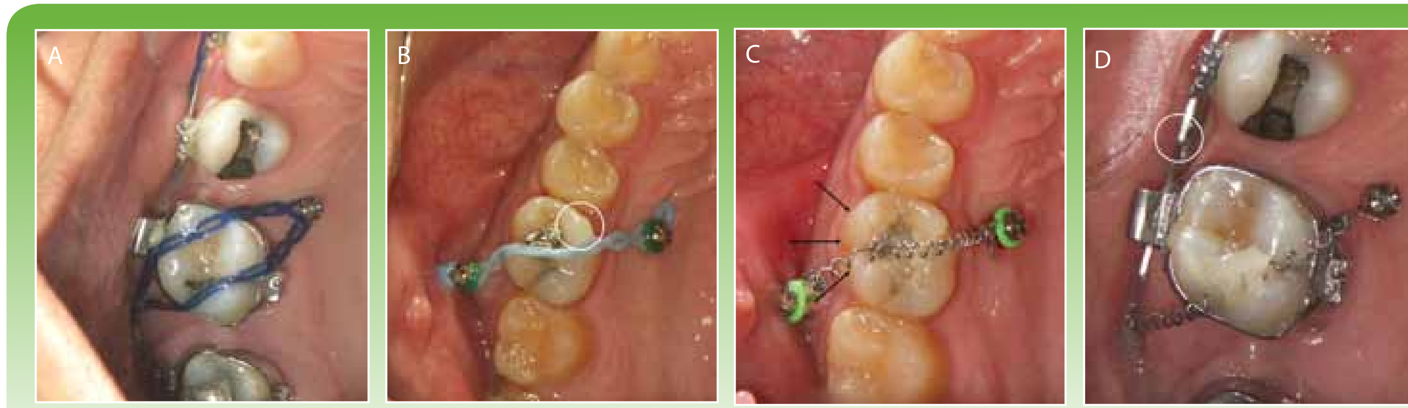

Figure 5. Molar intrusion with two temporary anchorage devices (TADs). The buccal TAD was placed between the first and second molar, and the palatal TAD was placed between the second premolar and the first molar. Placement of the palatal TAD mesial to the first molar avoids the greater palatine foramen and D4 bone. **A.** Criss-cross design with elastic chain. **B.** Twisting of the elastic chain and cuspal buildup with resin-based composite (white circle) prevents the chain from slipping off the occlusal table during mastication. **C.** A 150-gram nickeltitanium (NiTi) coil. Notice the tendency of the molar to tip palatally during intrusion (black arrows). D. A 150-g NiTi coil stabilized with band cement to the occlusal surface. Partial fixed appliances (white circle) minimize unwanted tipping.

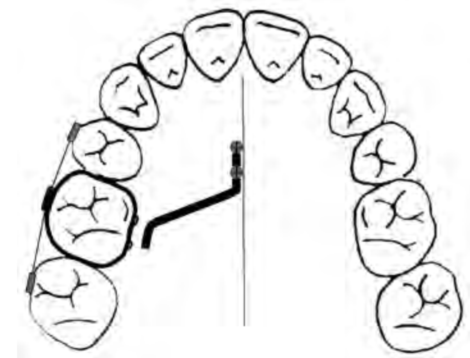

Figure 6. Extension bar. Palatal miniscrews will require an extension bar to reach up the palatal slope for molar intrusion. Often, two temporary anchorage devices are placed to prevent rotation of the bar. Partial fixed appliances minimize palatal crown tipping.

Rate. The rate of single molar intrusion[2,32,34-36,38] (Table) is approximately 0.75 mm per month. Yao and colleagues[2] investigated maxillary molar intrusion in 26 first molars and 17 second molars. The authors reported a mean intrusion of 3 to 4 mm (range, 3.68-8.67 mm) for the first molar and a mean intrusion of 1 to 2 mm for the second molar in 7.5 months. Sherwood and colleagues[38] presented two case reports of maxillary first molar intrusion and reported a mean intrusion of 4.1 mm after 6.5 months. Sherwood and colleagues[39] intruded maxillary first molars in four adults and reported a mean intrusion of 2.0 mm (range, 1.45-3.32 mm) after 5.5 months. Park and colleagues[33] presented two case reports of maxillary first and second molar intrusion and reported an intrusion rate of 0.5 to 1.0 mm per month (Figure 7).

The rate of en-masse intrusion of the second premolar and the first and second molar is approximately 0.5 mm per month. Erverdi and colleagues[36] performed en-masse intrusion in 10 adults and reported that the maxillary first molar intruded 2.6 mm in 5.1 months. In a case report of en-masse intrusion by Erverdi and colleagues,[35] the authors found that the maxillary first molar intruded 3.6 mm in seven months. In a case report by Yao and colleagues[1] in which the first and second molars were intruded simultaneously, the authors reported that the first molar and second molar intruded approximately 3 mm in five months.

Root resorption. Teeth undergoing orthodontic intrusion may be highly susceptible to root resorption.[40] Pressure from intrusive forces concentrate at the root apex, leading to compression and necrosis of the periodontal ligament. Several studies have examined root resorption of posterior teeth in regard to traditional orthodontic treatment. Sharpe and colleagues reported that molars have the second highest incidence

Amount of maxillary molar intrusion and length of active intrusion time.

Study	Tooth Measured	Intrusion Time (Months)	Mean Amount of Intrusion (mm*)
Single-Tooth Intrusion			
Yao and Colleagues[2]	First Molar Second Molar	7.5 5.0	3-4 (range, 3.68-8.67) 1.0-2.0
Park and Colleagues[33]	Second Molar First Molar	5.0 8.0	0.5-1.0 mm/ month
Sherwood and Colleagues[38]	First Molar Second Molar	5.5 7.5	4.0 4.2
En-Masse Intrusion			
Yao and Colleagues[1]	First Molar Second Molar	5.0 5.0	3.0 2.0 - 3.0
Erverdi and Colleagues[35]	First Molar	7.0	3.6
Erverdi and Colleagues[36]	First Molar	5.1	2.6
Sherwood and Colleagues[39]	First Molar	5.5	2.0 (range, 1.45-3.32)
* mm: Millimeters			

TABLE

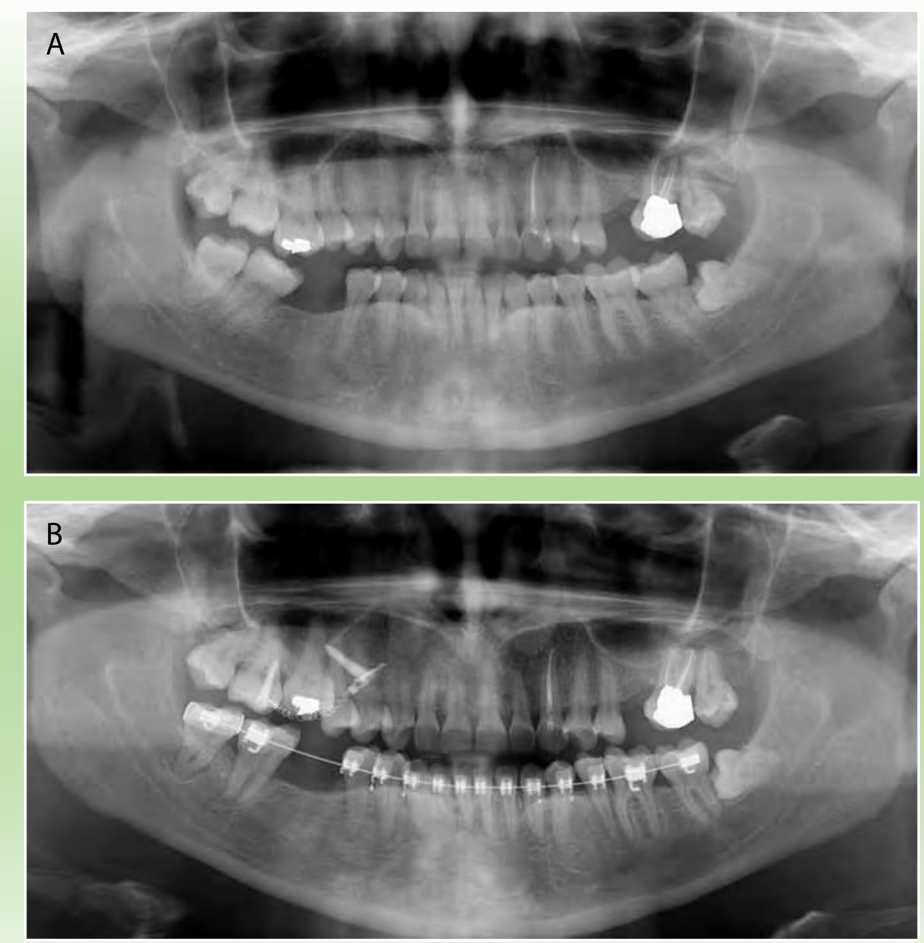

Figure 7. A. Pretreatment panoramic radiograph of patient with a supraerupted maxillary first molar as a result of early loss of the mandibular first molar. B. Postintrusion panoramic radiograph taken before removal of the temporary anchorage device, showing that 4.4 millimeters of molar intrusion was achieved in less than six months without the need for a fixed appliance. The maxillary molar was intruded within the maxillary sinus without radiographically detectable root resorption. A removable retainer was made to allow the molar to settle into proper occlusion.

of root resorption, after incisors. Beck and Harris[42] reported root resorption in first molars undergoing tip-back and intrusion mechanics. McNab and colleagues[43] reported root resorption of the maxillary first molar after distalization and intrusion with a high-pull headgear. Reitan[44] showed histologically that resorption may occur in premolars subjected to 25 to 240g of force. In contrast, Owman-Moll[45] reported no difference in root resorption for premolars undergoing light (50g) and heavy (200g) orthodontic load in the buccal direction.

DISCUSSION

Miniscrew-supported molar intrusion has drawn great interest among researchers, especially in terms of whether molars can be intruded under continuous heavy force without significant root resorption or perforation of the sinus floor. Ari-Demirkaya and colleagues[46] measured root resorption of maxillary first molars after intrusion with TADs. The study compared 16 consecutively treated adults who underwent molar intrusion by means of skeletal anchorage with a control group of 16 adults who had undergone fixed orthodontic treatment without molar intrusion. The authors concluded that the amount of root resorption detected after molar intrusion was not clinically different from that in control groups treated without intrusion mechanics. In an animal study, Daimaruya and colleagues[47] intruded maxillary second premolars into the nasal floor of six beagles to histologically elucidate the effects of molar intrusion against the maxillary sinus floor. The beagle's nasal sinus and bony floor are histologically similar to the human maxillary sinus. The authors reported a mean apical root resorption (± standard deviation) of only 0.18 ± 0.18 mm after seven months of intrusion. The sinus floor membrane lifted intranasally with the intruding palatal root.

Risks and complications of molar intrusion. The potential risks of TAD placement must be understood clearly by both the clinician and the patient.

Root trauma. Trauma to the periodontal ligament or dental root may lead to loss of tooth vitality or ankylosis. If there is no pulpal involvement, the outer root and periodontium may demonstrate complete repair in three to four months.[48]

Stationary anchorage failure. TADs may become loose,[6] tip and extrude[29] under orthodontic load. Miniscrews that become mobile will not regain stability and may need to be removed and reinserted. Inadequate primary stability on initial placement likely is a result of inadequate cortical bone thickness.[49] Delayed mobility that occurs days or months after placement likely is a result of inadequate cortical thickness and excessive force load.[50]

Soft-tissue irritation. TADs placed in loose alveolar mucosa may result in soft-tissue irritation, tissue overgrowth and minor aphthous ulceration.[6]

-Nerve injury. Placement of TADs in the maxillary palatal slope risks injury to the greater palatine nerve. The greater palatine nerve exits out its foramen, which is located laterally to the second or third molar,[51] and it travels anteriorly along the palatal slope 5 to 15 mm from the gingival border.

Sinus perforation. Small (< 2 mm) perforations of the paranasal sinus floor will heal by themselves without complications[52,53] and should not affect miniscrew stability.[54] Larger perforations may result in sinusitis or a chronic oroantral fistula.[52] TADs diameters rarely exceed 2 mm, and TADs may not need to be removed if the patient is asymptomatic.

Relapse. Relapse extrusion of intruded molars may occur. The average relapse rate for first and second molar intrusion is approximately 30 percent.[54]

CONCLUSION

The scope of orthodontics is expanding. TADs have allowed the orthodontist to overcome anchorage limitations and perform difficult tooth movements predictably and with minimal patient compliance. Restorative dentists, periodontists and surgeons should ensure that they have a clear understanding of the many applications of orthodontic TADs when presenting patients with options for correcting occlusal problems.

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A Comprehensive Study of *Kinetic Frictional Forces on Brackets*

By Doctors'

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THE WINNER IS SYNERGY LUX

Figure 1: Clinical effects of the Synergy lux on alignment, leveling and torque control.

BACKGROUND OF THE STUDY

The Straight Wire Technique is one of the most commonly used prescriptions by leading Orthodontists around the world. Sliding mechanics dictate how critical the friction generated between the brackets, ligatures, and arch wires is during early alignment and space closing phases (Figure 1).

The aim of this study was to determine the frictional forces on a series of three offset fixed brackets, thus simulating the alignment phase. The study determined which arch wire-bracket-ligature combination resulted in the lowest alignment friction. By understanding the importance of these forces, it provides a more efficient way to achieve effective tooth movement and maintain the optimum biological response. Each bracket was cemented to a positioning jig at various heights in order to simulate a series of different crowding conditions.

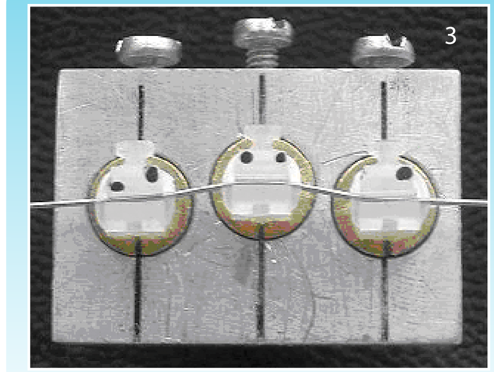
Once the clinician can manipulate various forces, it is easier to achieve efficient tooth movement, while maintaining the optimal biological response. Some of the many advantages of optimizing treatment include minimizing patient discomfort, decreasing the clinician's chair time, decreasing the number of appointments, and reducing the duration of overall treatment time.

Adult patients are quickly becoming a large segment of the treatment population and aesthetically pleasing brackets are their treatment of choice. Adults typically require treatments involving combinations of transparent splints, removable appliances, lingual orthodontics, and aesthetic brackets. Various problems occur with these "invisible treatments" because they are not appropriate for the orthodontist, are too complicated, change the management style of the office, or simply because the appliances are of poor quality. As for the friction forces being generated, aesthetic brackets have traditionally had more problems than those of stainless steel. Enamel fracture, difficult debonding, attrition by teeth occluding against the bracket, lack of strength and stiffness, and poor torque control due to deformation of the slot make ceramic brackets difficult to work with. Ceramic brackets limit the rotation control during treatment and have also been known to cause staining.

The growing request for "invisible treatment" and technological advances in product development have caused different kinds of wires, accessories, micro screws, and brackets to be designed. The most recent bracket designs take advantage of the properties of new "super wires" while keeping customer satisfaction at the highest level.

Bracket Type	Feature	Configuration	Composition	Arch Slot	Prescription
Synergy LUX	Friction Selection Control	Low friction	Polycrystalline with a 18-kt gold insert	.022"	-7° 0 °0°
LuxiTM II	Twin bracket	Conventional	Polycrystalline with a 18-kt gold insert	.022"	-7° 0° 0°
SignatureTM III	Twin bracket	Conventional	Polycrystalline	.022"	-7° 0° 0°
Synergy® Classic	Friction selection control	Low friction	Stainless steel	.022"	-7° 0° 0°
Mini-Taurus®	Twin bracket	Conventional	Stainless steel	.022"	-7° 0° 0°

Figure 2



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MATERIALS AND METHODS

A total of 180 brackets were tested: 36 polycrystalline conventional ceramic brackets (Signature III, RMO, Denver CO), 36 polycrystalline ceramic brackets with gold arch slot inserts (Luxi® II, RMO, Denver CO), 36 conventional stainless steel brackets (Mini-Taurus®, RMO, Denver CO), 36 Friction Selection Control (FSC) stainless steel brackets (Synergy® Classic, RMO, Denver CO), 36 Friction Selection Control (FSC) gold insert aesthetic brackets (Synergy LUX, RMO, Denver CO). All the brackets used in this study were maxillary premolar brackets with the following identical features: nominal slot dimension (.022" inch), prescription: torque -7°, angulation 0°, and rotation 0° (Figure 2).

The test assembly was designed to use a special metal positioning jig in order to position 3 brackets in any vertically and horizontally misaligned state (Figure 3). Interbracket distance was 7mm and the central bracket was positioned 1mm upward relative to the remaining two brackets. The vertical jigs on the outside brackets were also 1mm outward with respect to the opposing background plane. All test brackets were individually bonded, using composite resin (MonoLok2, RMO, Denver CO) to a brass mount in a setting apparatus before being inserted into the positioning jig. The cylindrical brass mount contained a hole in order to retain the resin and achieve good physical retention. The midline acted as a guide for reproducible bond positioning of the bracket and correct placement of the cylinder in the jig. Bonding was achieved by positioning the bracket on the cylinder, using a supporting .016" x .022" inch stainless steel wire as described by Thomas et al.[12] (Figure 4). Correct bracket placement was achieved by using the largest size arch wire (.022") to fill the entire slot height, thus representing the alignment phase of treatment. Lastly, the metal ligature (Preformed ligature wire .010", RMO, Denver CO) was used during bonding in order to assure that the wire came into contact with the base of the slot. This assured that friction was not induced by adverse tipping, torsion, or rotational movements.

All the arch wires used in this study were straight thermal NiTi .014" (Thermaloy®, RMO, Denver CO). We used this wire because it is one of the most common wires to start with in the alignment phase of treatment. The ligatures used to tie the brackets to the jig were elastic Synergy low friction ligatures (RMO, Denver CO), ligated conventionally on all the brackets except for Synergy. The Synergy brackets were tied on the center wing only in order to utilize the low frictional force for advanced sliding mechanics. RMO refers to their Synergy ligating options as Friction Selection Control (FSC), and this encompasses low friction, minor rotation, major rotation, conventional, and full control functions.

MEASUREMENT TECHNIQUE

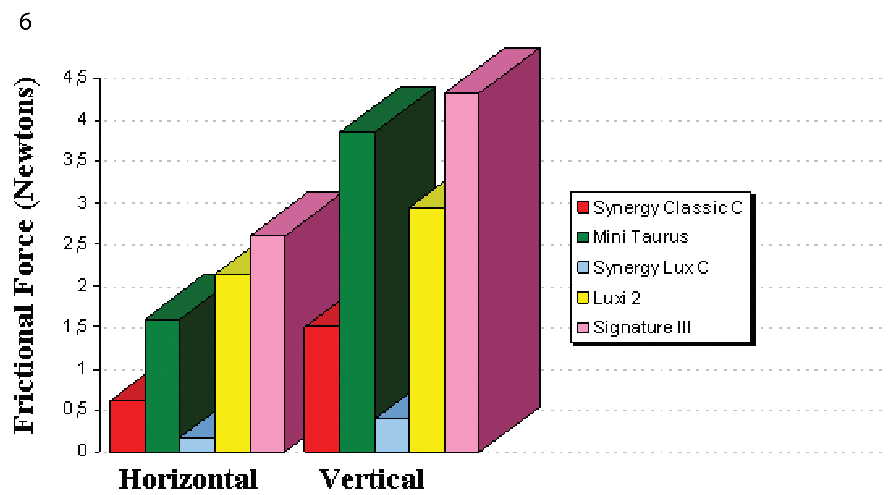
A frictional testing machine was designed and made by the Istituto per i Processi Chimico Fisici (IPCF) of the Consiglio Nazionale delle Ricerche (CNR) in Messina (Italy), especially for this study. The testing machine consisted of a static carriage, which supports the positioning jig described above, and runs along two vertical parallel rods with four smooth linear ball bearings. The carriage weight acted on a force-sensor through a vertical rod to which it was firmly fixed. Each output from the sensor was read through an interface and fed into the computer. The arch wires were threaded through the brackets and assembled to a moving carriage that was driven by a computer controlled step motor. The step motor drove the moving carriage at a constant speed of 4mm/minute. The corresponding force measured by the sensor varied for each bracket type due to the frictional coupling between the moving arch wire and the brackets (Figure 5).

Tests were carried out in a dry state at 37°C in order to maintain an active state in the thermal arch wire. The computer calculated the average kinetic frictional force over 100 data points, while running the arch wire through the set of three brackets on a 5 mm segment of the arch wire. A single test was carried out with 3 new brackets, elastic ligatures and an arch wire. At the end of each test, the testing machine was turned off, the brackets and arch wire assembly were removed, and three new brackets were installed to eliminate the influence of wear. Six trials were performed for each bracket/arch wire combination. Before starting each test, the brackets and arch wires were cleaned with 90% ethanol to remove any surface debris.

Once the data was obtained, it was displayed and recorded by software specially dedicated for this study on a XY recorder. The XY recorder measured the frictional forces with respect to the horizontal (X) and vertical (Y) vectors. This was necessary in order to accurately quantify the results in a predetermined misaligned state.

RESULTS

The results of the frictional forces exerted by the different bracket types are presented in the table (Figure 6) below (both horizontal and vertical vectors). With respect to the horizontal friction, there were large differences between FSC Synergy brackets and conventional brackets. Synergy LUX showed the lowest friction values followed by Synergy Classic, Mini-Taurus, Luxi II, and finally, Signature III. The difference between Synergy FSC and conventional brackets was even greater for the vertical misalignment. Synergy LUX again displayed the lowest friction, then Synergy Classic, followed by Luxi II, Mini-Taurus, and then Signature III.



DISCUSSION

There are a large number of variables that influence the frictional forces generated by fixed orthodontic appliances. In order to focus on one segment of orthodontic movement, we evaluated those related to bracket and slot, form and material, and to the type of misalignment. In regards to bracket form, Synergy Classic and Synergy LUX were more advantageous than twin brackets (Mini-Taurus, Signature III and Luxi II) in terms of sliding mechanics. The Synergy Classic and Mini-Taurus were fabricated using Metal Injection Molded (MIM) technology. Signature III brackets are made of polycrystalline alumina and the Luxi II/Synergy LUX have gold arch slot liners in the polycrystalline alumina.

Measurements of friction with respect to the horizontal vector for stainless steel twin brackets showed that the Mini Taurus exhibited 2.6 times more drag than Synergy Classic brackets (low friction configuration - only tied on the central wings) - "C". We attribute a large portion of the reduced friction to ligating Synergy Classic brackets around the center tie wing only. The elastic ligature does not touch the arch wire and this is the fundamental difference between Synergy FSC and traditional brackets that restrict the movement (Figure 7).

