RMO®’s NEW
SWLF Synergy R™
Bracket System

Molar Intrusion
with TADs

Indirect Bonding
REVEALED

Early Treatment:
Wilson® 3D® Quad-Helix & Maxillary Expansion
Take control of your treatment with FSC. Combined with SWLF Synergy™’s integrated convertible cap, FSC modes deliver maximum tooth-by-tooth control throughout the entire course of treatment. Plus, clinicians can still satisfy color requests even during unconverted bracket stages by ligating the center wings without compromising performance. (Ligatures illustrated using original Synergy® bracket.)

Features and benefits include:

• cuspid and bicuspid brackets feature an integrated convertible cap
• can reduce treatment time and appointment intervals
• no moving parts—no broken clips, doors, or slides
• large flared lead-ins reduce kinking and binding
• low profile—comfortable for your patient
• convert to a standard Synergy style bracket at any time for advanced FSC modes

SWLF Synergy R provides minimal friction and rapid wire changeout, with cuspid and bicuspid brackets that can be converted into traditional Synergy® style brackets at any time during treatment. Clinically tested and proven effective, SWLF Synergy R is designed, engineered, and manufactured with pride in the USA.

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SWLF Synergy R represents the latest development in ConverTechnology: Passive when you want it, total control when you need it. No clips, no doors, and no failures. SWLF Synergy R combines the simplicity and ease of self-ligating bracket design with the flexibility and advanced performance of Synergy’s Friction Selection Control (FSC) modes.

For more information or to order call:
1.800.525.6375

The World’s Oldest Synergistic, Bioprogressive®, Breathing Enhancement Orthodontic Company.™

* Indirect Bonding System will not be available from RMO® until early 2008.
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 professional life. 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 the practice that starts 250 cases per year, costs of a quality conventional bracket. For every two dollar increase per bracket to elastomeric ligatures, arch wire change time savings are less dramatic at approximately 1 minute faster per arch wire.

Conventional Twin Bracket

MODERATE ROTATION

MAXIMUM ROTATION

CONVENTIONAL CONTROL

MAXIMUM CONTROL

Figure 1a

FSC

REVIEW OF SELF-LIGATION

Although the idea of self-ligating brackets dates back to the 1930’s with the 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.

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, 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, contraindicated on patients with calculus forming tendencies making clips difficult to open, removal of calculus on clips risking debond.

Active Clip: An active clip effectively reduces slot depth. The claims that active clips pass actively only holds true if the teeth are aligned. Harradine accurately described if the arch wire (or the tooth is rotated) is sufficiently lingually placed, a higher total force will be applied in comparison to the passive clip. Passive clips act passively. Another misunderstanding explained by Harradine is the fact that an active clip produces a greater peak force which the rectangular wire is not fully engaged. This increases the slope between the rectangular wire and the slot. Harradine stated that "these factors probably explain the 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."

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 baccal 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.

• FSC

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 complicate 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, elastomers can still be employed in a reduced friction configuration (Fig "FSC")

A true rectangular slot size available in both 0.08" and 0.022” – 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 ligation 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 ConversionTechnology assures easy conversion only when desired

Convertable clip ensures integrity of the slot dimensions when debonding and repositioning by adding a fourth wall to the slot

Removable clip allows easy conversion only when desired

Conventional Twin Bracket

MAXIMUM ROTATION

Figure 1b

Partly open between arch wire and the Energy Chain

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: Maier and Smith found a four-fold reduction in ligation time compared to wire ligation of conventional brackets, but when compared to elastomeric ligatures, arch wire change time savings are less dramatic at approximately 1 minute faster per arch wire.

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).

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.

* "After" images represent first scheduled rebate appointment at only 10 weeks.
...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 techniques 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 bonding 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. 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 synergetic 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 markman’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 true and proprietary technology utilizes a cutting edge Metal Injection Molding (MIM) process that molds the cap directly into the slot, 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.

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” Orthodontal. 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 bracket (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 temporary 1x2 brackets are ligated in usual fashion with the color of our patient’s choice. In our office this method has reduced the average time an arch wire change time by an average of 38% over standard elastomeric ligation.

The operator has the flexibility to utilize all the ligation options SWLF Synergy R offers.

We tend to ligate the incisors around all the wings initially for full rotational control. Ligation of the incisors only does away with the need for ligating the mesial or distal of the incisors because ligatures allow the arch wire to be pulled to the base of the slot on incisors for optimal activation and alignment of contacts.