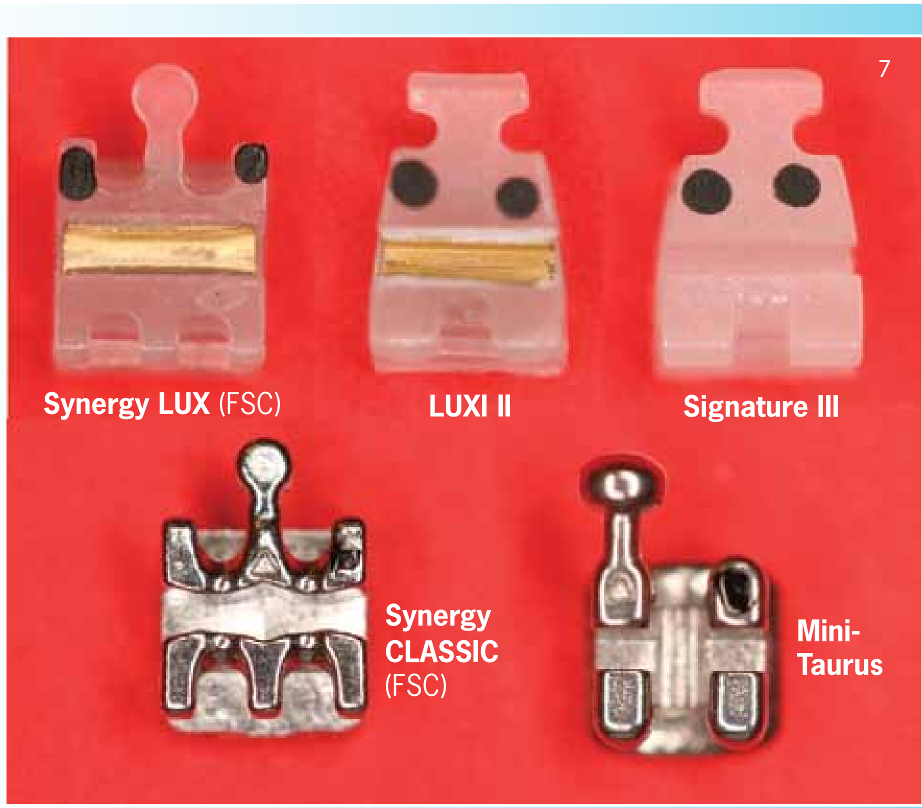


Figure 7

The curvatures at the mesial and distal ends of the Synergy slot prevent the arch wire from binding during the alignment phase. The coupling effect of greater interbracket distance and less frictional drag allow the teeth to move very quickly during the initial stage of treatment. This can significantly reduce overall treatment time when the clinician is treating patients with severe crowding.

The same frictional advantage occurs when comparing Synergy LUX with polycrystalline alumina twin brackets; however they exhibit even less drag on the arch wires during movement. While measuring the friction with respect to the horizontal vector, Luxi II brackets exhibited 12.8 times more drag than those measured with Synergy LUX brackets (low friction configuration "C" - only tied around the central tie-wings). Signature III polycrystalline alumina brackets exhibited 15.6 times more drag than those measured with the Synergy LUX brackets. This enormous difference among frictional forces was due to the greater drag, which is usually generated when comparing aesthetic brackets to stainless steel brackets as reported in the studies of Thorthenson and Kusy, Loftus et al., Cacciafesta et al., and Rajakulendran and Jones. The Synergy LUX bracket showed the lowest horizontal friction force of 0.19 Newtons, which is close to 0 friction, followed by Synergy Classic, Mini Taurus, Luxi II, and finally Signature III.

The differences between triple wing brackets and other bracket types were even greater for the vertical component of frictional force. While simulating vertical misalignment, Mini-Taurus had 2.6 times more drag than Synergy Classic, which was the same result for the horizontal vector. We attribute this reduction in friction to the curved mesial and distal ends of the slot as well as center tie-wing ligation. Luxi II exhibited 7.5 times higher drag than Synergy LUX and Signature III was 10.8 times higher than Synergy LUX. These results could be attributed to the low levels of friction generated between Synergy brackets and arch wires when tying the ligature around the center tie wing only. The ligature does not contact the arch wire, which further reduces the frictional forces. When the choice is aesthetic brackets, the results show Synergy LUX is the best for reduced friction and optimal sliding mechanics.

CONCLUSIONS

As we know, ideal biological and physiological forces are those light forces produced by the new thermoelastic wires during the first phase of treatment (the alignment phase). In order to fully utilize the new "superwires", clinicians should use brackets that allow free sliding and do not restrict movement in the arch slot. These characteristics represent low friction brackets.

In this study we used Friction Selection Control brackets (Synergy brackets tied with a ligature around the center tie-wings only) and found that they are the gold standard for the alignment phase during fixed orthodontic treatment. These brackets are also the best for the space closing phase. Thanks to the versatility of Synergy brackets, we could use low friction control when we need it and quickly change to other modes of friction control throughout all phases of treatment.

Until now, we did not have light force, low friction brackets with the aesthetics that patients wanted. Despite the intention companies had to reduce friction generated in aesthetic brackets, they fell short of achieving their goals. With the Synergy LUX bracket, RMO did not fabricate just another aesthetic bracket line but also produced the lowest frictional forces in our study.

We would like to thank the Istituto per i Processi Chimico Fisici (IPCF) of the Consiglio Nazionale delle Ricerche (CNR) in Messina (Italy) and Rocky Mountain Orthodontics for supplying materials.

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The SYNERGY bracket design & its Aptitude for Working with Low Friction Mechanics

By Doctors'

Riccardo Nucera, Giovanni Matarese, Cristina Barreiro Torres, Sergio Sambataro, David Suárez Quintanilla, Giancarlo Cordasco

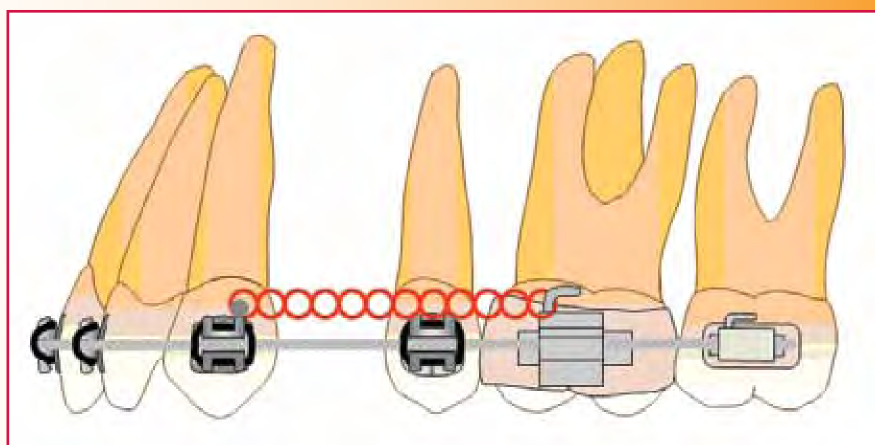

Figure 1. Emblematic clinical situation of space closure. If hypothetically the net force necessary to move the canine is 50gr and the frictional force at the canine-bracket/wire interface is 50gr, consequently the posterior anchorage system will be charged with 100gr. If we reduce the amount of frictional force, we will reduce the load to the anchorage.

INTRODUCTION

Nowadays, the straight-wire orthodontic techniques are in widespread use. Whenever orthodontic straight-wire mechanics are used, dental movement occurs along with the sliding between bracket and wire. In this type of mechanics, the frictional forces play a critical role on the level of force transmitted to the periodontal structures of teeth. Indeed, orthodontic appliances currently employed in orthodontic mechanics must transmit to the brackets adequate level of force to:

1. Overcome the frictional forces that oppose sliding between wire and bracket

2. Exert on the periodontal ligament (PDL) an appropriate amount of residual force to produce dental movement[1].

Keeping this assumption in mind, it becomes obvious that it is critically important to estimate proper frictional forces in every phase of treatment.

The use of insufficient forces in dental movement slows down treatment, whereas the use of exaggerated forces can overload the periodontal structures. By the use of low friction mechanics, and consequently low force mechanics, clinicians are able to acheive two important goals:

1. To preserve anchorage systems (Figure 1).

2. To exploit more predictable and more appropriate levels of force.

Unfortunately it is not possible to estimate in-vivo resistance to sliding (RS), consequently the only data available for the clinicians arise from in-vitro research on frictional forces.

To evaluate in-vitro the impact of different variables that contribute to frictional forces becomes a complex subject. The complexity of this topic is related to the large number of variables necessary to isolate this kind of in-vitro study and clarify how they affect frictional forces: bracket design, type of ligation, wire and bracket alloy, bracket-slot dimensions, wire cross-section dimensions, the presence of saliva or other lubricating liquids, and the presence of second and/or third order angulations.

In 1699 Amontos and in 1781 Coulombs experimentally demonstrated that in dry conditions frictional forces are directly related to:

1. The amount of force acting on the direction perpendicular (Normal) to the direction of the displacement, and

2. A constant value (μ) for 2 given materials that vary on the surface characteristics of the contacting materials during the sliding process, according to the formula:

$$FFR = \mu \, FN \quad (2)$$

This constant is distinguished as 'μs' when the sliding object is initially in a motionless state (static friction), or as 'μd' when the sliding object is moving at a constant speed (dynamic friction).

Due to the complexity of orthodontic biomechanics, it is not possible to exactly reproduce these mechanics in experimental testing. For this reason, the experimental models failed in providing the exact quantification of frictional forces. In effect, some experimental conditions are necessarily different when compared with clinical situations. The wire sliding for example, occurs during the in-vitro tests at a speed varying from 4 to 10 millimeters, while in the oral cavity the sliding speed of the wire is at least 1000 times inferior.

Figure 2 and 3. Conventional ligatures (both elastomeric modules and SS ligature wires) apply a force that pushes the arch-wire against the bottom of the bracket-slot - this leads to an increase of frictional forces.

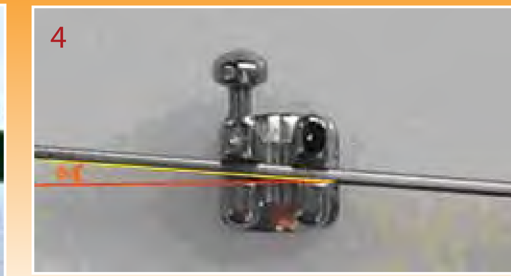

Figure 4. The critical contact angle for binding (θc)

Taking into account that the coefficient of friction for two given materials (μ) varies as a function of the wire sliding rapidity in the "very low velocity range" of orthodontic mechanics[3], it is understandable that experimental tests fail in providing exact frictional values to add algebraically to the forces exerted by orthodontic pre-calibrated appliances. However, it is important to observe that experimental tests are able to provide important qualitative comparisons between different orthodontic materials.

FRICTIONAL FORCES IN STRAIGHT-WIRE MECHANICS

We previously mentioned that frictional forces depend directly on forces that are perpendicular to the direction of movement. In straight-wire mechanics, these forces are essentially:

1. Ligation forces

2. Binding forces

Ligation forces are frictional forces produced by conventional ligatures. Figures 2 and 3 illustrate how conventional ligatures (both elastomeric modules and SS ligature wires) apply a force that pushes the arch-wire against the bottom of the bracket-slot. With conventional ligation, this frictional force is a constant during all orthodontic treatment. Ligation forces can be reduced or eliminated by making use of suitable bracket designs that keep the wire in the lumen slot and avoid pushing the arch-wire against the bottom of the slot, thus leading to reduced friction.

In straight-wire mechanics, the binding forces allow clinitians to achieve dental movement with adequate root control. Unlike ligation forces, binding forces cannot be completely eliminated. Binding can be defined as the force that opposes sliding between wire and brackets, generated when the angulation between bracket-slot and wire exceeds the critical contact angle (θc)[4-6] (Figure 4).

The critical contact angle for binding (θc), is the second-order angulation (Figure 4) at which the archwire first contacts both opposing edges of the bracket. The situation in which θ>θc is defined as active configuration.

The bracket-slot/wire angulations are present in every phase of the orthodontic treatment: during alignment when dental elements are rotated, tipped or not level; during space closure when the sliding of the bracket along the wire is preceded by a tipping movement of the crown; during torque control (critical contact angle of binding from torque in the third-order of space).

HOW TO REDUCE LIGATION FORCES

Self-ligating brackets (SLB) can be defined as orthodontic brackets able to hold orthodontic wire inside the slot without making use of conventional ligatures. SLB can reach this aim by a labial metallic face that is able to close the slot, permitting retention of the wire in the slot. The absence of ligatures helps to avoid the ligation forces mentioned above.

Although self-ligating brackets have been commercially available for many years, they have been used in significantly greater quantities during the last decade. Their increased use was a reflection of superior construction and assembly techniques, which also led to important progress in clinical efficiencies. The self-ligating brackets should be: easy and quick to open and close without the application of forces that could cause bracket de-bonding or patient discomfort; present no "ligation force" between bracket and arch-wire; permit high friction and good torque control when desired. Nevertheless, self-ligating brackets are still complicated in design, complex to assemble, and sometimes difficult to use in practice.

RMO developed the Synergy bracket in the 1990s. While the Synergy bracket is a conventional bracket, its design presents a

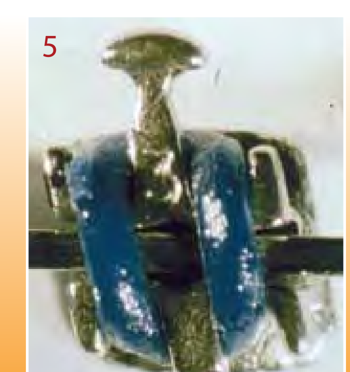

Figure 5, 6, & 7. The Synergy bracket is ligated to the arch-wire by the use of a conventional ligature tied only to the central wings of the bracket (C configuration) - no ligation force is present.

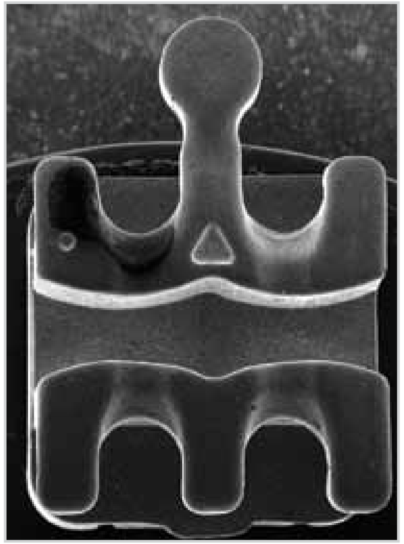

Figure 8. SEM photography of the Synergy bracket. Note the rounded arch-slot walls that are extensively rounded off on their lateral sides.

high aptitude for working with low friction mechanics. The Synergy bracket features six wings instead of the classic four wings of conventional twin brackets. Similar to self-ligating brackets, and thanks to its unique design, the Synergy bracket allows ligating the wire without generating ligation forces. As observed in figures 5, 6, and 7, when the bracket is tied with a conventional ligature only to the central wings of the bracket ('C' configuration), no ligation force is present. In this condition the wire slides freely within the slot of the bracket.

HOW TO REDUCE BINDING FORCES

Ligation force is a constant, while binding force can theoretically increase indefinitely; so the amount of friction produced by the binding force could be much higher than the friction created by the ligation force. For this reason, it is extremely important for the clinician to know which variables affect binding forces.

In the case of active configuration, decreasing wire stiffness and binding angulations can reduce binding forces and consequently resistance to sliding.

The Synergy bracket was designed to reduce binding and frictional force. This bracket presents rounded arch-slot walls and floors that are extensively rounded off on their lateral sides (Figure 8).

At the binding angulations employed in ordinary clinical conditions, the arch-wire contacts with the portion of the arch-slot walls that are rounded off, rather than with the lateral edges of a conventional slot. This feature reduces the effective portion of wire that interacts with the slot of the bracket, and increases the effective inter-bracket distance of the wire between two adjacent brackets.

The increased amount of wire between the brackets leads to a reduction in the stiffness of the wire, and consequently to a reduction of frictional forces during straight-wire mechanics.

MATERIALS AND METHOD

To prove the above mentioned assumption, two experimental model groupings of three non-aligned brackets were created. One in-vitro model presented the central bracket vertically (more apical) mis-aligned by 1mm compared to the other two adjacent brackets (Figure 9). The other experimental model presented the central bracket mis-aligned by 1mm horizontally (more vestibular) (Figure 10).

The experimental models were designed to perform tests in the active configuration regarding binding forces. Kinetic frictions arising between a .014" Thermal NiTi wire (RMO) and both the experimental models were evaluated by a testing machine. During testing, temperature was kept at 37°C and the study was carried out in a dry state.

Two different brackets were tested: Synergy Fx and Mini-Taurus. The Synergy bracket was tested in two different conditions: Ligating elastomerics only to the central wings of the bracket ('C' configuration), and ligating the elastomerics conventionally around all wings of the bracket ('O' configuration). The nominal mesio-distal width of the tested brackets were 3.15 mm for Synergy Fx and 2.95 for Mini-Taurus. The distance between the narrowest portions of the Synergy slot is 1.52mm.

RESULTS AND CONCLUSIONS

Figures 11 and 12 detail the results arising from our experimental tests.

Significant statistical differences ($p<.05$) emerged between all brackets tested in the vertical experimental model. In this experiment, the Synergy bracket delivered an average 50% less frictional force in the 'C' configuration when compared to the 'O' configuration. This result demonstrates the significant influence of ligation forces on resistance to sliding (Figure 11).

The Synergy bracket tested in the 'O' configuration showed reduced frictional forces when compared to the Mini-Taurus bracket, despite Synergy's larger mesio-distal width.

Figure 9. In-vitro model presenting the central bracket vertically (more apical) mis-aligned by 1mm compared to the other 2 adjacent brackets.

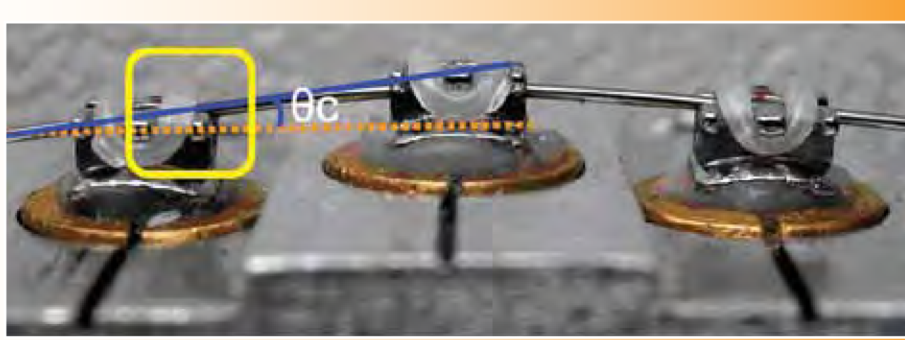

Figure 10. In-vitro model presenting the central bracket horizontally (more vestibular) mis-aligned by 1mm compared to the other 2 adjacent brackets.

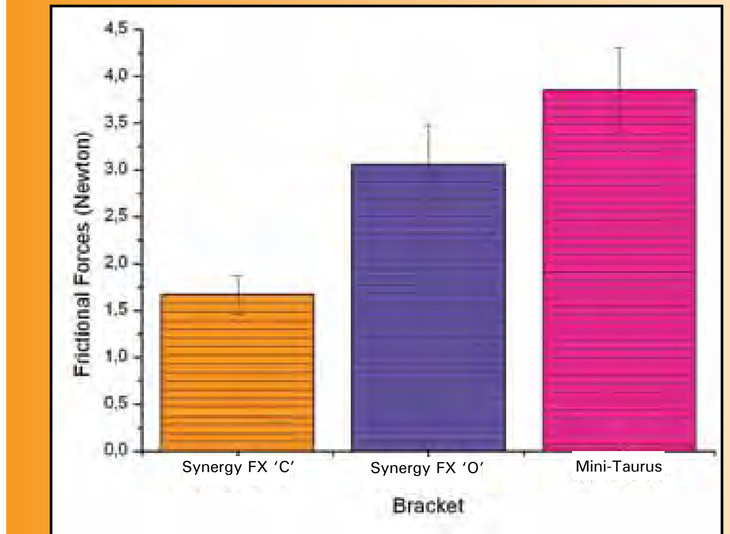

Figure 11. Frictional forces obtained testing the vertical experimental model.

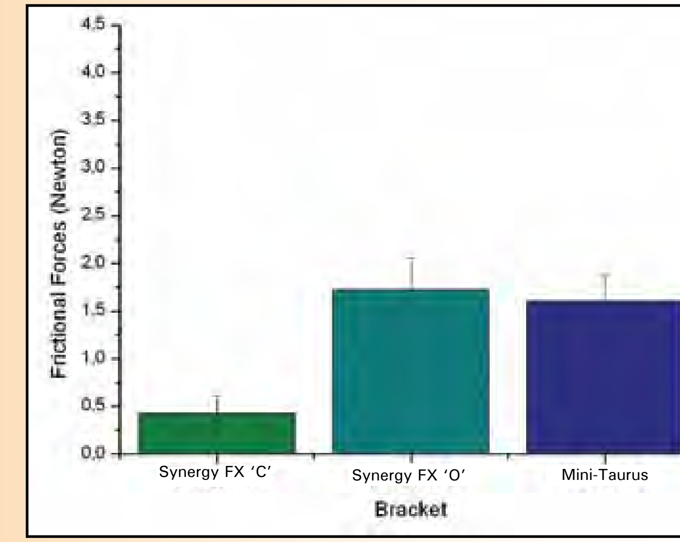

Figure 12. Frictional forces obtained testing the horizontal experimental model.

This outcome illustrates the impact that Synergy's rounded arch-slot edges have regarding frictional forces.

In the horizontal experiment, significant differences ($p<.05$) emerged between the Synergy bracket ligated in the 'C' configuration vs. the other two testing conditions. In this in-vitro model, the Synergy bracket shows an average 66% less frictional force in the 'C' configuration when compared to the other two testing situations (Figure 12).

In this case, the greater reduction of frictional forces compared to the vertical in-vitro model is related to the increased adaptation of the elastomeric module when ligated to the central wings. The adaptation of the elastomeric module reduces the binding angulations in the horizontal plane and therefore the frictional forces. No statistical difference emerged between Synergy ligated in the 'O' configuration vs. the Mini-Taurus bracket in the horizontal in-vitro model (Figure 12).

The absence of ligation force is similar between self-ligating brackets and the Synergy bracket when ligated in the 'C' (center wing) configuration. In contrast the presence of an adaptable vestibular stop (conventional 'O' ligation) of the wire is a peculiar characteristic of the Synergy bracket. This is an important characteristic of the bracket that can increase frictional forces.

In this condition it is possible to use a SS ligature wire to ligate the wire, ensuring full arch-slot engagement of the wire and thus maximum control of rotation also.

Full bracket-slot engagement is required as well during the final phases of treatment to improve torque expression of the preadjusted appliance.

Usually during the alignment phase of orthodontic treatment the wire has to exert a sufficient amount of force to neutralize the frictional forces and generate dental movement.

Taking this assumption into consideration, it is evident that clinicians must couple low friction mechanics with orthodontic wires that exert lower levels of force when compared with the materials traditionally employed. In fact, if we do not reduce the exerted levels of force we could run the risk of overloading the periodontal structures.

Producing dental movements employing forces that are appropriate and predictable is certainly a common goal for clinicians. Theoretically, the most appropriate (and efficient) force to generate dental movement is that one able to produce bone resorption adjacent to the dental root avoiding blood vessel occlusion and therefore the ischemic necrosis localized in the periodontal ligament1. Nevertheless the orthodontic literature does not clarify what is suitable force to generate dental movement. Ren[7] et al. after a systematic literature review deduce that the optimal force to generate dental movement is at the moment still unknown.

Without certain data about the adequate quantification of suitable forces to generate dental movement and the exact amount of frictional forces, we share the opinion of Oppenheim[8], who considered eligible the use of the lightest force able to stimulate tooth movement. Therefore, in the absence of certain scientific findings, we consider the aim of excellence in dental movement to be of fundamental importance, combined with the orthodontist's clinical experience using the appliances frequently employed in his practice.

The use of Nickel-Titanium (NiTi) orthodontic wires has become relevant in recent years during the dental alignment phase. In cases where NiTi wire is coupled with low friction mechanics, it is possible to reduce the amount of exerted force in two different ways: decreasing the cross-section wire dimension or choosing NiTi thermal activated arch-wire rather than super-elastic NiTi wires.

The recent introduction of smaller cross-section dimensioned NiTi wires (.013" inch) reflects the clinical need to apply lower forces that are able to reduce patient discomfort during the beginning of orthodontic treatment.

The use of thermal activated NiTi wires has radically improved radically arch-wire technology. Figure 13 illustrates how thermal activated NiTi wires present load-deflection characteristics able to reduce the force level by almost 50% during unloading (and therefore during their clinical use) when compared with super-elastic NiTi wires.

For the above mentioned reasons NiTi thermal activated wires are especially indicated in case of dental alignment with low friction mechanics.

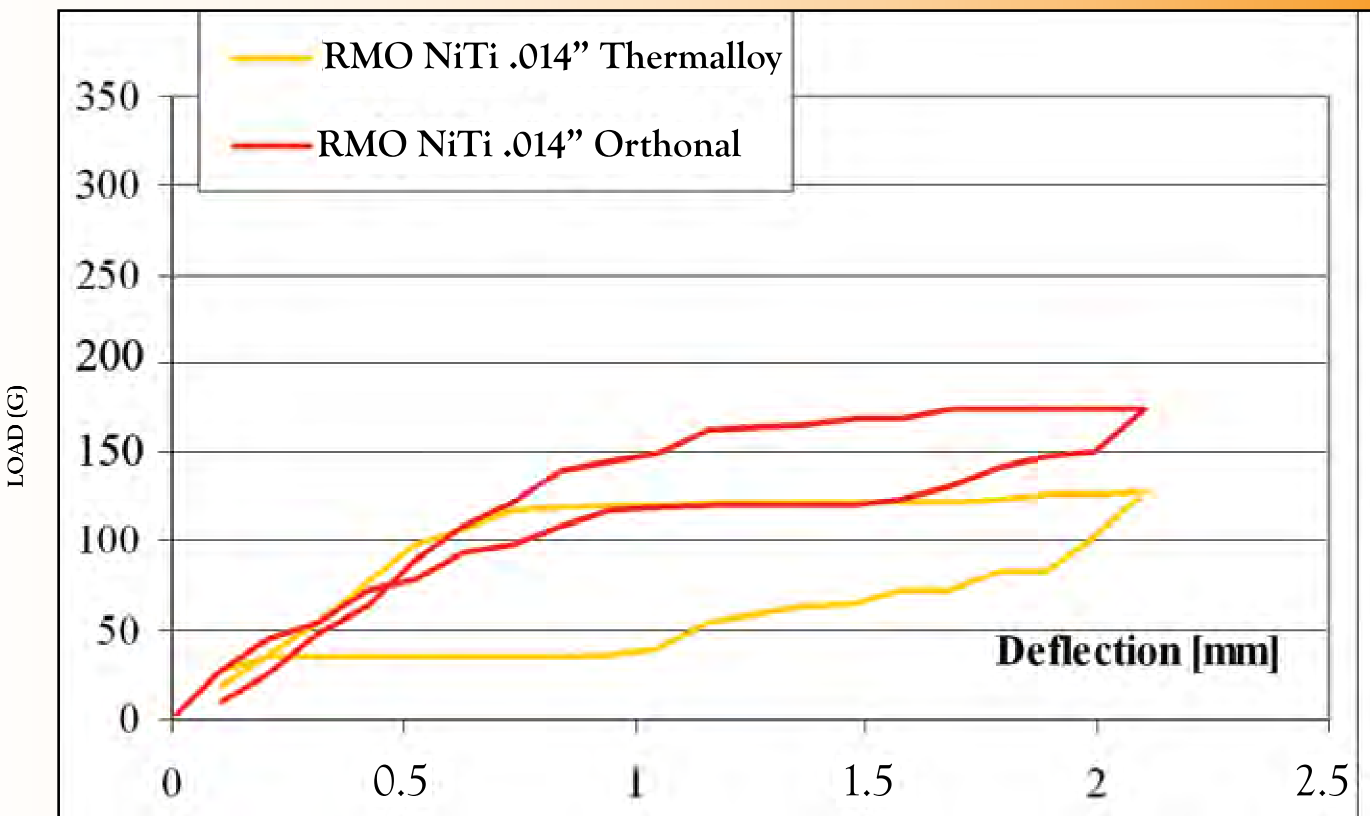

Figure 13. Load-deflection curve of super-ealstic (red) and thermal-activated (yellow) .014" NiTi arch-wire.

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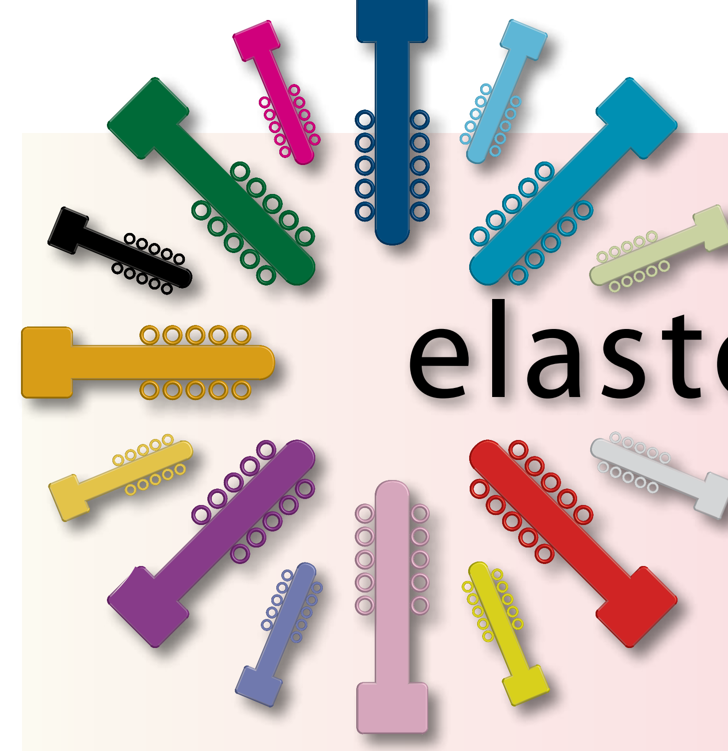
NEW!



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- Gray (J00350)
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- Azure (J00352)
- Dark Green (J00353)
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The Wilson 3D Quad-Helix *and Maxillary Expansion*

By Nelson Oppermann D.D.S.
(Clinical instructor of orthodontics at the Association of Dental Surgeons of Campines (ACDC), Sao Paulo, Brazil

Facial changes before and after 3D Quad-Helix expansion treatment

A narrow maxilla is a common problem in orthodontics. Approximately 80% of orthodontic patients need some type of arch expansion.[1] The incidence of posterior cross-bite is high and is present in more than 50% of the orthodontic cases, with upper molars being affected in more than 80% of cases, and lower molars affected in more than 19% of those cases.[2]

A narrow upper arch can produce undesired transverse growth changes. In order to intercept abnormal development and properly guide the patient's growth into a physiological pattern, it is often necessary to expand the maxilla. Maxillary expansion will avoid occlusion problems that can produce occlusal and facial disharmony (asymmetries). The cross-bite can not be corrected without treatment, regardless of the etiology and modality of clinical occurrence.[3] Early cross-bite corrections lead to a stable and normal occlusion pattern, and contribute to symmetrical condile growth, harmonious TMJ, and overall growth in the mandible.[4-7] Young patients should start visiting the orthodontist around 4 years of age. Thus, the orthodontist can identify and intercept a narrow maxilla early, avoiding late treatment and the risk of creating a symmetrical occlusion in an asymmetrical skeletal system. Waiting until after 9 years old can lead to TMJ problems and future relapse.[8]

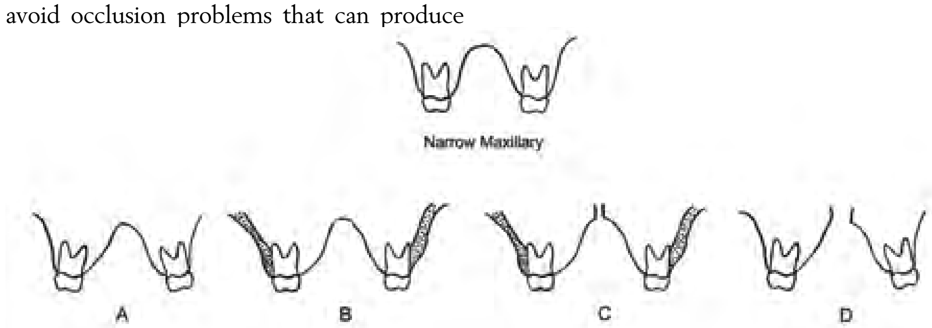


Figure 1. Expansion Movement Possibilities for the Maxilla and Upper Molars.

Correcting the narrow maxilla fosters an increase in the Mandibular width measurement and releases the mandible to a normal transverse growth.

When approaching arch expansion, the practitioner should always consider proper diagnosis and planning procedures in all three planes of space, converting information from the models, comprehensive cephalometrics analysis (lateral and frontal), and divine proportions analysis.[29] The postero-anterior radiograph is a very important tool to be used when analyzing the transverse plane.

Maxillary expansion procedures can be divided in two major categories according to previous literature. The first, Rapid Maxillary Expansion or RME, is a procedure that is generally accomplished by using an appliance incorporating a screw, for example a Haas or Hyrax. These appliances tend to disrupt the midpalatal suture. The second category for maxillary expansion is the slow maxillary expansion group. These appliances apply slow and continuous forces which do not attempt as a main objective to open the midpalatal suture. These appliances include: removable expansion plates, Porter W arch, and Quad-Helix. The Quad-Helix was developed in 1975 by Dr. Robert Murray Ricketts from Porter's "W" arch, adding four loops to the appliance, increasing the wire length from 40 to 50mm. The objective was to soften the forces and better control molar rotations.[32] Many authors have written that the Quad-Helix appliance can deliver sufficient forces to promote skeletal changes on maxillary bone in younger patients (during deciduous and mixed dentitions phases).[2,7,10-13,15,17-19]

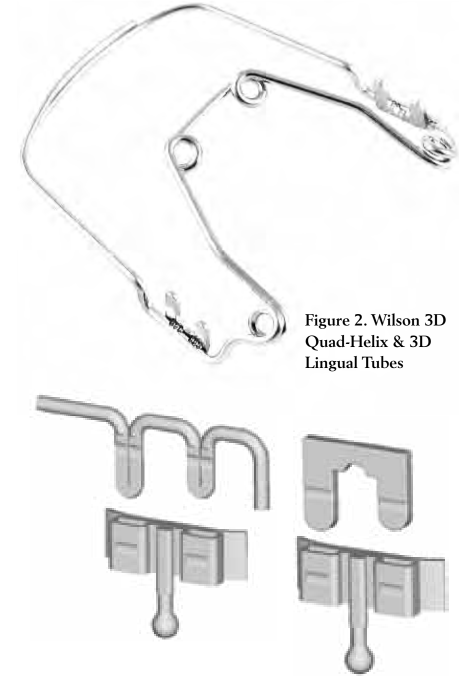


Figure 2. Wilson 3D Quad-Helix & 3D Lingual Tubes

Slow maxillary expansion using the Quad-Helix appliance is a recommended choice, and it is widely accepted and applied by orthodontists. Many practitioners prefer the Quad-Helix as an expansion device because it is a very versatile appliance, with applications such as: molar rotation control, and torque and tipping control. It can also produce advancement in the incisor region and create greater anterior expansion, resulting in an improved arch form (taking advantage of the anterior arms that deliver a "sweeping action"). Furthermore, the practitioners don't need the patient's or parent's cooperation to reach the set objectives.[7,19-21]

Transverse maxillary expansion is achieved using a combination of movements such as: buccal tooth version (A), alveolar bone and molar buccal translation combined with molar torque control (B), midpalatal suture opening and buccal molar translation (C), midpalatal suture disrupting (D), and a combination of two or more of those factors (Figure 1).[3]

It is possible, when the treatment plan demands, to open the mid palatal suture on a young growing patient from 400g of transverse pressure applied.[10,22]

The amount of force delivered by the Quad-helix depends on two major factors: Quad-Helix construction and amount of activation. Basically the Quad-Helix is constructed by 4 helicoids on .036 round wire. Dr. Ricketts recommends the use of blue Elgiloy wire to deliver softer forces and easier bending.

In general, using the Quad-Helix for treatment leads to skeletal changes in maxillary bone when desired by the practitioner and indicated in the treatment objectives. Adjustments are made by simply changing the amount and frequency of the activations. The Quad-Helix can provide a force range from 221 grams to 1149 grams. The Quad-Helix can rotate the supporting molars and it can be adjusted to expand the molars and anterior teeth differentially.[17] It can also be used to control molar torquing. These features make the Quad-Helix an extremely versatile appliance.

It is observed that when correctly employed, the Quad-Helix can produce similar results to the RMEs and also correct all transverse problems in growing patients.[8] These findings also coincide with what Cotton concluded after his work with monkeys.[26] Hicks reported substantial skeletal changes with slow expansion, especially in younger children.[11] Additionally, slow expansion is related to a more physiological reorganization of the maxilla in the three planes of the space, providing more stability and less relapse possibilities than RMEs. We can observe these findings in the works produced by Ohshima[26] and Storey.[27]

The conventional Quad-Helix is typically installed pre-activated with a certain amount of expansion. When the case being treated needs additional activation, the clinicians can normally do it using a three jaw plier inside the mouth. This modality of activation strongly depends of the practitioner's experience to control the amount of force and movements delivered. Due to this situation, many authors recommend removing the Quad-Helix from the mouth to place new actions, and recementing it after these changes. To avoid removing and recementing the bands, many practicers usually construct the Quad-Helix to be inserted on lingual sheaths tubes for horizontal insertion and removing. This type of Quad-Helix is commonly pre-fabricated and available from many ortho manufacturers.

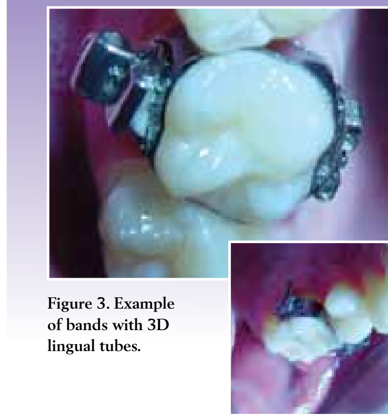


Figure 3. Example of bands with 3D lingual tubes.

In 1983, Wilson & Wilson[30] presented to the orthodontics community a system of vertically inserted 3D fixed/removable appliances. This method of insertion introduced improved versatility and easier inserting/removing procedures due to an innovative vertical insertion. Using Wilson's 3D Quad-Helix it is possible to control the molars in all three planes of space during expansion movements. The fitting system is composed of stamped twin posts laser soldered to the Blue Elgiloy .038" Quad-Helix and inserted into vertical lingual tubes (Figures 2 & 3). The 3D Quad-Helix very precisely allows the orthodontists to control the amount of forces employed and control molars in the three planes of the space, strongly increasing overall movement control.


Figure 4. 3D Quad-Helix adapted to be passive to the maloclusion.


Figure 5. 3D Quad-Helix - checking the amount of expansion forces.


Figure 6. 3D Quad-Helix checking the amount of rotation forces.

CASE 1

Figure 7. Expansion case 1 sample after 4 months - note molar rotation.

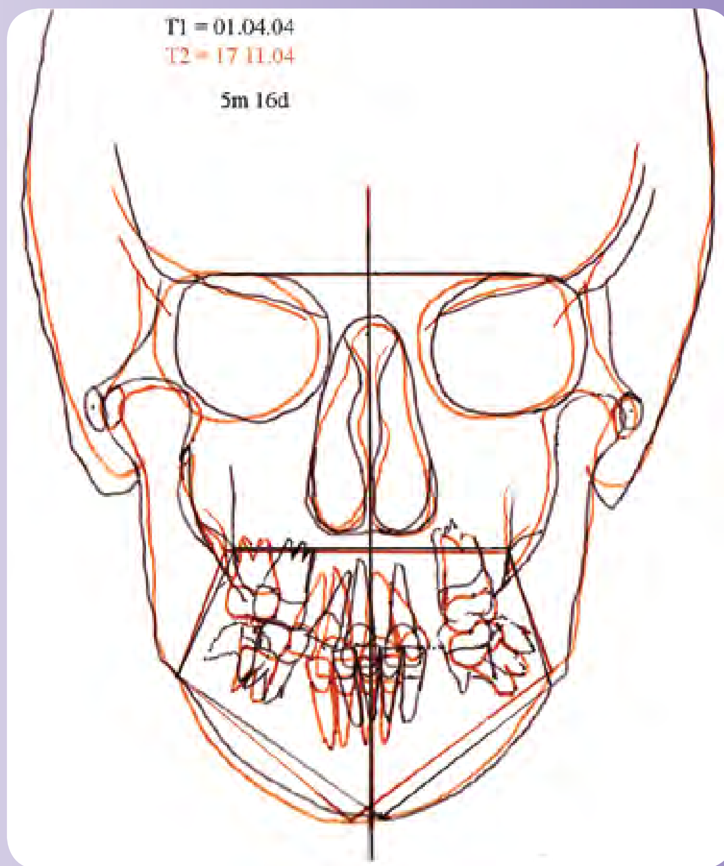


Figure 8. Superimposition of T1 and T2 tracings on case 1 for checking changes after expansion - note the amount of expansion and molar torque control.

CASE 2

Figure 9. Pictures taken before treatment on Case 2.

Figure 10. Occlusal view before treatment on Case 2.

Before Treatment

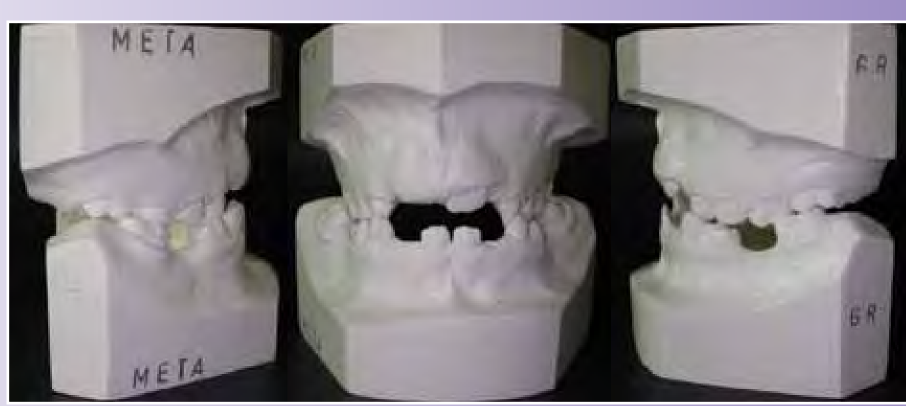
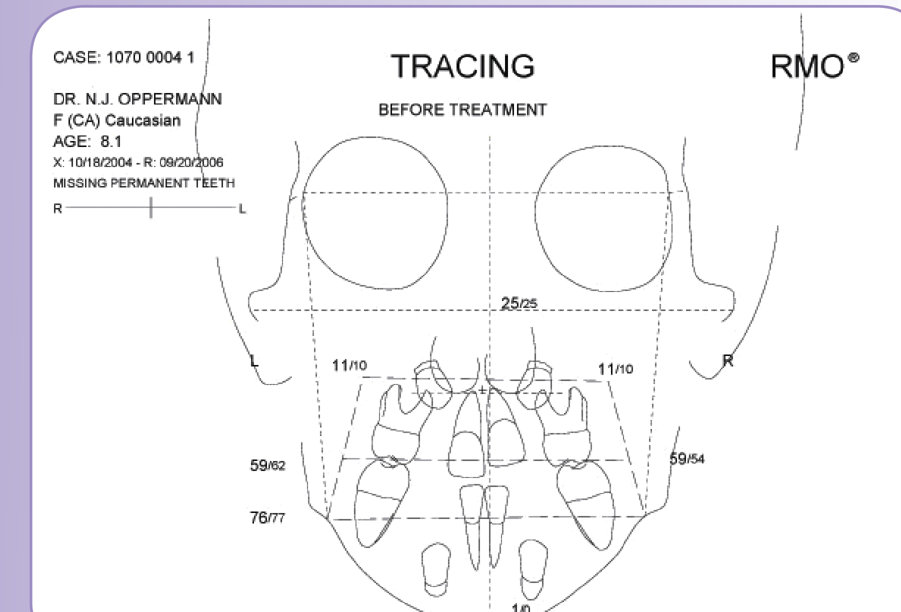


Figure 11 - Models before treatment on Case 2.

CASE 2 (Continued)

Figure 12. Occlusal view of the models for Case 2 before treatment.

Figure 13. Transverse dimension (49mm molar width) of the maxilla before treatment on Case 2.