After a progress panorex has been taken, the integrated convertible cap adds a fourth wall to the bracket slot, thereby minimizing arch wire 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 Figs 8a and 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.

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 specifically designed SWLF Synergy R. .013” or .015” Orthodontal (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” Thermoly® (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 difficulty and these extended intervals allow the efficient repositioning of brackets vs. one’s natural predilection to jumping in and forcing things to happen. Depending upon the needs of the case, up to a .017” x .025” Bendaloy wire can be placed without difficulty and these extended intervals allow the efficient repositioning of brackets vs. one’s natural predilection to jumping in and forcing things to happen.
Case 1

Patient treatment planned for asymmetrical 4 bicuspid extraction due to Class II/III 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” Therm-Alloy maxillary arch/.013” Therm-Alloy 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.

Before and after with total treatment time of 16 months

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

1st scheduled retie appointment at only 10 weeks

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 scheduled retie appointment at only 11 weeks

Case 2

Patient indirect bonded with posterior turbo’s and .016” OrthoMon wires placed. Follow up photos taken at 11 weeks after initial bonding when .016” x .022” OrthoMon 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.

Before and after with total treatment time of 16 months

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

1st scheduled retie appointment at only 11 weeks

Case 3

Transfer patient treatment planned for 4 bicuspid extraction to address bi-maxillary protrusion, dolichocranial skeletal pattern and the patient’s chief complaint of fullness of profile. Patient indirect bonded, .016” Therm-Alloy 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 cephal 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, deconing, and alignment while the teeth and musculature adapted to keep a difficult case in good control.

Before and after with total treatment time of 16 months

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

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
Clinical Review 2007-2008

Case 4

Patient presented with high cuspid and right buccal segments in cross bite. 0.13” SWLF Synergy R wire in .018” slot at 9 week follow up.

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 swingarm 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 cup 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.

1. 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 thread it through the arch wire slot (under the convertible cap) and tighten it down (think of this as a vertical cover) and lasso the wire to the bracket cover though the arch wire slot (under the convertible cap releasing the cover at the proper force (Fig 10a, 10b, & 10c). You can also 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 auxillary 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.

REFERENCES

INDIRECT bonding

By Robert T. Rudman
D.D.S., M.S.
Denver, CO

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 63° 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:

  • The RMO 63° LC Flowable Adhesive is a light cured flowable composite in a precision delivery system. This allows for maximum control, no working time, and allows the uniquely formulated RMbond Inner Tray Material to fully encapsulate the gingival aspect of the brackets and resist separation.

  • RMO’s 63° Indirect Bonding System provides excellent contrast to the 63° LC Model Adhesive, allowing for easy flash clean up (Fig 2). A light curing unit, having a built-in 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 the adhesive center of the bracket pad. After all brackets are fully cured, the turbos can be placed. Models are then replaced in the patient model storage box.

  • RMO’s 63° 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.

  • RMO’s 63° Inner Tray Material is a transparent PVC material that materializes well defined and not in need of trimming.

  • RMO’s 63° Inner Tray Material is supplied with the RMO Indirect Bonding Kit before final clean up (Fig 2). A light curing unit, having a built-in 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 the adhesive center of the bracket pad. After all brackets are fully cured, the turbos can be placed. Models are then replaced in the patient model storage box.

TURBO CONSTRUCTION:

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 RBond 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. Allow the models to dry completely (over night) Apply two liberal coats of tinted separating medium or tinted 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. The 63° 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 63° Indirect Bonding Kit before final position 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 turbos” utilizing the 63° LC Material to temporarily open the bite. (These turbos 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 63° LC Model Adhesive, allowing for easy flash clean up (Fig 2). A light curing unit, having a built-in 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 the adhesive center of the bracket pad. After all brackets are fully cured, the turbos can be placed. Models are then replaced in the patient model storage box.

5. The models are returned to the lab where the border of the tray is defined by red utility rope wax (63° 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 63° Inner Tray Material to fully encapsulate the entire bracket.

6. The 63° Inner Tray Material should be stored in a refrigerator prior to use to extend its working time. It is applied with the 63° 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 remnants to stick to your finger (Fig 5).