MEASURED VALUE/NORM

SIGNIFICANT CONSIDERATIONS	
CONDITION	REASON
Lingual Crossbite	due to both arches
Skel Lingual Crossbite pattern	due to the maxilla
Md arch wide compared to jaw	

FACIAL PATTERN: MILD VERTICAL

# FACTORS	MEASURED VALUE	NORM	CLINICAL DEVIATION
Intermolar Width (B6-B6)	49.1 mm	54.0 mm	2.5 **
Denture Midline	0.7 mm	0.0 mm	0.4
Max-Mand Width Left	-11.0 mm	-10.5 mm	-0.4
Max-Mand Width Right	-11.1 mm	-10.5 mm	-0.4
Denture to Jaw Midlines	-0.0 mm	0.0 mm	0.0
Nasal Width	24.7 mm	24.7 mm	0.0
Maxillary Width (J-J)	58.9 mm	62.2 mm	-1.7 *
Mandibular Width (AG-GA)	76.3 mm	76.8 mm	-0.3

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Figure 15. Tracing and finds on T1 before expansion on Case 2.

Figure 14. Postero Anterior X Rays Image - T1.

Phases of Treatment

Figure 16. Beginning of treatment.

Figure 17. After 2 months.

Figure 18. After 4 months.

CASE 2 (Continued)

Figure 19. Before and after Quad-Helix 3D expansion - 5 months total time.

End of Treatment

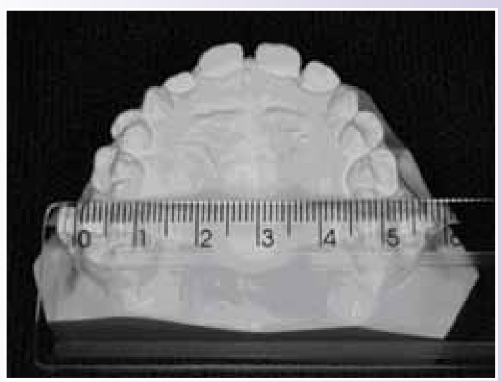


Figure 20. Transverse dimension (57mm molar width) of the maxila after expansion on Case 2.

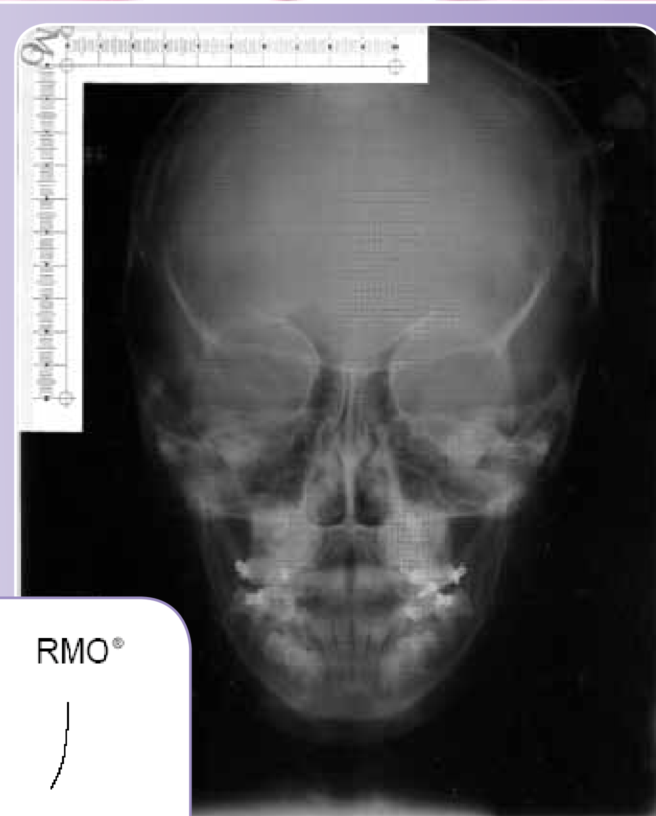
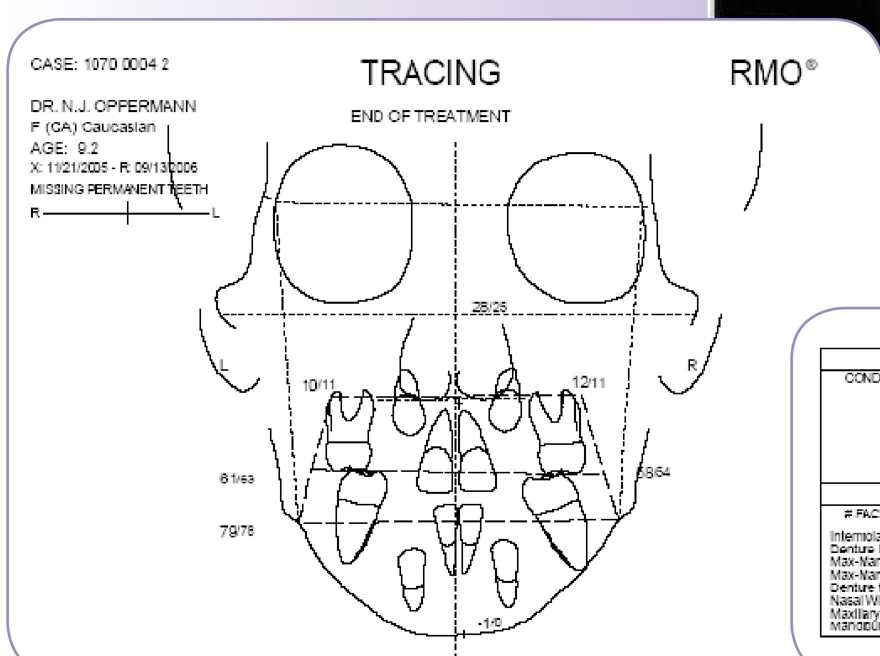


Figure 21. Postero Anterior X Rays Image - T2.



MEASURED VALUE/NORM

SIGNIFICANT CONSIDERATIONS

CONDITION	REASON

FACIAL PATTERN: DOLICHOFACIAL

# FACTORS	MEASURED VALUE	NORM	CLINICAL DEVIATION
Intermolar Width (B6-B6)	57.7 mm	54.0 mm	1.8 *
Denture Midline	-0.5 mm	0.0 mm	-0.4
Max-Mand Width Left	-10.4 mm	-11.0 mm	0.4
Max-Mand Width Right	-11.5 mm	-11.0 mm	-0.3
Denture to Jaw Midline	-0.9 mm	0.0 mm	-0.6
Nasal Width	27.8 mm	25.3 mm	1.2 *
Maxillary Width (J-J)	61.4 mm	62.8 mm	-0.7
Mandibular Width (AG-GA)	78.9 mm	78.2 mm	0.4

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Figure 22 - Tracing and finds on T2 after expansion on Case 2.

Dr. Wilson recommends installing the appliance during the patient's first visit in an absolute passive state relative to malocclusion, and beginning activation of the 3D Quad-Helix on a second visit. New activations should be posted on 40 day periods. In the majority of cases, activation should not exceed 1 to 2mm in order to keep cases under control (Figures 4, 5 & 6). In addition, because the Quad-Helix is prefabricated in 6 different sizes, orthodontists save time and money by avoiding laboratorial steps and installing the appliances chair side with minimal adaptations. Clearly, the Wilson 3D Quad-Helix provides dynamic control of expansion forces with the added convenience and functionality of a vertical insertion/removal system. Further, molars can be controlled with proper torque, tip, and rotation during all expansion movements.

The clinical case 1 (Figures 7 & 8) exemplifies the expansion and 3D molar control using the 3D Quad-Helix. Note how the upper molars were expanded with complete torque control.

On case 2 (Figures 9-22) it is easy to see the features and possibilities of the 3D Quad-Helix during an expansion treatment. Note the severe transverse problem at the beginning and the high amount of expansion obtained after treatment. Figure 20 details 8mm of total molar expansion. The P.A. tracings showed 2.3mm increasing of J-J width, 8.6mm on upper molar width, and 3.1mm enlargement on Nasal Cavity width. Similar to Case 1, the upper molars had torque properly controlled.

The full 3D system kit includes a variety of additional appliances the orthodontist can choose according to the needs for each case. The ability to exchange appliances during treatment without removing the molar bands is a significant advantage. Dr. Wilson calls this full kit system the Wilson 3D Tool Box.

I strongly recommend orthodontists use the vertical inserting system developed by Dr. Wilson. The appliances keep expansions and upper molars fully 3D controlled due to the inventive fitting system, they save precious time cutting off lab steps, and the system is extremely cost effective. No doubt a great upgrade on Dr. Ricketts' invention!

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SS/Ni-Ti/β-Ti Wires

LOW-FRICTION Systems

Kinetic Friction Evaluation Testing

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LIGATURE REFERENCE KEY

In this article, the author refers to various bracket designs and ligature/ligation options as detailed in the following images:

Figure 1

Straight Wire Step Brackets

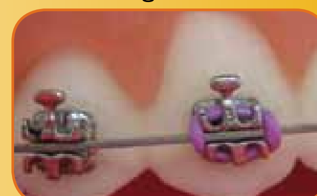
Figure 2

Synergy® Brackets .022" x .028"

Figure 3

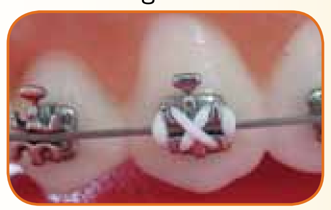
C shape ligature (center tie wings)

Figure 4



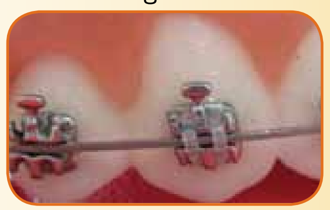
O shape ligature (conventional ligation)

Figure 5



8 shape ligature (maximum control)

Figure 6

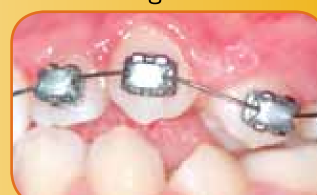


C shape silicone ligature (center tie wing)

Figure 7

Time 2 self-ligating brackets

Figure 8



Slide ligatures

INTRODUCTION

In this preliminary research[3], three low-friction systems have been tested, comparing them with straight wire twin brackets. The different systems which were tested are:

- Straight wire STEP brackets .022" x .028" (Leone) (Figure 1)
- SYNERGY Brackets .022" x .028" (Rocky Mountain Orthodontics) Figures 2,3,4,5 & 6)
- Self-ligating TIME 2 .022" x .028" (American Orthodontics) (Figure 7)
- SLIDE ligatures medium (Leone) (Figure 8)
- Wire ligatures .010" (American Orthodontics)
- Elastomeric ligatures (American Orthodontics)

A "standard model" was created for each kind of bracket, bonding the entire upper arch on an acrylic model (5 to 5). The same "standard model" was subsequently used for all tests carried out, changing wires (SS .016", Ni-Ti .016", SS .016" x .022", and Ni-Ti .016" x .022" - preformed Leone) and ligatures (.010" wire, elastomeric, silicone, and Slide). For each system, two tests were carried out, replacing wires and ligatures each time with brand new materials. Each standard model was screwed down (at Department of Mechanics, Genoa University - Italy: Prof. C. Balboni) to an oil hydraulic machine (Schenck, Hydropuls - Figure 9). Each orthodontic wire was pulled from the left side, applying a force on the wire, which slides inside the arch slots, at a speed of 10 mm/minute, for 1 cm. The most interesting results are summarized in Tables 1 and 2. It's not possible to directly compare the results obtained in different "standard models" (because it's almost impossible to bond brackets in a perfectly identical way, although all bonding procedures have been accurately standardized). That is, the standard models are not exactly identical; however, they are very similar. On the contrary, it's very important to compare results achieved on the same standard model.

Figure 9 - Oil Hydraulic Machine

MATERIALS AND METHODS

At Department of Mechanics, Genoa University -Italy: (Prof. C. Balboni), new tests have been carried out, based on the above-mentioned research, using the same oil hydraulic machine (Schenck, Hydropuls) (Figure 9). Tested materials are:

- SYNERGY Brackets .022" x .028" (Rocky Mountain Orthodontics) (bonded on standard model) (Figure 2):
- Straight Wire STEP brackets .022" x .028" (Leone) (on standard model):
- SS, Ni-Ti, β-Ti .016", .016" x .022" preformed arches (Leone)
- Wire ligatures (diameter .25mm / .010") (American Orthodontics)
- Elastomeric ligatures (diameter .75 mm, interior dimension 1.14mm) (American Orthodontics)
- Silicone elastomeric ligatures (diameter .69mm, interior dimension 1.27mm) (Rocky Mountain Orthodontics)

Tests were performed in a dry field. Each test was repeated twice (for each wire or ligature), and every time the materials were replaced with new ones.

TESTED SYSTEMS:

- SYNERGY Brackets, various ligatures, and ligation "modes" (C shape, O shape, 8 shape, silicone C shape), in association with SS and Ni-Ti .016", plus SS and Ni-Ti .016" x .022" wires. (Table 3)
- C shape ligature on Synergy bracket: Elastomeric vs. silicone ligatures. (Table 4)
- Elastomeric ligatures on straight wire STEP twin brackets vs. O shape ligatures on Synergy. (Table 5)
- Straight wire STEP twin bracket: Wire ligatures vs. elastomeric ligatures vs. silicone ligatures. (Table 6)
- β-Ti wires: Synergy (various ligatures and ligation "modes") vs. Time 2. (Table 7)

DISCUSSION

Changing how the ligatures are placed on the Synergy bracket produces significant differences in the kinetic friction which is generated: C shape ligature (ligating just the center tie wings) produces a frictional force of approximately 32 gm (Ni-Ti .016"), 286 gm (SS .016" x .022"), and 350 gm (β-Ti .016" x .022"). Ligating with the ligature in the 8 shape, friction rises to 995 gm (SS .016") and 4269 gm (β-Ti .016" x .022") respectively (Table 3). The different ligating options can be used simultaneously in the same arch according to specific needs, making therapeutic treatment on individual teeth simpler and easier.

Ligating with the 8 shape ligature on Synergy showed significant frictional forces. This confirms the indication to use the 8 shape ligature on Synergy to enhance friction, reduce bracket movement on the wire, and to strengthen anchorage. This could be very useful after alignment and leveling phases when clinicians need to maintain position of the teeth, particularly in the posterior regions.

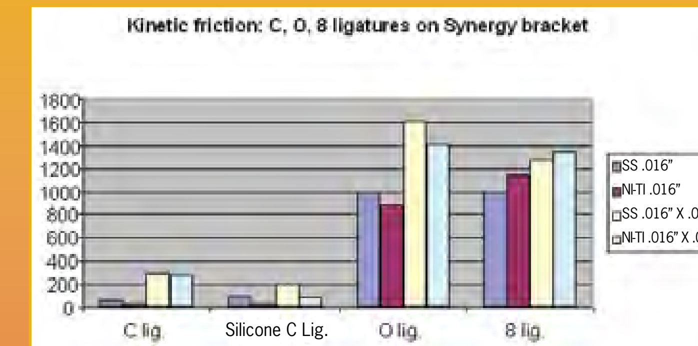
O shape ligatures on Synergy enhance friction, vs. elastomeric ligatures on Twin brackets, particularly with SS wires. (Table 5)

Silicone ligatures showed less friction, both on twin brackets and on Synergy, even though the tests were carried out in a dry field.

TABLE I

SYNERGY BRACKETS

C Shape vs. Silicone C Shape vs. O Shape vs. 8 Shape Ligatures

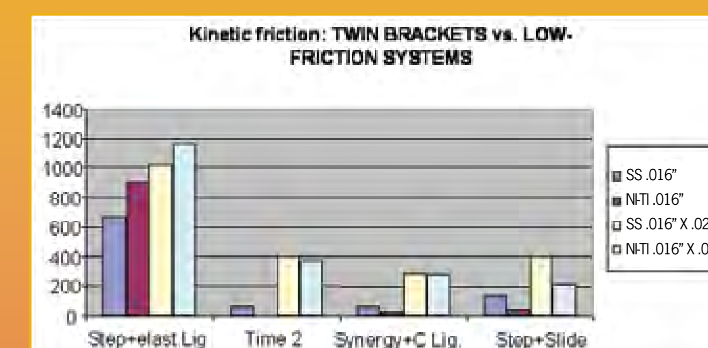


SYNERGY BRACKETS (Kinetic Friction) - Grams				
Arches	"C" Ligatures	Silicone "C" Ligatures	"O" Ligatures	"8" Ligatures
SS .016"	63	87	1000	995
Ni-Ti .016"	32	35	871	1142
SS .016" x .022"	286	204	1612	1269
Ni-Ti .016" x .022"	274	79	1406	1346

TABLE 2

TWIN BRACKETS STRAIGHT WIRE STEP

(Leone) + Elastomeric Ligatures vs. LOW-FRICTION SYSTEMS
(Time 2, Synergy + C Shape Ligatures, Step + Slide Ligatures)

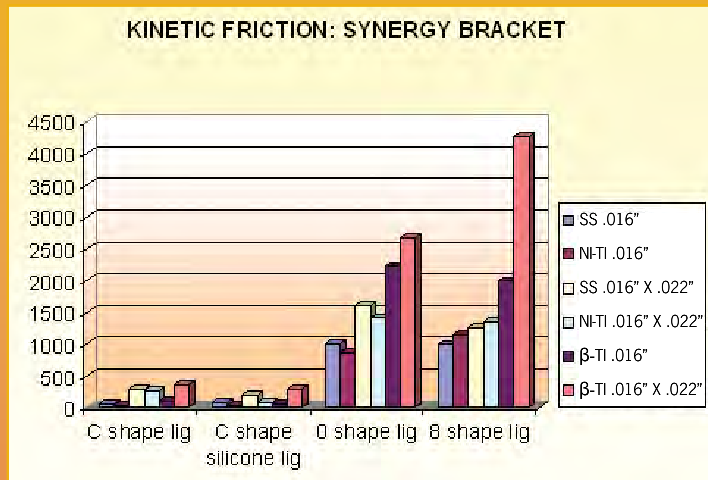


SW BRACKETS vs. LOW-FRICTION SYSTEMS (grams)				
Arches	SW STEP+ Elastomeric Ligatures	Self Ligating TIME 2	SYNERGY + C Shape Ligatures	SW STEP + SLIDE Ligatures
SS .016"	674	60	63	133
Ni-Ti .016"	908	18	32	43
SS .016" x .022"	1021	402	286	397
Ni-Ti .016" x .022"	1167	364	274	211

TABLE 3

RESULTS

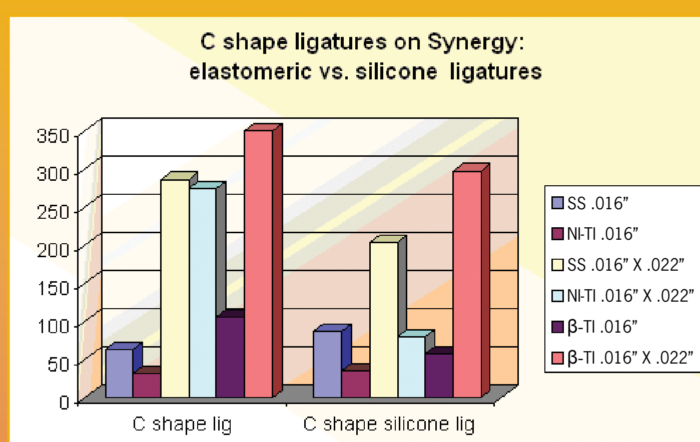
Results are summarized in Tables III, IV, V, VI, VII



SYNERGY (Grams)				
Arches	C Shape Lig.	C Shape Silicone Lig.	O Shape Lig.	8 Shape Lig.
SS .016"	63	87	1000	995
Ni-Ti .016"	32	35	871	1142
SS .016" x .022"	286	204	1612	1269
Ni-Ti .016" x .022"	274	79	1406	1346
β-Ti .016"	106	57	2221	1994
β-Ti .016" x .022"	350	297	2669	4269

TABLE 4

RESULTS



Arches	C Shape Ligature	C Shape Silicone Ligature
SS .016"	63	87
Ni-Ti .016"	32	35
SS .016" x .022"	286	204
Ni-Ti .016" x .022"	274	79
β-Ti .016"	106	97
β-Ti .016" x .022"	350	297

• Using .016" x .022" β-Ti wire, reduced friction was recorded with the C ligature (ligating on the center tie wings) (350 gm) vs. Time 2 (2006 gm); ligating with the ligature in the 8 form, friction rises to 4269 gm (Table 7).

• SS wires produced a higher kinetic friction compared to Ni-Ti wires. This is probably due to the particular form and shape of low-friction brackets (Table 1).

• With the .016" SS and Ni-Ti wires, the lowest kinetic friction was produced by Time 2 brackets, followed by Synergy (C shape ligature) and Slide Ligatures (Table 2).

• With the .016" x .022" SS wires, the lowest kinetic friction was produced by Synergy (286 gm), while Time 2 and Slide ligatures produced a higher friction (about 400 gm) (Table 2).

• With the .016" x .022" Ni-Ti wires, the lowest friction was produced by Slide ligatures on Step brackets (211 gm), followed by C shape ligatures on Synergy (274 gm), and Time 2 (364 gm) (Table 2).

• Slide ligatures showed a high reduction of friction on twin brackets compared to elastomeric ligatures (133 vs. 674 gm) (Table 2).

• Self ligating Time 2 brackets produced the lowest friction with Ni-Ti .016" wire (18 gm) (Table 2).

• From this data, we observe that wires don't always have the same behavior: sometimes there is less friction produced with Ni-Ti wires, other times with SS wires. Only β-Ti wires consistently create more friction, probably because of their roughness combined with a certain stiffness.

CONCLUSIONS

• Today we can purchase many systems which reduce friction according to various designs, and by combining different brackets, wires, and ligatures.

• Some of these systems are similar and comparable (e.g., wire vs. elastomeric ligatures on twin brackets), ---- others are completely different.

• We need to conduct a thorough investigation about the action of wires in order to explain the synergistic action that we noted using Ni-Ti wires combined with low-friction brackets (that produced a considerable increase in speed of tooth movement).

• Among the brackets that we tested, only Synergy offers the option of varying the friction, simply by changing how it is ligated. The particular arch slot shape and flare allows superelastic Ni-Ti wire to follow a more gentle angle. This improves the leveling action and reduces negative forces at the same time, which are loaded on the adjacent teeth. The curved walls in the Synergy arch slot (like the humps of a camel) reduce contact between wire and the metal of the arch slot, further reducing friction (Figure 10). By ligating in the "O Shape" (Conventional) form or in the "figure 8" form, Synergy becomes a "high-friction" appliance. Bracket movement along the wire can be almost completely stopped, and full control achieved.

It seems therefore more correct to speak about "systems" rather than single brackets or wires or ligatures: the interaction between these three variables, together with bracket form and shape, produce completely new situations both about biomechanics and about tissue response to tooth movement.

Low friction systems have some similar characteristics. However, they each have specific differences which will affect their results. New studies should be carried out in order to better understand clinical indications and targets.

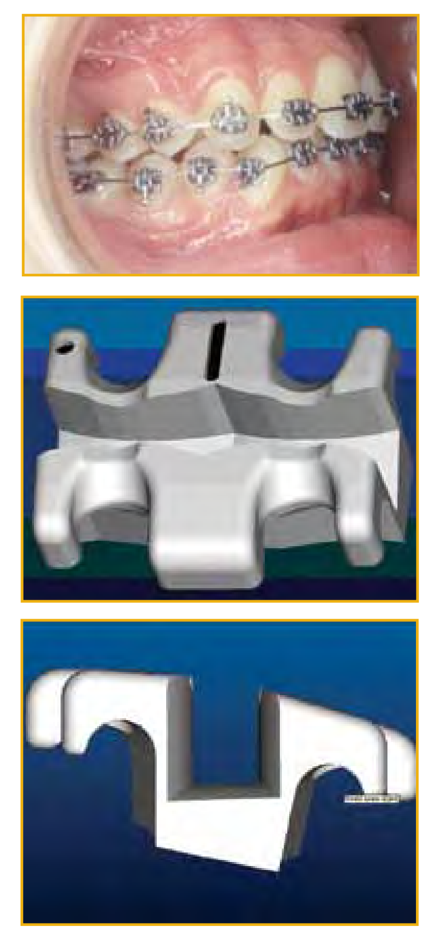
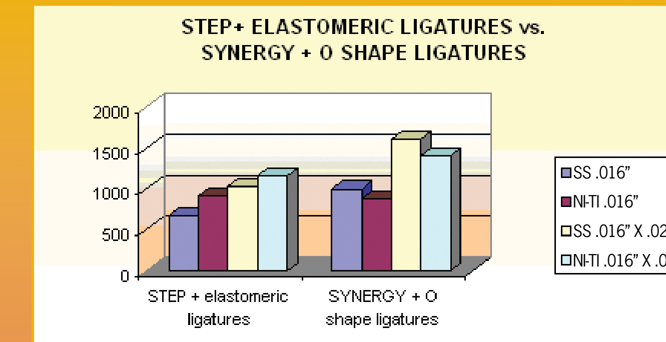


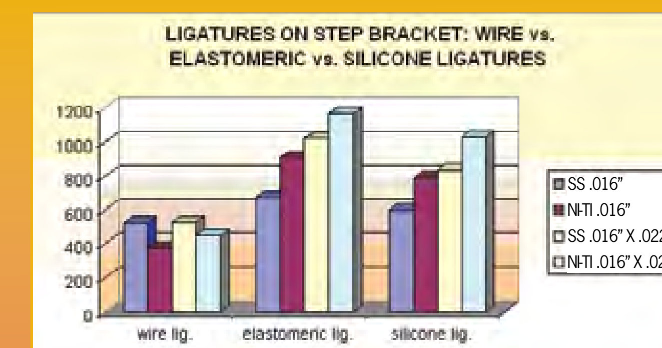
Figure 10: Synergy bracket: Patented arch slot shape and flared openings

TABLE 5



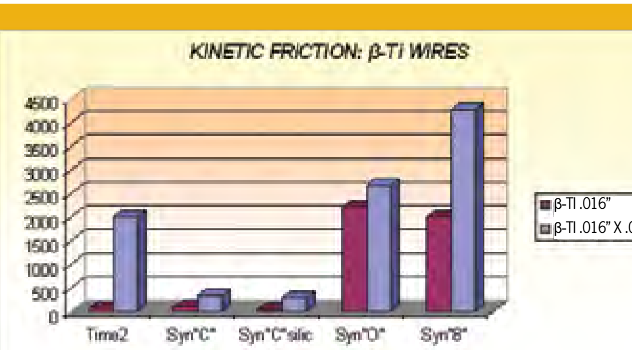
Grams		
Arches	STEP + Elastomeric Ligatures	SYNERGY + O shape ligatures
SS .016"	674	1000
Ni-Ti .016"	908	871
SS .016" x .022"	1021	1612
Ni-Ti .016" x .022"	1167	1406

TABLE 6



STEP SW (Grams)			
Arches	Wire Ligature	Elastomerics Ligature	Silicone Ligature
SS .016"	524	674	600
Ni-Ti .016"	372	908	787
SS .016" x .022"	525	1021	837
Ni-Ti .016" x .022"	450	1167	1031

TABLE 7



	TIME 2	Synergy C	Synergy C silicone	Synergy O	Synergy 8
β-Ti .016"	88	106	57	2221	1994
β-Ti .016" x. 022"	2006	350	297	2669	4269

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SWLF

Straight Wire Low Friction

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General approach and elements of the straight Wire Low Fiction (SWLF) Technique: Why the need for a new technique?

Orthodontic techniques are continually improving through advances in research, new technology, and society's changed expectations. New approaches to biology, the biochemistry of dental movement and craniofacial growth, new means of achieving direct bone anchorage, Temporary Anchorage Devices (TADs) and micro-implants, and advances in the design and manufacture of brackets and wires have all led to a significantly changed landscape in the world of orthodontics. Demand for orthodontic treatment has increased, an ever-greater number of people have access to our services, and currently available technology has simplified the biomechanics and many of our treatments.

Furthermore, three basic trends can be discerned: patients are becoming ever more demanding and are seeking quicker and more effective treatment, our clinics have seen an increase in adult patients, and thirdly, patients are asking for 'à la carte' treatments ranging from simple alignment of the incisor to complex treatments combining implants and orthognathic surgery. Orthodontics has become more complex in respect to diagnosis, but conversely, it has become simpler in terms of biomechanics, and public pressure has led to the easier and moderately complex cases becoming more accessible to the general practitioner. Meanwhile, specialists require greater standardization of treatment practices, which means the establishment of diagnostic and therapeutic procedures to make their clinical activities more rational and ergonomic. Patients go to specialists with increased expectations about the quality, speed, and comfort of treatment, as well as improved levels of service. Specialists are obliged to use reliable and quick techniques of proven effectiveness and efficiency. The golden rule in modern orthodontics is the old Spanish saying of "reinvent yourself or die."[1]

Taken together, the elements identified above represent a world in which orthodontic practitioners are required to change their outlook by adopting the approach we have synthesized into the Straight Wire Low Friction (SWLF) Technique in an attempt to bridge the gap between new diagnostic and therapeutic techniques and the longest-standing paradigms of scientific orthodontics.

DIAGNOSIS AND TREATMENT BASED ON SCIENTIFIC EVIDENCE

Modern day medicine and dentistry must base their diagnostic and therapeutic procedures on experimental and clinical research. One isolated case, an expert opinion, or even the long experience of a practitioner is not as valuable as a well designed experiment, prospective study, or critical meta-analysis.

The exercise of our profession is currently being shaped, and will continue to be shaped, by changes of three different kinds: conceptual, technological, and socio-economic change. With respect to conceptual changes, so-called Evidence-Based Orthodontics (EBO) ensures that our diagnoses, treatment, and clinical activities are based on proven scientific evidence rather than subjective opinions, individual experience, and biased personal interpretations. EBO sets the clinical standard and represents the future of this profession. Although admittedly limited, recent advances in our knowledge of the biology of dental movement highlight the need for the forces employed in our treatments to be intermittent, light, constant, and prolonged.[1]

The ideas on which the SWLF Technique is based and its clinical procedures have relied are derived from the latest scientific research into facial aesthetics, the function of the stomatognathic system, the biology and biochemistry of orthodontic dental movement, craniofacial growth, metallurgy, the biomechanics of low friction, etc. Our points of reference consist of research published in internationally recognized quality journals such as the European Journal of Orthodontics, the American Journal of Orthodontics and Dentofacial Orthopedics, Angle Orthodontics, Orthodontics and Craniofacial Research and Dental Research.

SWLF is not just a technique involving a bracket. We have attempted to incorporate all the recent technological advances in orthodontics into an extremely simple therapeutic protocol and system of biomechanics. The technological changes affecting modern orthodontics which have lead to the creation of the Straight Wire Low Friction (SWLF) technique are super-elastic wires, the latest generation of titanium-molybdenum wires, low-friction brackets, and orthodontic TADs.

SWLF DIAGNOSTIC PROTOCOLS

The SWLF would be of little interest to modern day orthodontics if it solely concerned some new brackets and one more prescription to be added to the many which already exist. Clinical experience has taught us that the approach to be adopted by any technique in orthodontics must be patient-centered and must help to provide a quick and effective solution to patients' problems and the concerns which have brought them to our practice. Our teaching experience has shown us that practitioners must establish clear, accurate, and practical diagnostic and therapeutic protocols. The SWLF Technique is much more than a simple bracket or a new prescription; it is a diagnostic philosophy drawing on new technologies – the E-Ceph online cephalometric diagnosis, with the powerful database created by Professor R. M. Ricketts at Rocky Mountain Orthodontics in Denver, Colorado and a wide range of protocols for varying malocclusions.

The following section aims to demonstrate some of the protocols employed in this technique. This simple diagram allows us to identify sagittal orthodontic problems during the patient's first visit. The molar class is compared with the canine class, overjet, Steiner's ANB and Jacobson's Wits Appraisal, which can be increased (IN), normal (N) or decreased (DE). Where there is a Class II molar and canine and the other values are greater, the patient is undoubtedly skeletal class II, both quantitatively and qualitatively (position). The way to extract more information (i.e. the source of the problem, its size and seriousness) is to undertake a detailed examination of the cephalometric data.

Where the molar class is II, the canine class is I and the other variables are normal, the conclusion to be drawn is that the patient does not really have a Class II problem, but rather a local problem, particularly if it is unilateral and at the molar level (ranging from Class II "local" with secondary molar rotation to premature loss of primary molars, etc.) What is happening in the last row, where all the variables point to a Class II but the Wits is normal? This is undoubtedly a patient with a Class II sagittal skeletal problem, in which posterior mandibular rotation has played an important role in the etiology of mandibular distal occlusion. It would be a qualitative rather than quantitative Class II, and might improve with anticlockwise mandibular rotation and vice versa.

The increased overjet cannot be a cause of "confusion" in Class II cases. It is important to remember that orthodontists can move teeth better than their skeletal foundations and that malocclusions with a strong element of decompensation (ANB < overjet) are easier to resolve than those cases, as in many Class II examples, which exhibit prior natural dento-alveolar compensation (ANB > overjet).

Protocols for assessing labial aesthetics and the smile. As part of this technique we believe that "an orthodontic smile is forever" and that it is therefore very important to assess the degree of dental/gingival exposure and to ascertain how it develops with age and ageing: gingival smiles improve with age and the lack of upper incisive exposure worsens with age. We should definitely think twice before intruding incisors in cases of overbite with only a small amount of dental exposure.

A detailed study of static and dynamic occlusion is key to achieving the ideal results we all aim for in occlusion. Evidence-Based

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MAXILLARY BRACKETS	Angulation	Torque	Rotation	Width
Central	3°	17°		3.6mm
Lateral	9°	8°		3.2mm
Cuspid	8°	0°		3.2mm
First Bicuspid	0°	-7°	2°DO	3.2mm
Second Bicuspid	0°	-7°	2°DO	3.2mm
MAXILLARY TUBES				
First Molar	0°	-14°	10°DO	3.8mm
Second Molar	0°	-14°	10°DO	3.3mm

MANDIBULAR BRACKETS	Angulation	Torque	Rotation	Width
Central	0°	0°		2mm
Lateral	0°	0°		2mm
Cuspid	0°	0°		3.2mm
First Bicuspid	0°	-17°	4°DO	3.2mm
Second Bicuspid	0°	-17°	4°DO	3.2mm
MANDIBULAR TUBES				
First Molar	-1°	-25°	8°DO	3.8mm
Second Molar	-1°	-20°	8°DO	3.3mm

Orthodontics demonstrates that 'ideal occlusion' is more of a desideratum, a Holy Grail for which we strive but never attain and it is no longer correct to affirm that there is a close link between an ideal model of occlusion and the absence of dysfunctional pathology. However, orthodontics can do much to improve the health and survival of teeth, and it is of great importance during infancy and adolescence in preventing subsequent cranio-facial pain-dysfunction syndromes.

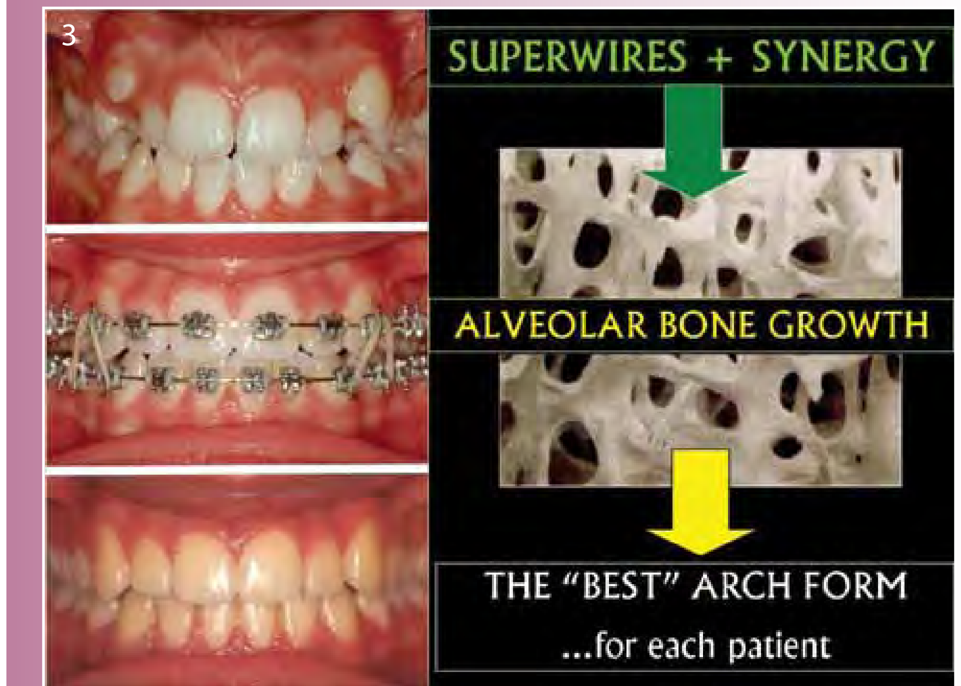
THE FRICTION PROBLEM IN CONVENTIONAL SW BRACKETS

The SWLF technique enjoys all the advantages of the traditional straight wire approach but eliminates one of its main failings: static and dynamic friction. Although friction ensures occlusal stability and three-dimensional control over the root in the last stages of treatment, it is equally true that it is also the principal obstacle to dental alignment and leveling, thereby reducing the effectiveness of super-elastic wires, decreasing the potential for dental movement with these wires, and in short, complicating and prolonging our treatments.

According to Lionel Sadowsky and Emile Rossouw, Light Continuos Forces (LCF) move teeth MOST efficiently and with the least amount of patient discomfort and tissue damage.[2,3] Orthodontic Tooth Movement combines the laws of friction and physiology. It is essential to have an understanding of the frictional forces between brackets and wires in order to produce effective tooth movement within the range of optimal biological response. Root surface area, bone density, and occlusal interferences each influence the effect of force on a tooth, while friction between the bracket and arch wire adds yet another variable. The portion of the applied force lost because of the resistance to sliding can range from 12 to 60%. It has been estimated that with conventional EW or SW brackets and elastic or metallic ligatures 50 per cent of applied orthodontic force is dissipated due to friction, so that the total force applied to orthodontic brackets has to be twice that needed to produce an effective force in the absence of friction. Classical SW bracket design doesn't work well with sliding mechanics.

If frictional forces are high, the efficiency of the system is affected and the treatment time may be extended or the outcome compromised because of little or no tooth movement and/or loss of anchorage.

Factors which might affect friction in a pre-adjusted appliance include the wire size and arch wire stiffness, which in turn depends



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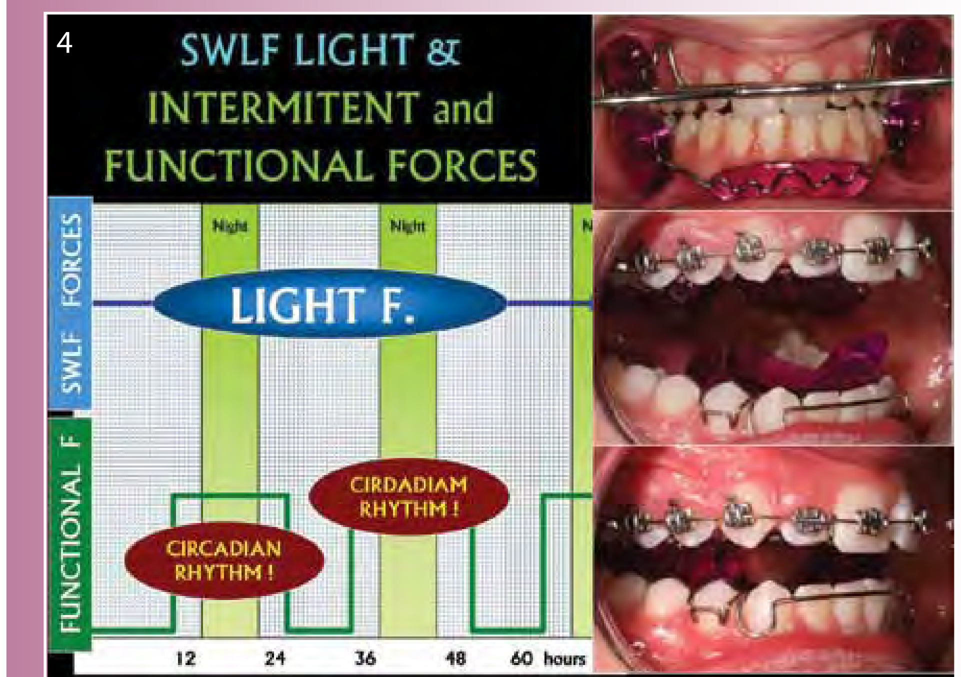

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not only on cross-sectional size and Young´s modulus, but also on interbracket distances. Frictional force is inversely proportional to bracket width, and wide SS brackets sliding on SS wires produce less friction than other combinations of alloys. According to Moore[4] movement of brackets along a .021" x .025" SS wire produced almost three times as much friction as movement along a .019" x .025" wire, the overall jeans being 3.0 and 1.2 N, respectively. Friction doubled with every degree of bracket tip. Space closure should be completed on a .019" x .025" arch wire before a .021" x .025" wire is used to complete tooth alignment by utilizing the full prescription of the brackets. Bracket slot to wire angulation is the most important determinant of friction in orthodontics. Torque had a less dramatic effect on frictional forces.

The ability to quantify and control friction will lead to less anchorage loss, more predictable tooth movement, and the use of ideal force levels to overcome friction and optimize physiological tooth movement[2,4].

SWLF BIOMECHANIC FEATURES

Thanks to the cooperation between the Orthodontic Department and Mathematics Department of the University of Santiago de Compostela (Spain) and the Rocky Mountain

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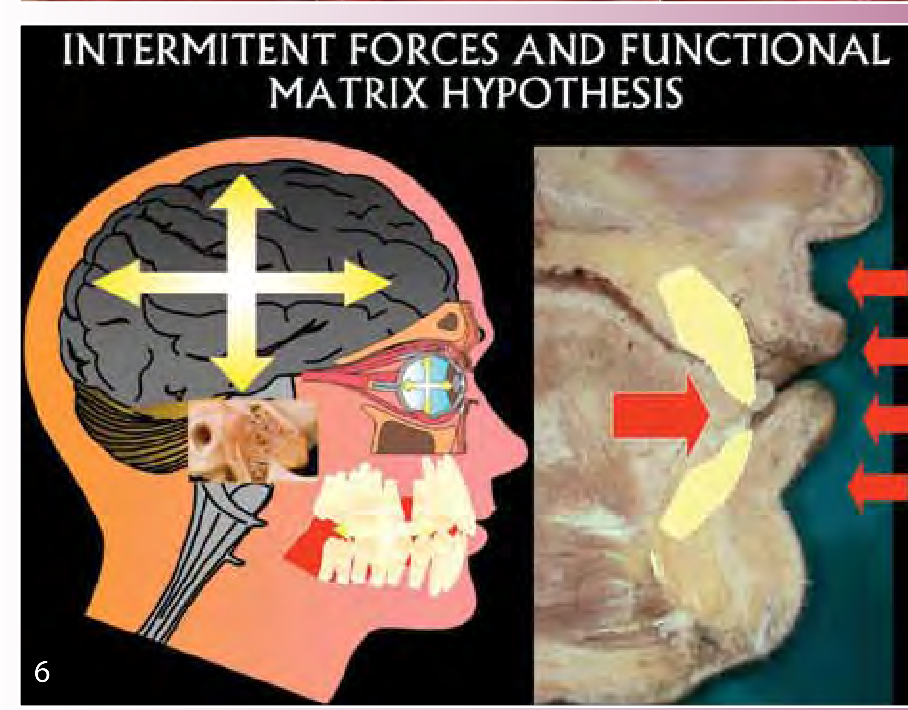

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Orthodontic laboratories in Denver (USA), we are developing the brackets, wires and elements of the SWLF technique:

1 - Synergy Brackets:

- Synergy Classic
- Synergy Fx: A new one-piece design of the Synergy Classic
- Synergy Lux: A ceramic Synergy with gold arch slot to reduce the friction

2 - New SWLF Superwires kit in a well designed box with a simple and clear chart for proper selection:

- Thermoelastic (Thermaloy) wires for the alignment phase: Thermal NiTi (.013", .015", .017", etc.)
- Beta III Titanium (Bendaloy) for the finishing phase and pliers to make intraoral bends at the end of the treatment

3 - New Low-Friction (Silicone) Ligatures

4 - New Elastomeric Modules

5 - Conventional Crimpable Hooks and a new design of pliers to fit them in the mouth

6 - Long Crimpable Hooks to combine with TADs

7 - TADs and different accessories to use with them.

THE SYNERGY BRACKET IN ITS VARIOUS EMBODIMENTS IS THE HEART OF SWLF BIOMECHANICS

The Synergy bracket has an intelligent and innovative design which does not forego the advantages of traditional straight wire brackets. Its two main characteristics are: three pairs of wings with the central wings being raised up, which prevents contact between the wire and the ligature and reduces friction, reaching levels of almost zero, and the rounded design of the arch slot ends which provides swift and early insertion during alignment of thick thermoelastic (Thermaloy) rectangular arch wires. Simple adjustments to the type of ligature and the way in which the wire is ligated to the brackets is sufficient to control friction tooth-by-tooth and turns the Synergy bracket into a multi-use bracket which can act as a self-ligating bracket at the beginning of treatment and as a traditional bracket at the end.

The appearance of brackets is extremely important for many patients. Many patients will only use braces if they can use invisible orthodontics or aesthetic brackets. Aesthetic brackets, particularly those with polycarbonate or ceramic slots, suffer from increased friction and reduced effectiveness and speed of alignment with super-elastic wires. One of the great advances achieved with the SWLF Technique is the new ceramic and gold Synergy Lux aesthetic bracket. This has a ceramic body with excellent appearance, three pairs of wings like the classic Synergy, and a gold-lined arch slot to improve sliding. The new aesthetic Synergy Lux bracket represents an excellent alternative for those adult patients who require maximum therapeutic effect in the shortest possible treatment time and also an attractive appearance.

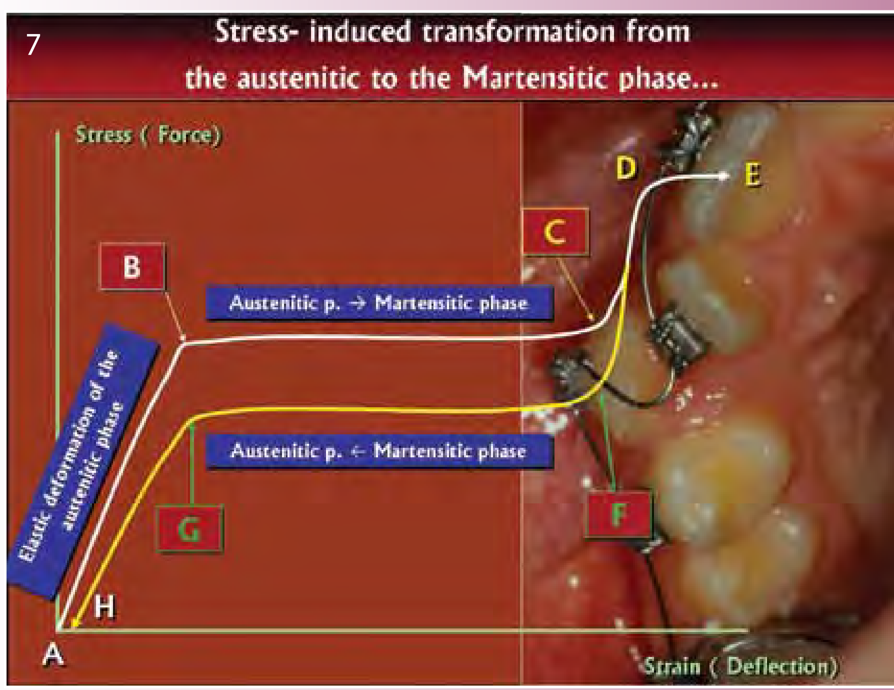
CONTROL OVER FRICTION

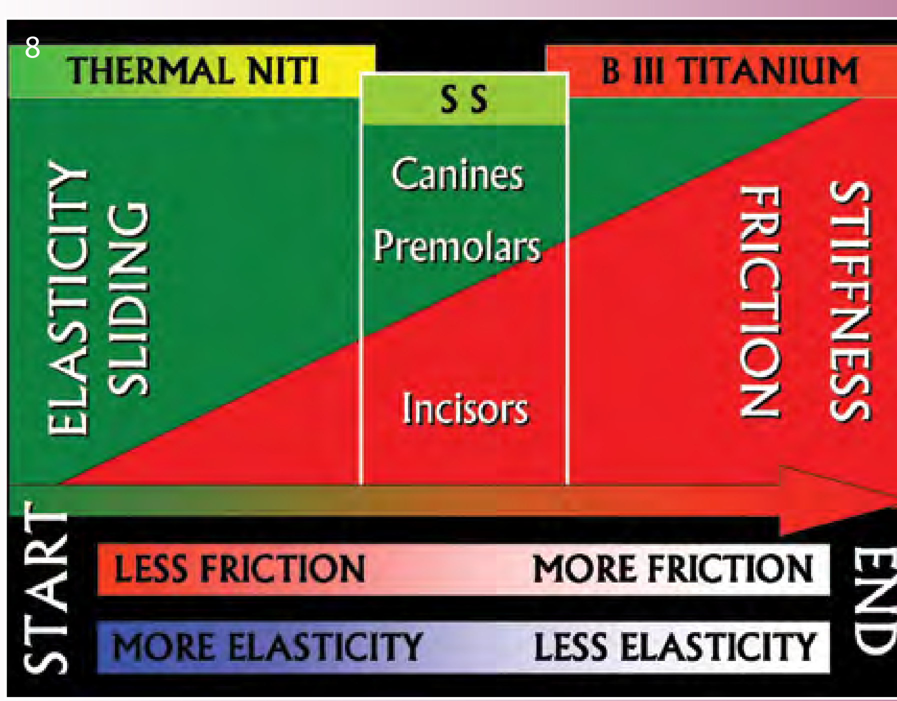
The SWLF Technique makes it possible to control the movement of individual teeth, tooth-by-tooth, through the appropriate choice of brackets and ligatures. Unlike other systems, whether traditional or self-ligating, the control of dental movement in the SWLF Technique is highly versatile and very simple to apply. The Synergy bracket's unique design, in its various metal and aesthetic versions, helps greatly in simplifying our biomechanics and in shortening treatment time.

Depending on whether we use metal, conventional elastic, or low-friction (silicone) ligatures, and depending on how we ligate the arch wire to each bracket (in the center, in a triangular pattern, in a conventional manner in an "O" or an "8") we can achieve various degrees of friction and dental movement: Does anyone offer you more for less?

The manner in which the arch wire is ligated in each bracket determines the degree of sliding and friction. Friction and resistance to movement drops to nearly zero when the central wings alone are ligated with low-friction (silicone) ligatures.

The Synergy Bracket has all the advantages and ease of use of a traditional straight wire twin bracket (the orthodontist who has been using other brackets does not need to familiarize himself with a "different" bracket when changing to the Synergy technique), but it also adds certain new ingenious design features which provide three fundamental clinical improvements by enabling:[2,4,8]





1. Maximum sliding in the initial stages of treatment with super-elastic wires. The Synergy system has 3 pairs of tie-wings rather than 2. The sides of the central tie-wings are raised in such a manner that when the ligature is applied solely to the center wings, the contact between the wire and the ligature is minimal or non-existent, thus reducing friction almost to zero and optimizing the effect of the super-elastic wires. Numerous studies have demonstrated that alignment with super-elastic arch wires in a case with pronounced irregularity is much swifter and effective with low-friction brackets such as Synergy than traditional single or twin brackets.

2. Early use of rectangular arch wires. One of the problems caused by use of traditional brackets which have slots ending in 90º angles is the biomechanical difficulty of inserting rectangular wires at the beginning of treatments and the need to employ "laceback" or "tieback" ligatures to achieve distal movement of the canines (in many techniques the use of "laceback" ligatures depends on the design limitations of the classical SW brackets rather than the limitations of the biology of orthodontic dental movement).

The Synergy brackets provide an ingenious response to these difficulties with rounded arch slot openings to allow for quick insertion of the super-elastic rectangular arch wires and making "tieback" ligatures obsolete in the process. Slots which are rounded both on the floor and at the ends avoid the adverse effects of the early insertion of rectangular arch wires, i.e., the inadequate couples and the excessive initial movement of the roots allowing for earlier utilization of larger steel wires for the closing of spaces and torque. Synergy presents simple but very ingenious new design features that improve the biomechanical effectiveness of the wires and shorten and simplify treatment, given that less wires, less chair time, and less visits are needed.[5,8]

There are also other self-ligating low-friction brackets with similar characteristics to Synergy, but for me, they are more difficult to bond and handle. They are too bulky, pliers and special keys are necessary for their handling, on occasions the cap can break, the colorful ligatures which children like so much cannot be put into place without losing part of their biomechanical effectiveness, and importantly for our pockets, they cost four times more and the patient does not like to pay more for metallic brackets.

3. Individual "tooth-by-tooth" control of tooth movement and anchorage. The main advantage of the Synergy bracket over other low-friction brackets, whether standard or self-ligating, is the ability to control dental movement and anchorage on a tooth-by-tooth basis by only changing the ligature.

We can basically ligate in four ways:

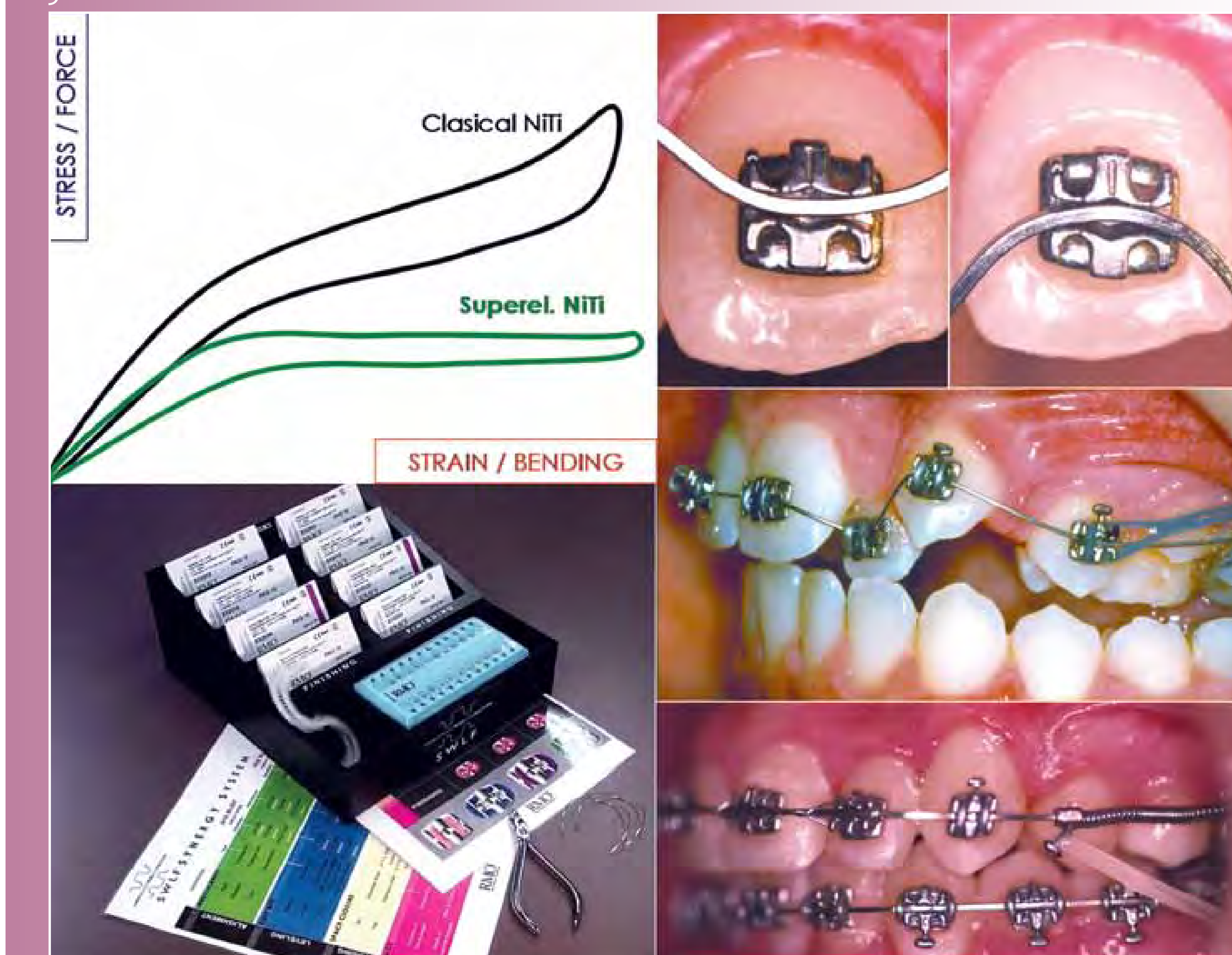
- In the center "C" or in a Triangular shape (two or three wings) to achieve maximum sliding and maximum tooth movement. We ligate in this way when we require maximum displacement: in initial phases of alignment with round or rectangular super-elastic wires, for distalizing canines or lateral sectors, etc.

- Standard (conventional) "O". We ligate the corner wings just like a conventional twin bracket, thus achieving maximum control of rotations and a medium amount of sliding. The friction created by contact between the ligature and wire will condition the degree of tooth movement. We use the new low-friction (silicone) ligatures when we need at the same time low-friction and control of the rotations.

- In a figure of '8'. In this particular case, we produce close wire-ligature-slot contact, thus obtaining total expression of the wire on the bracket and maximum control of the root. Thus, we ligate the teeth where we want to have perfect control over the three planes, where we need to maintain or recuperate torque, and/or we want to obtain tooth anchorage through friction.

THE CONCEPT OF TOOTH-BY-TOOTH FRICTION SELECTION CONTROL (FSC)

Low-friction brackets are now all the rage, and all the orthodontics manufacturers are racing to improve arch/bracket sliding. Many in the profession have opted for conventional low-friction brackets, self-ligating brackets, or mixed low-friction brackets. RMO opted for the friction selection control (FSC) tooth-by-tooth alternative with its Synergy bracket many years ago. When I started to use the Synergy bracket over eight years ago, I soon realized that it was not only a low-friction bracket, but that it also had the capabilities of a conventional bracket and that simply by modifying the ligature (materials and shape) it would be possible to control friction, or its opposite, sliding, on a tooth-by-tooth basis. Unlike low-friction self-ligating brackets, which are excellent during alignment but of limited use for dental control in the torque and finishing stages (in my experience it is not easy to finish the cases with self-ligating brackets), the Synergy bracket allowed us to obtain friction (with elastic or metallic ligatures placed conventionally or in a figure of eight) when the treatment required excellent tooth control. Remember that friction during orthodontic treatment is

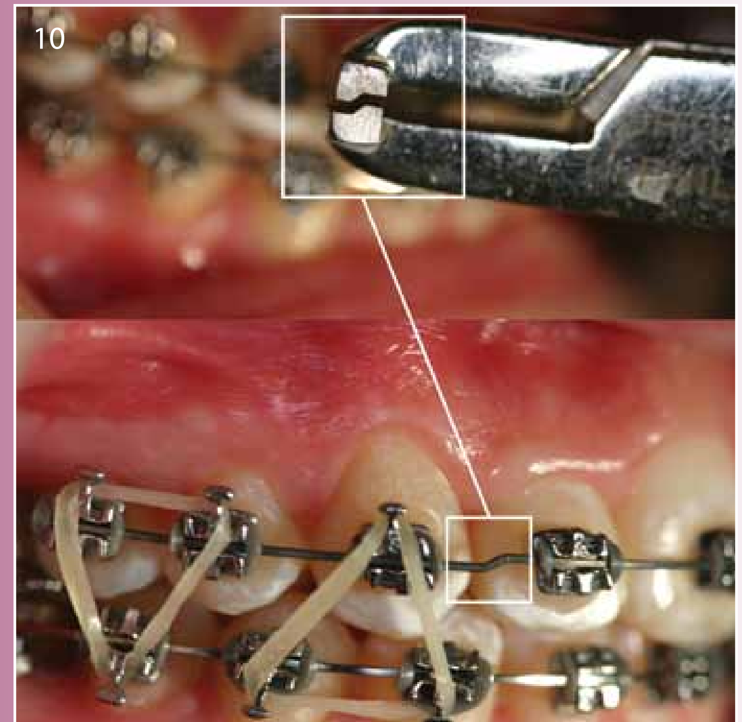


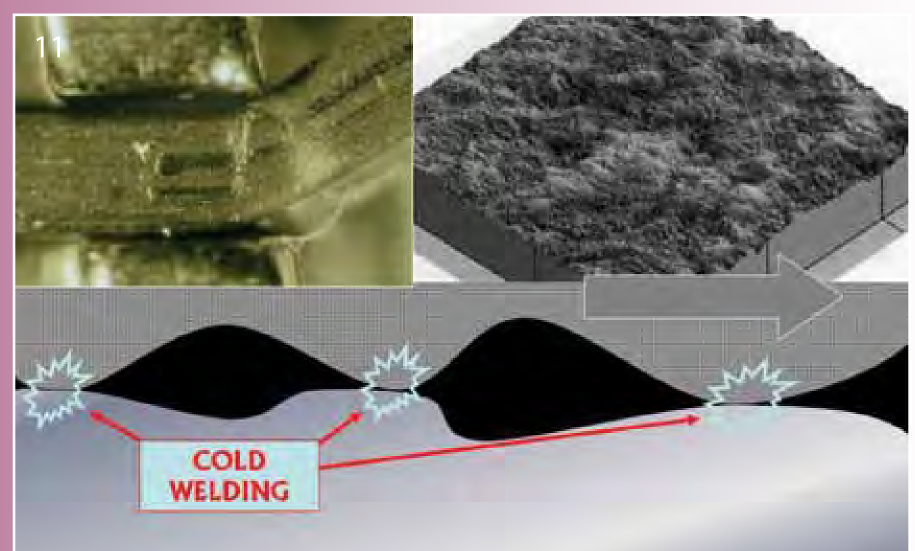
not bad itself. In many cases we need friction to move the teeth! (Fig.1)

SWLF PRESCRIPTION

With the benefit of hindsight since the initial Andrews prescription, we are aware that the only novelty in many of the earlier new techniques was a small, clinically insignificant, variation in angulation and/or torque. The SWLF technique would not have merited any attention if it had solely offered yet one more prescription. Although we believe that pre-adjusted brackets help to simplify treatment, we do not feel that small variations in the average in/out, tipping and torque figures are determining factors when choosing one technique over another. The scientific literature we have consulted in respect of the differences between prescriptions confirms our views and reveals that many of these prescriptions are little more than marketing exercises. Small modifications of a few degrees, particularly when the largest caliber wires used by the majority of practitioners are those which still allow for a considerable degree of free space on the inside of the slot (.017" x .025" in a .018" slot and .019" x .025" in a .022" slot), have no noticeable clinical effect at the end of treatment. The evident commercial side to prescriptions (their use to differentiate the brackets of one author from those of another) will be clear to the practitioner who analyzes the 'torque in play' between a 'thick' .019" x .025" wire in a .022" slot. The freedom of movement (the degree to which the wire is able to turn on itself within the bracket) is over 30º! Are a few degrees variation in an incisor so important? Isn't a significant part of the 'battle of the prescriptions' a question of marketing rather than science? Is there such a great difference in the outcomes between one prescription and another? Which has most bearing on the outcome: a few degrees of torque or dental anatomy and the variations between each individual patient and each malocclusion?

We have used these simple and clear ideas as the basis for a prescription which aims to approximate itself to the average values in the most popular prescriptions while leaving the canines and incisors with standard values (Fig. 2). We believe it is important to overcorrect the torque in the upper central incisors (17º) due to their tendency to lose torque during retraction with thick rectangular arch wires. In relation to the Roth prescription, we have reduced the overcorrection of the torque and rotation of molars and the inclination of the upper canine by up to 8º where the use of conventional brackets means that distal shift of the canine is less likely than with SWLF.





The same philosophy has led us to opt for the standard prescription in the lower incisors, where negative radicular torque of only a few degrees can create undesirable contact between the fine roots of the incisors with the thick cortical vestibular and give rise in certain patients with little inserted gingiva or an unfavorable periodontal biotype to radicular reabsorption and/or gingival recession. Modifying lower incisor torque is very often more the wish of the orthodontist than a clinical reality, which frequently comes up against the limitations imposed by the gingiva and/or the cortical bone. One of the most fascinating aspects of orthodontics is that no two patients, or their mouths, are ever the same. Practitioners are aware that the values given by the distinct prescriptions are no more than approximations to the ideal and individual prescription for each of our patients, with the result that when we reach the stage of finishing and detailing the occlusion, we have to 'individualize' our prescription with some 1st, 2nd, and 3rd order bends in the arch wire. For this purpose we recommend the use of Beta Titanium III (Bendaloy) as final arch wires. Beta Titanium III (Bendaloy) allows us to create bends inside the mouth without removing the arch wire in order to make our prescription more precise and tailored to the patient.

APPLYING NEW IDEAS CONCERNING ORTHODONTIC TOOTH MOVEMENT

Recent experiments investigating the biology of orthodontic tooth movement demonstrate the need for adequate and permanent periodontal vasculature throughout our treatments and the great advantages enjoyed by intermittent forces, given that they provide rest and recuperation of the vasculature. Furthermore, few clinicians today doubt the effectiveness of functional orthodontic forces in correcting many skeletal problems during growth. Our approach believes in Ecological Orthodontics, i.e. the use of natural forces generated by our musculature and soft tissues.

According to Birgit Thilander, an optimal orthodontic force intends to induce a maximal cellular response and to establish stability of the tissue. An unfavorable force does not result in a precise biologic response and many initiate adverse tissue reactions. We can apply with the SWLF technique two different types of forces: continuous and intermittent. The purpose of applying a light force is to increase cellular activity without causing undue tissue compression and to prepare the tissues for further changes. Generally, the magnitude of the force determines the duration of the hyalinization.

The SWLF Technique employs Thermal Nickel-Titanium (SWLF Thermal NiTi) with three goals in mind: it is easily inserted into the brackets without discomfort to the patient thanks to its being relatively ductile when the wire is cold, it applies gentle and constant forces during the initial alignment stage independent of the degree of deflection or deformation of the arch wire, and it generates intermittent forces upon changes to the intra-oral temperature, be they spontaneous (e.g. during drinking, eating, talking, keeping the mouth open, etc.) or intentional (swilling the mouth out with hot/cold water). The simultaneous combination of wires and functional intermittent forces (such as those generated by functional braces, i.e. the Frankel Functional Regulator, Twin-Block, Bimler's elastic appliance, the Occlusal Hinge, etc.), provides excellent results in the treatment of Class II and III cases (Fig. 3,4,5 & 6).

NEW SWLF ARCHWIRES

One of the most significant advances in orthodontics in the last ten years has undoubtedly been the introduction of the new superwires. These days, it is impossible to conceive of swift, effective, and efficient treatment without use of the latest alloys in our arch wires. However, this panoply of wires is confusing for the practitioner and makes it more difficult to select the correct wire for each stage of treatment.

From the very moment when we began to design the SWLF technique we attempted to establish a simple and effective choice of wires based on three guiding principles:

- The smallest possible number of arch wires during treatment, with the aim of simplifying the biomechanics and our choice of wires, limiting the number of patient visits and reducing stock and clinical costs.

- Use of the best alloy and size for our arch wires at each stage of treatment.

- Establishing a clear and simple protocol for the selection of arch wires at each stage of treatment.

There are three basic alloys used in the SWLF Technique: Thermal Nickel-Titanium (Thermaloy), Stainless Steel, and Beta Titanium (Bendaloy). All three have highly distinct metallurgical qualities and, taken together, are sufficient to cover the entire spectrum of current orthodontics (Fig. 7, 8 & 9). To a lesser extent, we also employ other alloys such as pseudoelastic Nickel-Titanium and Elgiloy (chrome-cobalt).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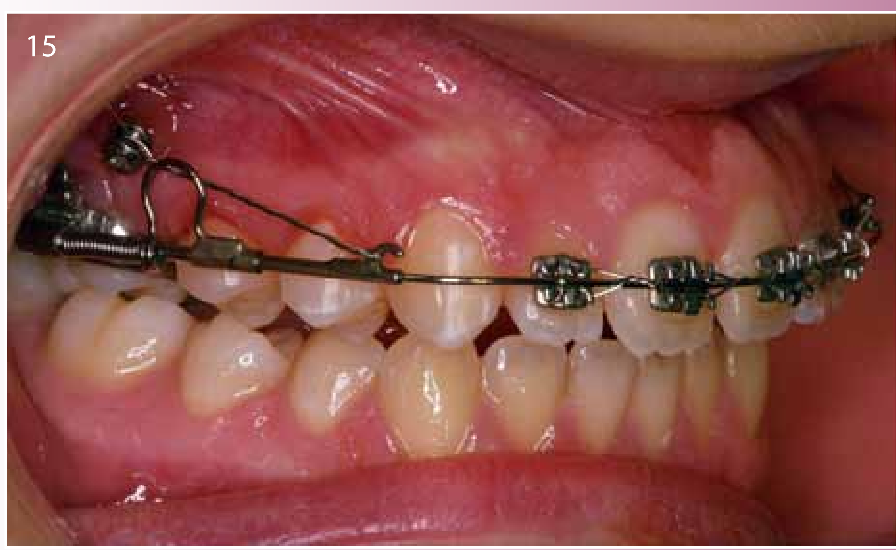
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We have attempted to simplify the choice of wires and make it more convenient by designing an Introductory Clinical Kit which presents the Technique's wires arranged according to each stage of treatment: thermoelastic Thermal NiTi (Thermaloy) for alignment, Curve of Spee NiTi for leveling and polishing, stiff Stainless Steel (Tru-Chrome) for space closure, and the excellent Beta III Titanium (Bendaloy) for final finishing and detailing.[5,8]

The team of engineers at RMO-Denver has developed new high-tech arch wires for the SWLF technique, particularly for the alignment stages (thermoelastic wires) and the finishing and detailing stage (Beta-III Titanium Wires). We made use of the traditional stainless steel RMO wires for the finishing and detailing stages, and NiTi arch wires with Spee's curve for leveling. We have also added new .013", .015", and .017" dimensions which are better adapted to the requirements of alignment, both for .018" and .022" arch slots.

The new Thermal NiTi (Thermaloy) SWLF wire is characterized by a high degree of elasticity and the generation of very light forces, independent of the amount of arch wire deformation. The patient's intraoral temperature aids the phase change (from martensite to austenite and vice versa). The new Thermal NiTi SWLF wires produce light, constant, and prolonged forces. These wires optimize dental movement during the initial alignment process and allow the patient's best arch shape to 'express itself' through the stimulus it gives to the formation of alveolar bone.

With the Thermal NiTi (Thermaloy) SWLF wire, the force is predetermined by the manufacturer, and strictly speaking, remains the same whatever the degree of deformation applied to the arch wire when inserting it into the brackets in order to align the teeth. The fact that the forces are predetermined and constant, particularly when they are located in the light to medium band (between 50 and 100 grams), heightens the effect of dental movement on the physiological force levels and prevents the creation of intense forces in the case of particularly uneven arches. One practical effect is the ability to create severe deflections in the arch wire, as when aligning canines in high vestibular position, without generating the excessive, even iatrogenic forces formerly produced by traditional NiTi wire, which obeyed Hooke's Law and generated huge forces when deformed, creating a risk of periodontal necrosis, ankylosis and/or radicular resorption of the tooth and loss of anchorage and stability in neighboring teeth.

As its name indicates, the edgewise technique from which our own technique is derived draws its principal therapeutic effect from rectangular stainless steel wires. As a result, our aim is to align and level the arches as soon as possible in order to arrive at these arch wires swiftly while employing the minimum number of wires to do so. As the new rectangular superwires come in varying pre-set force levels, we can clinically reduce the number of prior round arch wires (we do not see why it should be necessary to use square arch wires). As a result, in most of our treatments we reach .019" x .025" stainless steel arch wires in a .022" slot after the use of just one or two prior arch wires.[2,4,8]

The new wires have a longer average activation period than traditional NiTi arch wires. We are therefore obliged to amend our practice of seeing patients once a month in order to change arch wires and ligatures, and to allow the wires to act and express the prescription for 6 to 8 weeks. The properties of thermoelastic wires alter in response to the change in temperature from the austenite to martensite phase. Given that intraoral temperature is a constant, at 36.5° centigrade, the metallurgical industry is conducting research into new wires capable of precisely adjusting their phase change to this constant working temperature. Differential heat treatment also enables one single wire of uniform caliber to contain distinct levels of elasticity/rigidity in the anterior-incisor, premolar, and posterior molar regions, which brings us yet closer to EH Angle's dream of one single wire for the whole treatment process.

We use the SWLF Beta-III Titanium (Bendaloy) in the finishing phase. It is a titanium-molybdenum wire with the best elastic properties among nickel-titanium wires and the conformation ability of steel. This is the ideal wire for final detailing of the occlusion and is highly effective when combined with short and strong elastics and the special SWLF step pliers (for .5 and 1.0 mm) for intraoral correction of small defects in first, second, and third order compensations when we are concluding the treatment.

LOW FRICTION LIGATURES

Ligatures, elastic chains, and elastic modules play an extremely important role in this technique, and some of these items, as with the new crimpable hooks and pliers system, have been specifically designed by RMO-Morita in Japan. When the Synergy bracket is ligated in the center, and also in the conventional position, it is advisable to use special low-friction (silicone) ligatures in order to control rotations. RMO has developed some excellent low-friction ligatures coated with a polymeric film which increases their ability, compared with conventional ligatures, to slide when they come into contact with saliva. We employ RMO's Energy Chain for closing adjacent spaces, and the new elastic SWLF modules for 'remote' traction, e.g. from the canines or posts in .019" x .025" closing loop arches. We feel that modules are more hygienic as well as effective and provide us with a greater degree of control over the force applied.

At the current time we are designing a new traction system for space closure achieved either conventionally or in combination with TADs, based on elastic modules, superelastic springs, and new crimpable hooks.

GETTING THE MOST OUT OF EACH ALLOY WITH THE NEW SWLF PLIERS

The new thermal alloys (SWLF Thermal NiTi) and Titanium-Molybdenum (SWLF Beta III Titanium) are excellent, and clinicians must learn how to handle these materials and get the most out of them. SWLF Thermal NiTi (Thermaloy) must be "allowed to act" and express itself for several weeks and then be reactivated through cooling each time the patient visits the practitioner. This makes it possible to space out check-ups over longer periods of time (every six weeks), and it is very good at moving the tooth quickly without discomfort. SWLF Beta III Titanium has the great advantage of 'cold welding' in order to increase friction at the latter stages of treatment, and can be bent inside the mouth without the need to take the wire out of the brackets and without discomfort for the patient. The balance between elasticity and ability to conform or bend makes this wire essential in final detailing (Fig. 10 & 11).

With the intention of squeezing the maximum possible out of each arch wire at the various stages of treatment, we have designed a series of pliers for the Technique in order to bend these wires. Use of these pliers simplifies the mechanics of the treatment and drastically reduces chair time.


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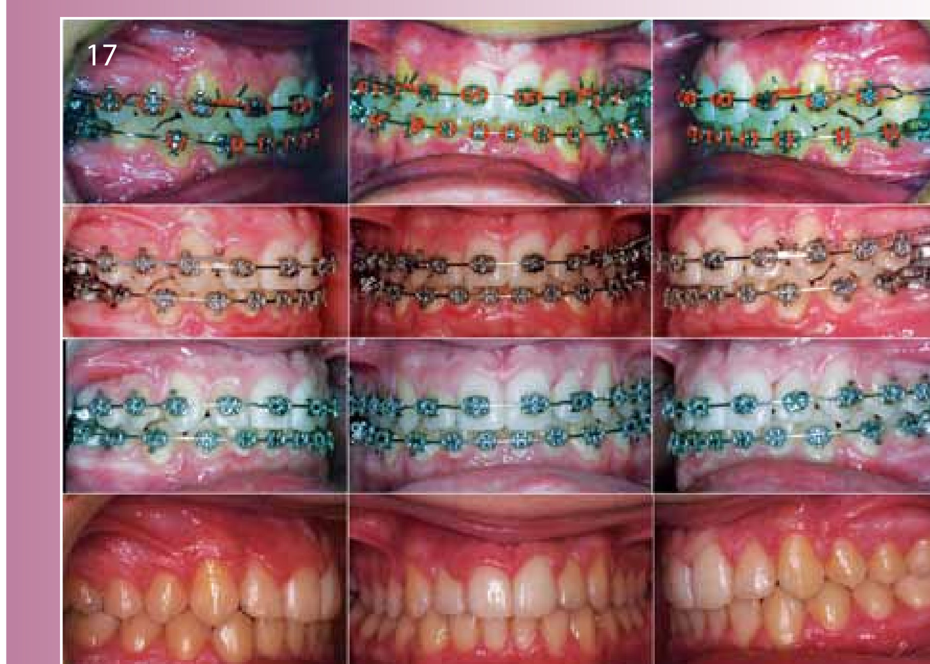
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PERMANENTLY ABSORBING CUTTING-EDGE TECHNOLOGIES: RMO'S "DUAL-TOP" TADS

Orthodontic techniques are greatly influenced by technological progress, and it is these advances in technology which continually force us to reappraise our diagnostic and therapeutic systems. The technological basis for the SWLF Technique rests on three solid pillars: bracket design, superelastic alloys, and TADs.

TADs represent a huge advance in this field as they provide a simple, trouble-free, swift, safe, and cost-effective means of achieving excellent bone anchorage, which creates a whole new range of therapeutic possibilities and helps us to simplify and increase the effectiveness of our treatment. TADs allow us to intrude and/or control molars three-dimensionally in a quick and easy way, to intrude or extrude incisors, to change the angle of the occlusal plane, to treat cases of skeletal open bite, etc. The uses to which TADs and new direct bone anchorage systems can be put is limited only by our imagination. The appearance of TADs in orthodontics represents a spectacular advance in the ability to control and manage anchorage and simplify the conventional orthodontic treatment. The biomechanics are greatly simplified and the screws have made it possible to obtain movement which was extremely difficult or even unthinkable with traditional anchorage systems (maximum posterior anchorage in periodontal patients, the intrusion of incisors in adults with periodontal problems, the intrusion and straightening of molars, the traction of impacted teeth without orthodontic braces, retrusion of the incisor-canine group 'en masse' and simultaneously, control of the vertical posterior dimension by molar intrusion, etc.) (Fig.12,13,14,15 & 16)

Research on animals and clinical observations have demonstrated the effectiveness of TADs even as an alternative to orthognathic surgery. There are numerous studies concerning openbite caused by posterior vertical maxillary excess which has been successfully treated with TADs for posterior molar intrusion. Ohmae, et al. have achieved an average of over 4.5 mm intrusion in mandibular premolars in dogs, and several biomechanical designs employing TADs in the posterior area have demonstrated the high degree of clinical effectiveness in molar intrusion and the treatment of posterior vertical dentoalveolar excess in patients with openbite. Daimaruya, et al. even state that intrusion can be achieved without difficulty inside the maxillary sinus.[2,4,8]

Unlike earlier systems based on osseointegration or miniplates, there are almost no anatomical limits to the location of TADs as they are appropriate for a very wide range of medical indications for which the only limit is the practitioner's imagination. TADs are very easy and quick to insert, very inexpensive, and they can be loaded immediately after insertion. TADs can be employed on growing patients, they are safe, and they have a very low rate of complication. In fact, the most important complications such as tooth, nerve, or vessel damage are extremely rare. Orthodontic TADs cause little discomfort to patients, they are easy to remove, and most importantly for me, they may be handled (inserted, loaded and removed) by an orthodontist with complete safety after only the briefest of training courses.

In our experience, most of the RMO Dual-Top Anchor System microscrews we have inserted require very little local anaesthetic (a few drops at the site of insertion). It is not necessary for the orthodontist to make cuts or flaps with a scalpel, and given that the screws are self-tapping and self-drilling, it is unnecessary to use a reamer for many patients. In most cases we simply use a hand driver (screwdriver) both to insert and remove the TADs. Inserting and removing a TAD is actually a much simpler process than cementation of rapid palate expansion, the adhesion of direct bonding tubes on second molars, or permanent lingual retainer bars, and in our experience, it does not disrupt clinical routines.

The routine use of TADs will undoubtedly feature heavily in orthodontic clinical practice in the coming years due to the significant biomechanical advantages it provides for our treatments in terms of effectiveness and speed. Using TADs is not only a very simple process, it is also safe and cost-effective and should soon become extremely commonplace. There is no need for a complex training course concerning either materials or equipment which the orthodontist does not already have in his clinic. With a minimum of training, an orthodontist may place a TAD in a favorable region in ten to fifteen minutes.

In our own clinical practice where the patients are approximately upper-working class, we have incorporated the TAD insertion protocol into our clinical routine without the slightest difficulty. Furthermore, the TADs have been very well received by patients, especially by adults, who see them as a means of avoiding use of more uncomfortable apparatus (headgear and extraoral appliances, intermaxillary elastics, Nance holding arches, lip bumpers, etc.) and of receiving better treatment with less apparatus over a shorter time span. TADs help us to reduce the duration and complexity of the course of treatment and limit the apparatus required in preprosthetic orthodontics and in cases concerning impacted teeth or orthognathic surgery. In addition to its very significant clinical advantages, the use of TADs is an additional marketing device as it helps to improve our service to the patient, stand out from our colleagues, and create a cutting-edge image for our clinic.

THE USE OF MULTI-PURPOSE SYSTEMS

All practitioners try to avoid complex techniques which require a large amount of material and inventory (different kinds of brackets, a large number of arch wires with different arch shapes, wires with pre-soldered springs or hooks in varying sizes, distalizing systems, etc.) Very often, the attempt to excel actually prevents good practice, and any attempt to ensure a clinic has a wide variety of arch shapes and braces simply makes it more difficult to choose and use them.

The SWLF Technique tries to ensure that each element of the technique has as many uses as possible for reasons of simplicity, ergonomics, and economy. An obvious example is the new SWLF Crimpable Hooks. Other techniques employ arch wires with pre-soldered hooks, but this means keeping a large number of arch wires in stock and their use is limited by the size of the arch, the fixed position of the hooks, etc. The high quality SWLF Crimpable Hooks stay perfectly positioned in the arch with the use of the special pliers designed specifically for the purpose. The Crimpable Hooks can be applied to different rectangular steel and beta titanium wire sizes, and they can be positioned unilaterally or bilaterally, symmetrically or asymmetrically, etc. We sometimes combine the SWLF Crimpable Hooks with distalization springs made of Elgiloy or Nickel-Titanium to distalize molars without any need for co-operation.

The elastomeric chains (Energy Chain) and modules which have been developed for the Technique in Japan open up new therapeutic possibilities for friction control (Polymeric Low-Friction Ligatures), space closure, and application of the Crimpable Hooks and TADs.

ARCHWIRE SELECTION IN THE SWLF TECHNIQUE

There is a Chinese proverb which states; give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime. When teaching staff or training courses introducing students to a specific technique, instructors are often prone to hand out fish rather than teach students to fish. This leads to teachers choosing wires as if from a recipe, which is highly unsatisfactory given that there is no spur to change to new wires and clinical evolution is blocked. The criteria we use to choose wires are simple and ready to embrace the developments which orthodontic manufacturers will undoubtedly produce in the future.

One of the keys to achieving a high degree of clinical effectiveness in orthodontics, i.e. quick treatments with only a few short visits, is the appropriate selection and use of the arch wires. We should use a small number of high quality wires which are able to generate light, constant forces over long periods. The new alloys allow us to reduce the number of wires used in the different stages of treatment.

We adapt the new SWLF wires to the biomechanical requirements of each phase:

- Alignment Phase. At the Alignment Stage we require superelastic wires with excellent shape memory which are highly elastic and capable, even in rectangular wires, of generating light, constant, and prolonged forces. The wires must be optimal in order to produce, in the words of Professor José A Canut, the "periodontal awakening" which sets in motion the cellular reactions and histochemical mechanisms which will lead to orthodontic dental movement and the formation of alveolar bone. We must allow the new wires to slide smoothly and freely through the brackets and express the best possible arch shape for each patient. For many years this initial stage of treatment was overlooked, but we now consider it to be of key importance for the rest of the treatment. In cases where we are unsure whether to expand or extract, we await the end of this stage before making our final decision.

- Leveling Phase. At the leveling stage we employ the R. M. Ricketts utility arch approach in mixed dentition or as an auxiliary element as part of intrusion in permanent dentition, and we use preformed curve of Spee nickel-titanium arch wires in the remaining patients where we need to level due to an excess of overbite or overbite effect. The biomechanics of these wires are controlled by the simple use of intermaxillary elastics: posterior when we require greater anterior intrusion, as in the case of overbite due to extrusion or excessive anterior dentoalveolar growth, and anterior when we require posterior intrusion, as with openbite cases.

- Space Closure Phase. We must combine sliding and canines and premolars shifting en masse with friction and the retention of torque in the incisors. Our wire of choice is rectangular stainless steel due to the ability to combine rigidity for achieving and retaining radicular torque with an excellent surface for sliding.

The space closure stage has been one of the challenges to which traditional Straight Wire techniques have been unable to provide a satisfactory solution. The friction generated by conventional twin brackets during sliding, with the resulting obstructed movement and loss of anchorage, led to several variations on the original Andrews technique to opt for preformed arch wires and wire/bracket displacement, which has the effect of reducing the biomechanical effectiveness of the wires and other elastic elements. The results of these biomechanical difficulties are plain to see in the high rate of extractions which clinicians are obliged to carry out when using the Straight Wire technique with traditional brackets. Space closure in our technique is very much improved by use of the Synergy bracket in conjunction with the SWLF prescription, due to its multi-faceted nature when selectively choosing the degree of sliding required on a tooth-by-tooth basis.

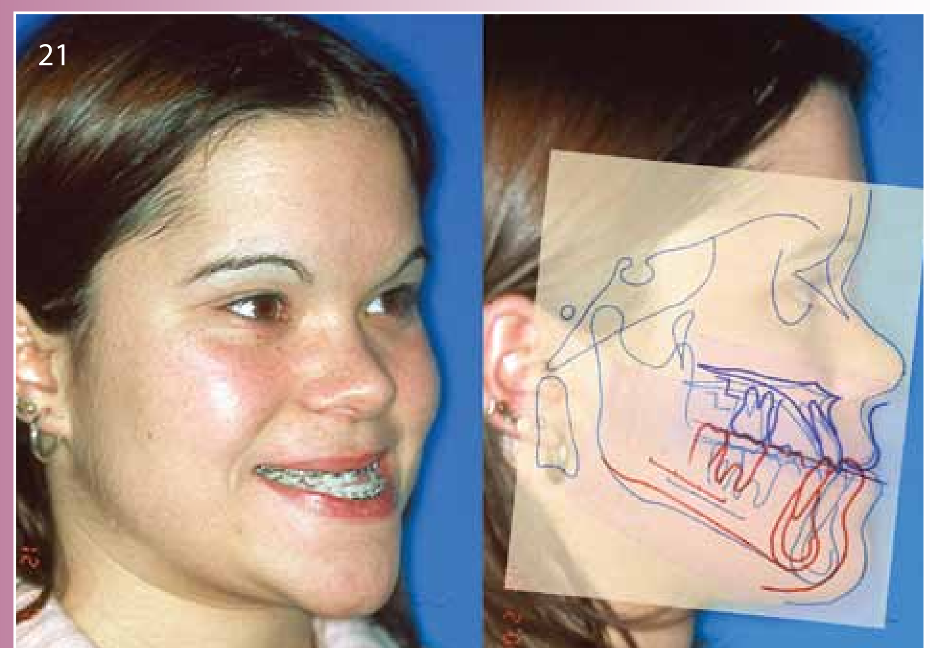
Given that one of our aims in developing the SWLF technique was maximum versatility and simplicity, we opted for the in-mouth positioning of hooks for space closure. RMO has developed new hooks for this technique with the appropriate size and a rounded surface, as well as a new pair of pliers for placing them quickly and simply on the arch. This alternative has innumerable advantages: it makes it possible to convert a conventional rectangular arch wire into a selective closing loop arch, we can choose exactly where we intend to produce closure and if it is unilateral or bilateral, symmetrical or asymmetrical, it can be combined with other additional parts such as intermaxillary elastics , distalization springs, TADs, and it avoids the need to keep large and varied stocks of preformed arch wires with crimpable hooks.

The simplicity of space closure in the SWLF technique makes it possible to space out appointments for monitoring and activation purposes and to reduce chair-time. The Synergy bracket guarantees excellent sliding of the arch wire in lateral areas and the retention of torque during incisor retraction.

- Finishing Phase. Our aim is to ensure that the occlusion settles, to maintain torque, and to correct small final irregularities. This is a very important stage, for which our first-choice wire is Beta III Titanium (Bendaloy), a new Titanium-Molybdenum wire specifically developed for the SWLF technique. The main advantage of this wire is that it achieves a perfect balance between elasticity, resilience, and an ability to conform. The new Beta III Titanium allows us to make intraoral bends with SWLF pliers without the need to remove the arch wire from the brackets, which reduces chair-time and appointments at a time when the patient is eagerly awaiting the end of treatment.

In those cases where there is no need for a great deal of detailing due to the results already achieved or the patients' biological characteristics and/or their malocclusion, and there is no difficulty maintaining torque, we use braided steel, rectangular braided SS arch wires.

The choice of arch wires must be practical and versatile, and cannot simply be a recipe which becomes obsolete upon the invention of new and better alloys. On the other hand, it is not an easy or realistic task



to program each and every one of the arch wires to be used in a specific treatment from the very beginning. In the SWLF technique, we have decided to select the preformed arch wires at each phase or stage of treatment independently, having regard to clearly established criteria which are nevertheless open to the diagnostic skill of individual practitioners.

After completing each stage and before commencing the next, we will assess the results achieved thus far and, of great importance, we will ask ourselves whether or not we could achieve more and improve results with the arch wires the patients already have inside their mouths. We should not be in a rush to change arch wires. We must be able to 'squeeze' the most out of the new super elastic wires used by this technique. It should not be forgotten that in the SWLF technique the way in which the ligatures are attached (on the center wings, conventionally, in a figure of eight, etc.) opens up new possibilities in comparison with other techniques. It is not always necessary to complete all the stages. Sometimes the malocclusion might not require leveling (where the overbite and the Curve of Spee in the arches are normal) or space closure. It is not unusual with the SWLF technique to complete many treatments with two arch wires per arch.

ALIGNMENT

Aims:

- Initial periodontal awakening with light forces
- Crown alignment and straightening control of rotations
- Dentoalveolar expansion and development
- Expression of the optimum Arch Form for this patient

Selection criteria:

- Irregularity index. This is the sum of the distances between points of contact of adjacent teeth. The higher the index (high irregularity), the greater the elasticity and the lower the caliber required of the initial alignment arch wire. When irregularity is low, we can commence treatment thanks to the design of the Synergy bracket's slot with its rounded ends, with the ligature tied to the center wings and with the use of rectangular wires. It must be considered whether the irregularity is localized or generalized.

- Skeletal-dental discrepancy (SDD) or crowding.

Arch wires:

We require superelastic wires generating light, constant, and prolonged forces. We use the Thermal NiTi (Thermaloy), a nickel-titanium thermoelastic wire with shape memory which undergoes a reversible process upon changing phase (austenite phase martensite phase) as a result of the patient's intraoral temperature. Thermal NiTi is offered in a range of new dimensions (.013", .015", and .017"). The dimension is chosen in accordance with the slot (.018" or .022"), the irregularity index, and the SDD.

Clinical details

- How to ligate: In general, all teeth are initially ligated in the center wings to avoid friction and thereby guarantee maximum sliding. On those teeth furthest away from the arch we recommend using metallic ligatures. As the wire is thermoelastic we cool it locally with a cotton bud dipped in cold water or ice to ease insertion. Care should be taken to ensure that the wire remains 'unimpeded', i.e., that it can slide smoothly when we pull on it from behind the finishing tube. If appropriate, at a second appointment with the same arch now reactivated, we recommend ligating in the conventional manner to control rotations.

- When to ligate distally: In general, when we do not wish to see a marked increase in the arch length, we recommend ligating the wire distally (either by turning it at the ends or bending it with special pliers). In general, we ligate distally in upper and lower Class I cases with biprotrusion, only on the upper distal in Classes II/1 and solely on the lower distal in Class III.

- Allow the wire to "express" itself. Thermal NiTi (Thermaloy) is an excellent wire and needs time to take effect. Allow it to act over 6 to 8 weeks before assessing its effects. Thermal NiTi can be 'reactivated' by removing it from the mouth and expanding it with the aim of extraorally facilitating its phase transformation .

LEVELING

Aims:

- To correct vertical problems
- To correct Spee's curve in each arch
- To correct increased or decreased overbite according to the facial biotype and the growth tendency

Selection criteria
Overbite and facial biotype:

- In patients with increased overbite (> 2/3) we must evaluate the degree of dental-gingival exposure with posed smile, the facial biotype, and the lower facial height. In general, we use NiTi Curve of Spee arch wires in order to intrude incisors and extrude molars. We use posterior elastics to increase posterior extrusion in patients with limited gingival exposure, brachyfacial patients, and those with a diminished lower third.

- Where patients have openbite (< 1/3) and with a view to simplifying the biomechanics, we use the same arch wires but with anterior elastics (strong and short) for 14 hours per day. This achieves a posterior intrusion vector which strengthens the action of the other intrusion mechanisms (Palatine Bar, High Pull Traction, etc.). In many patients with severe openbite and posterior vertical excess, we prefer to combine the NiTi Curve of Spee (in a reverse way) with TADs at the level of the molars.

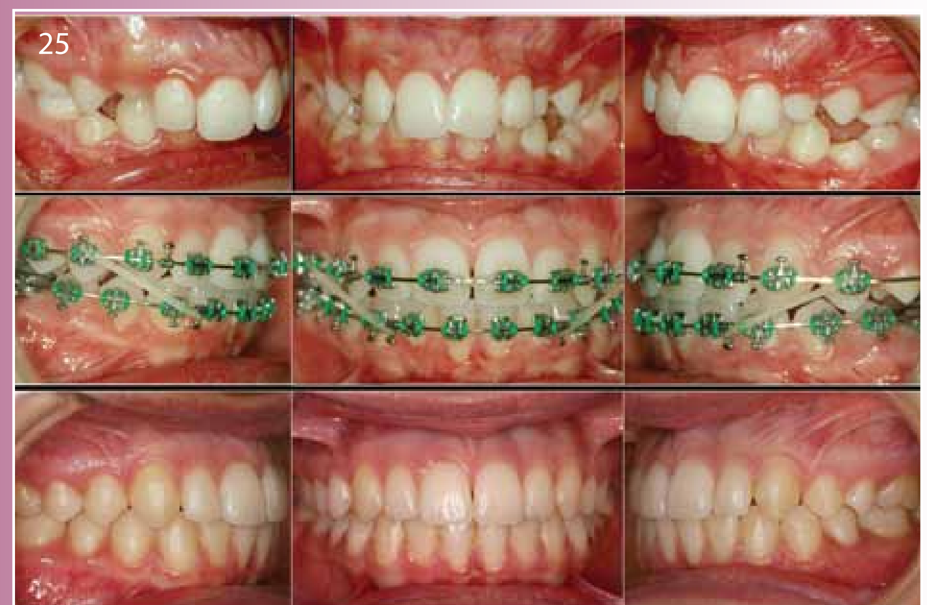
Arch wires:

For mixed dentition we employ the traditional Elgiloy utility arches by R. M. Ricketts. For permanent dentition we use nickel-titanium preformed curve of Spee arch wires. We differentiate the biomechanics of incisor intrusion and molar extrusion from that of incisor extrusion and molar intrusion by the differential use of elastics.

Clinical details:

- We recommend that the decision as to which wire and biomechanics we intend to use in leveling should be delayed until after initial alignment, as the initial alignment and expansion notably modifies overbite and the vertical relationships. The use of apparatus to distalize molars (Coil Spring with Crimpable Hooks, Wilson 3D Maxillary Bimetric Distalizing Arch, HP Spring-Gear or Ortoflex-Pendulum) improves the incisal relationship in patients with increased overbite.

- It is essential to determine the origin of the overbite or openbite and its distinct components (excessive anterior intrusion/extrusion or excessive posterior intrusion/extrusion). The degree of dento-gingival exposure, the facial biotype, and the growth tendency are three elements to be kept very much in mind. Openbite usually requires a different and more precise diagnosis than is the case with overbite, and occasionally requires more complex biomechanics which are beyond the scope of the issues discussed here.



SPACE CLOSURE

Aims:

• Closure of the gaps generated by expansion, distalization procedures and extractions in the optimal manner and sequence in view of the final objectives in the case in question

• Achieve optimal points of interdental contact with sufficiently paralleled roots and good periodontal health

Selection criteria:

- One of the aims of the SWLF technique is to encourage the development of the shape of the patient's potential arch and to avoid extractions whenever possible. As in other Low-Friction techniques, the SWLF technique drastically reduces the number of extractions thanks to the effectiveness of Thermal NiTi for initial expansion (light and intermittent forces stimulate the growth of the alveolar bone) in conjunction with the use of Functional Appliances (functional intermittent forces), the 3D control and distalization of molars and Orthostripping. Many of the spaces we have to close are those previously achieved by molar distalization techniques. The combination of the Synergy bracket with steel rectangular arch wire and hooks from which to obtain traction with chains, modules, or springs provides surprisingly good results in respect to space closure. We designed a new kind of multi-purpose Crimpable Hook that we use in the distalization of molars, and to open or close the space.

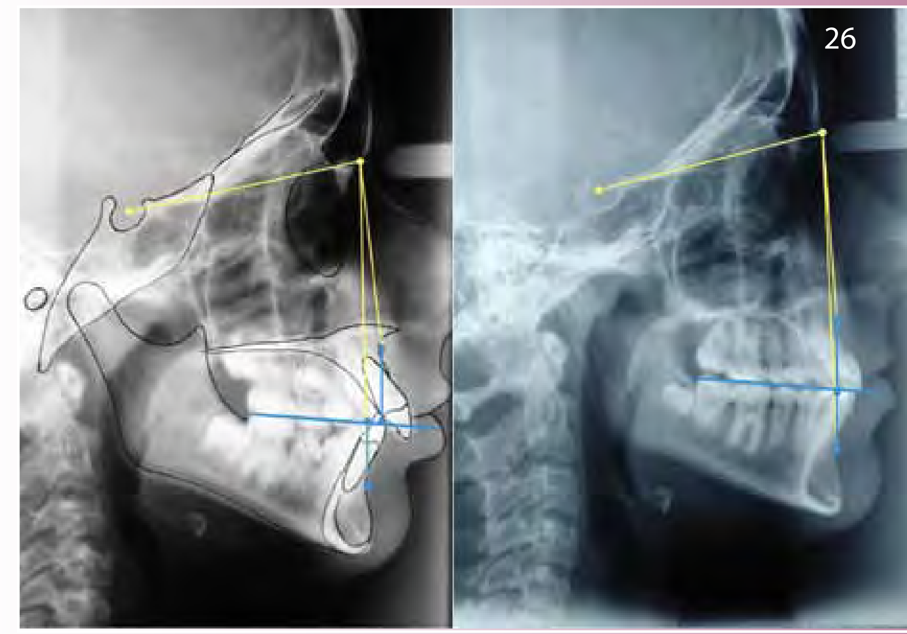
Arch wires:

We utilize rectangular stainless steel arch wires onto which we intraorally place hooks which have been specially designed for the SWLF technique by means of special pliers.

Clinical details

- One of the traditional problems of the SW technique is the biomechanical difficulty of closing spaces with sliding techniques. SWLF resolves the difficulty by improving the system by which the brackets slide along the arch wire and vice versa.

- The intraoral positioning of hooks is simpler and more versatile than the purchase of a large stock of arches with pre-soldered hooks. With the SWLF technique, the clinician can place the hooks in accordance with the location and number of spaces to be closed and the preferred level of control over anchorage. In some cases, the hooks may be placed asymmetrically (e.g. in order to correct middle line problems) or be used as stops on the arch. Intramaxillary and intermaxillary elastic elements may be fitted to the hooks. This system, which has been widely covered in orthodontic literature, is simple to use, very ergonomic, and is clinically very efficient.



- It is important to know how to ligate each of the brackets at this stage: normally in a figure of eight on the incisors and in the center on canines and premolars. The hook is most frequently placed distally on the laterals.

FINISHING

Aims:

• To consolidate the results achieved in the previous therapeutic stages

• To close spaces completely, parallel the roots, and control radicular torque

• To correct all the positional anomalies of the teeth and to establish definitive points of contact

• Detailing and final intercuspidation should be as close as possible to the ideal occlusion

Selection criteria:

- The arch wire of choice for the final detailing of the occlusion is undoubtedly Beta Titanium III (Bendaloy), a cutting-edge high-tech wire which combines the best of nickel-titanium and steel. The wire admits bends and final compensation corrections without removing the wire from the brackets, and somewhat surprisingly, without causing discomfort to the patient. Although we could use it as a matter of routine at this particular stage, we actually use it when we require a range of final detailing steps (in-set and off-set correction, inclinations and vertical problems) or we wish to retain torque and the patient's biology hinders the finishing process (periodontal patients, combined treatments, etc).

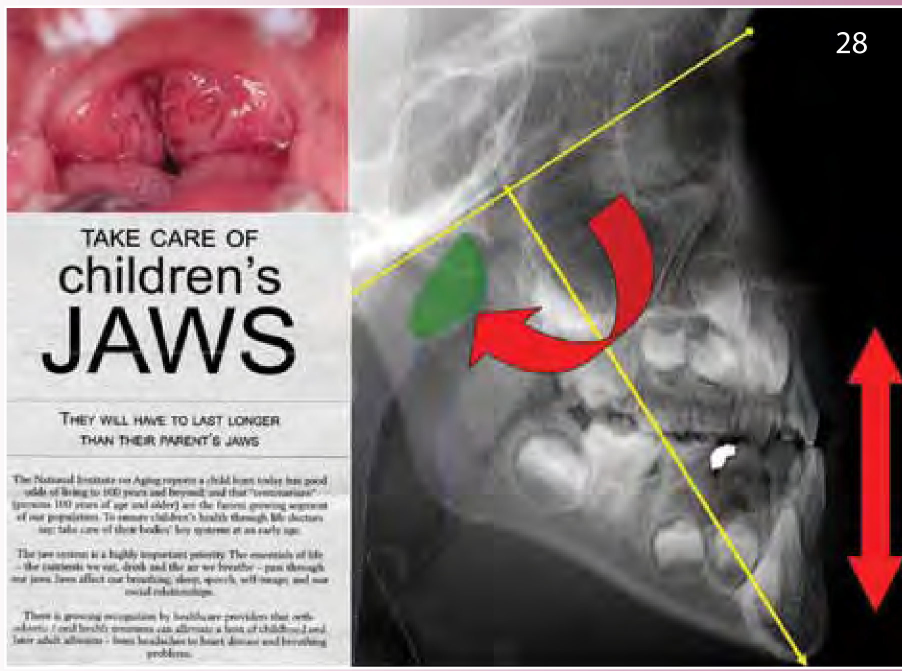
- As second choice, in very favorable circumstances, we employ stainless steel 8-strand braided arch wires.

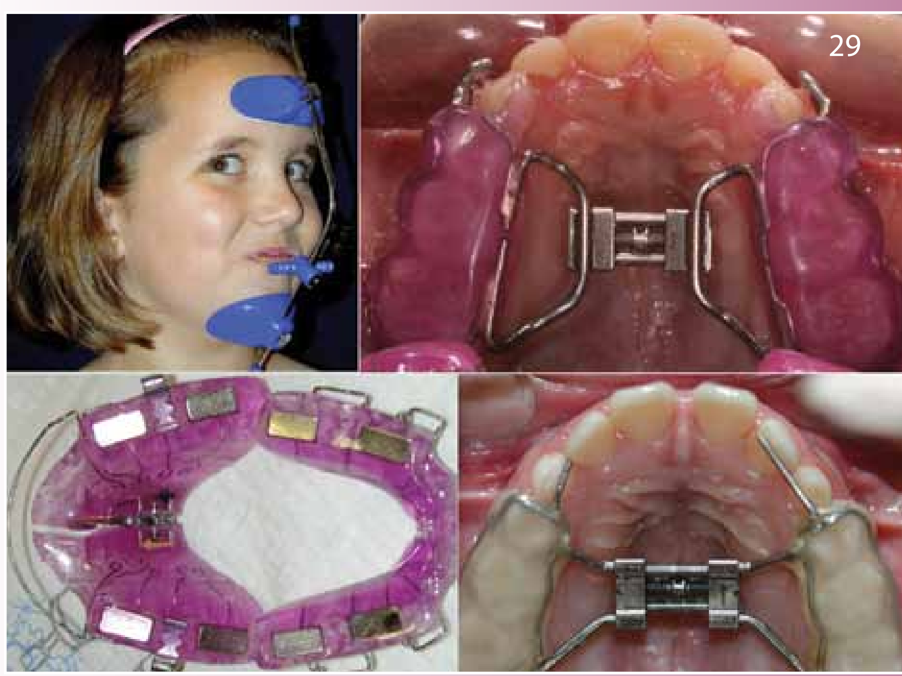
Arch wires:

We use Beta Titanium III (Bendaloy) arch wires, a high quality titanium-molybdenum alloy specifically created for the SWLF technique. An alternative is occasionally stainless steel 8-strand braided arch wires.

Clinical details
(Fig. 17,18,19,20,21,22 & 23):

- It is the final detailing and finishing which distinguishes one orthodontist from another. Mistakes at this stage of the treatment cannot be disguised and are clearly noticeable to the patient, and to other practitioners. Some of the time we have saved by using the SWLF





technique for alignment and space closure must be spent on final detailing.

- It should be considered whether or not the patient or malocclusion tends towards natural intercuspidation in order to decide which type of arch to use: braided when the answer is 'yes', and Beta Titanium III when the answer is 'no' and there is still a lot of 'work' to do.

- We must combine intraoral detailing with profuse use of short and strong elastics which help to settle the occlusion. If necessary, and the requirements of the anterior and posterior groups are quite distinct, we can cut the upper arch into three segments and apply elastics differentially.

- For final posterior occlusal settlement in the last two months of treatment we recommend using the 'reduced friction mode', i.e., ligated center wings on the canines and premolars.

APPOINTMENTS AND EXTRACTIONS WHILE RESPECTING TRADITIONAL ORTHODONTIC APPROACHES

The SWLF Technique is based on scientific evidence and the most traditional line of thought in orthodontics and should not therefore be confused with the present collection of techniques which appear to have discovered new orthodontics with 'miraculous' wires and brackets, promising that there is no further need for extractions or anchorage due to overexpansion of the arches and reduced concern for occlusion at the end of treatment. An overwhelming amount of scientific studies have demonstrated that techniques based on overexpansion fail in the long term. We know that lower intercanine width can be increased in a stable manner by no more than one or two millimeters, whether we use Rapid Maxillary Expansion, wires, or self-ligating brackets. Our approach in this matter could be summed up by stating that we must respect the arch shape independently of achieving the best 'expression' of that arch for each individual patient. It is not a matter of changing, but rather of making the most of the possibilities of each particular arch shape.

The combination of light and intermittent forces with the new brackets and the concept of Controlled Friction assists in the neoformation of alveolar bone during the initial stages of treatment, and in short, reduces the number of extractions needed as part of the treatment. Avoiding extractions is not a goal in itself in our technique, but it is intended that they should be reduced to those cases where they are strictly necessary (Fig. 24,25 & 26).

ORTHOSTRIPPING AND AN ENAMEL RESHAPING SYSTEM

One other novelty introduced by the SWLF Technique is a system and protocol for mechanical stripping employing diamond files of varying grits and sizes and a group of discs and reamers for reshaping enamel and the gums (Fig. 27). The system allows us to improve the final aesthetic and functional properties of the teeth, to increase the stability of the result achieved (by reducing the size of the teeth and increasing the interdental contact area) and to reduce the need for therapeutic extractions. Orthostripping does not damage the enamel, nor does it make teeth more susceptible to decalcification or caries.

EARLY TREATMENT AND ORTHOPAEDIC TREATMENT IN THE PREVENTION OF FUNCTIONAL PROBLEMS AND OSA

Although there is an ever increasing body of scientific evidence supporting the start of most treatment close to the pubertal peak coinciding with the eruption of the second permanent molars, we should not forget that many malocclusions must be treated immediately, almost as soon as they are diagnosed due to the risk that their subsequent development implies for patients' current and future oral function. This is the case with maxillary compression and posterior and anterior crossbite in conjunction with functional shift.

From E. H. Angle to Dr. Archie Brusse, former president of the AAO and founder of RMO, the fathers of modern orthodontics always established a close link between breathing and the growth of malocclusions (Fig. 28 & 29). Numerous experiments in monkeys and monozygotic twins have shown how inadequate oral breathing has been linked to changed tongue and mandible position, muscular imbalance, and abnormal craniofacial growth.

One particularly dramatic case where the orthodontist's responsibility is indeed heavy concerns children with respiratory problems and the prevention of Obstructive Sleep Apnea Disorder. While working with the SWLF Technique, we are aware that orthodontics should work in tandem with medicine and that early maxillary expansion during childhood, whether slow or quick, can be sufficient to avoid serious systemic disease in adulthood (heart failure, heart attack, ischemic stroke, ictus, hypertension, short leg syndrome, permanent daytime drowsiness, impotence, etc.).

MANAGEMENT AND MARKETING COMPLETE THE CIRCLE OF AN INTEGRAL TECHNIQUE

The Straight Wire Low Friction Technique not only consists of an integral diagnostic system, individualized therapeutic protocols, and a complete biomechanical system with new bracket and wire designs, crimpable hooks, new pliers and TADs, it also incorporates a specific approach to clinical management and marketing (Fig. 30). To a great extent, the success or failure of an orthodontic clinic depends on factors which have nothing to do with the practitioner's clinical knowledge or the effectiveness or efficiency of the particular technique he or she employs. Patients or their parents are unable to judge the quality of our clinical work because we use measures of excellence which they do not understand. We often complain that patients judge the results of treatment on the alignment and aesthetic appeal of the anterior front. Patients therefore tend to judge us by the quality of our service and draw their conclusions concerning the quality of our professional activities on the basis of these factors (the arrangement of appointments, waiting rooms, the multimedia case presentation, the degree of empathy established between staff and patients, how patients and parents

psychologically, the patient's motivation, the amount of attention paid to problems and complaints, etc.). Communication with the patient is of fundamental importance because they are not so concerned with how much you know but rather with how much you care for them. The SWLF Technique reserves a space for the analysis of all these issues, which are of huge importance in the overall success of the clinic.

If, as claimed by Professor R. M. Ricketts, we must begin our treatment with the outcome in mind, it must incorporate all those factors which help us to provide a complete quality service from the very beginning.

EXPERIMENTAL RESEARCH ABOUT SWLF

Many research works show us the advantages of the Synergy bracket in relation to other conventional or self-ligating brackets. You can compare the high effectiveness of the Synergy and SWLF brackets if you test them on a patient with different types of brackets (Fig. 31).

A TECHNIQUE IN ITS EARLY YEARS WHICH IS CONSTANTLY EVOLVING

Many of the excellent orthodontic techniques in existence today face the difficulty of age and their relative stagnation caused by the departure of the person who created and led them. SWLF is a young and energetic technique with a great future ahead of it. It also has a long road ahead during which time it will take on board new technological developments and will be able to improve day by day. The technique is designed by and for clinicians, from whom their patients demand quick and effective treatment of an appropriate quality, and very importantly, superb value for money.

In short, our SWLF Technique is not simply a bracket. The SWLF Technique encompasses concepts founded on scientific evidence, a clear and simple diagnostic system centered on a new analysis of occlusal development and facial growth, a detailed study of the aesthetics of the smile and the face, the dynamic occlusal function and its relation to craniomandibular dysfunctional pathology, temporomandibular joint, the clear and sequential description of objectives and therapeutic solutions, and the establishment of protocols for the various treatment options.

From the point of view of technique, we have simplified the biomechanics which has made learning the technique a simple and rational process.

TRAINING

Seminars and courses (theory and practice as well as Typodont) offering training in the SWLF Technique the world over is provided by a group of qualified orthodontists led by Professor David Suárez of Santiago de Compostela University in Spain. There are several options with respect to the level and length of the courses. The Orthodontics Department at Santiago University, the Suárez & Suquía Specialized Orthodontic Clinics in Galicia in Spain, and numerous postgraduate university departments and clinics throughout the world are ready to help those interested in the technique. You can find a wide range of information on clinical training in the Straight Wire Low Friction Technique on this web site: http://swlf.org/publicaciones/?lang=eng

Those of us who have developed the SWLF Technique believe a whole new world has opened up within the traditional world of orthodontic practice. Come and join us!

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