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 sucks 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.
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 bicuspid 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 area where close inspection of all etched surfaces takes place (it is nearly impossible to tell whether a tooth is sealed or not - using this technique, contamination is impossible to tell whether a tooth is sealed or not). The assistant then notifies the assistant to the assistant on proper placement of light utilization.

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 to 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 teeth/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 assistant 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 scaler to verify contact with the teeth/adhesive/bracket interface. The assistant places the tray back in a light curing apparatus (or use a light gun) to ensure that all adhesive on custom pads is cured. **TIP:** Depending upon the light utilized, curing 10-15 seconds is recommended. The assistant then moves on to the next bracket to be cured.

8. The assistant then re-cure the 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 11 a, 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 is excellent to place on the distal of the arch wire if the wire is to be left long for unswelling of crowding, and ensures the very light wires used in the SWLF Synergy System do not slip through the terminal molar tube preventing emergency appointments (Fig 15a & 15b).

**FINAL STEPS**

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 (cuspsids, 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 wire for easier insertion through RMO’s 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 unswelling of crowding, and ensures the very light wires used in the SWLF Synergy System do not slip through the terminal molar tube preventing emergency appointments (Fig 15a & 15b).
The use of Temporary Anchorage Devices for Molar Intrusion

ABSTRACT

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. SuperaMBEDed maxillary first molars can be intruded in 3 to 7 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.

SuperaMBEDed 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 equalization. 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-allyl microscrew, 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. Placement is minimally invasive and often completed using only topical anesthesia (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. 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.

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Soft-tissue health. Inflammation of the surrounding soft tissue is directly associated with stationary anchorage failure. TADs placed in nonkeratinized alveolar tissue have a greater failure rate than those inserted into attached tissue. 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 dentition, the greatest amount of interradicular bone is on either side of the first molar, approximately 1.1 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. If inadequate interradicular bone is available, the clinician can place the TAD palatally or diverge the roots before inserting it.
30 to 45 degrees to the occlusal plane to increase the surface area contact between the miniscrew and the thicker cortical bone. 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.3,10,14

Palavra and colleagues3 suggested loading forces of 50g in regions of thin cortical bone and fine trabeculae. Buchter and colleagues 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 with the periodontal ligament and minimize the risk of root resorption.**14,15 Kalra and colleagues11 used 90g of force to intrude maxillary molars in children. Melsen and Fiorelli32 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

**MAXILLARY MOLAR INTRUSION WITH TEMPORARY ANCHORAGE DEVICES**

Protocol. For maxillary molar intrusion using a single TAD, the miniscrew should be placed in the buccal dentinoalveolar 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 bucal 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 crosstable (Figure 5).

In the absence of adequate interradicular space, TADs can be placed in the palate, either in the midline region or 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.

**Rate.** The rate of single molar intrusion3,11,12,14,15,31,32,36 is approximately 0.75 mm per month. Yao and colleagues3 investigated maxillary molar intrusion in 26 first molars and 17 second molars. The authors reported the rate of 3 mm of intrusion (range, 3.68-8.67 mm) for the first molar and a mean intrusion of 1.2 mm for the second molar in 7.5 months. Sherwood and colleagues39 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 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 colleagues32 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 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,11 the authors found that the maxillary first molar intruded 3.6 mm in seven months. In a case report by Yao and colleagues in which the first and second molars were intruded simultaneously, the authors reported that the first molar and second molar intruded approximately 3.5 mm in five months.

**Root resorption.** Teeth undergoing orthodontic intrusion may be highly susceptible to root resorption.4,46 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.
of root resorption, after incisors. Beck and Harris reported root resorption in first molars after intrusion and interdental mechanics. McNab and colleagues reported root resorption of the maxillary first molar after distalization and intrusion with a bar. Purslow and his colleagues showed root resorption in maxillary incisors subjected to 25 to 240g of force in contrast, Osman-Moll reported no difference in root resorption for pressures undergoing light (50g) and heavy (200g) orthodontic load in the buccal direction.

**REFERENCES**

Microsuave-supported molar intrusion has drawn great interest, especially in terms of whether molars can be intruded under continuous heavy force without significant root resorption or perforation of the sinus floor. Ari-Demirayak and colleagues measured root resorption of maxillary first molars after intrusion with TADs. The study compared 16 intruded 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 animal studies, Danumary and colleagues intruded maxillary second premolars into the nasal floor. Six dogs were bilaterally eluted the effects of molar intrusion against the sinus floor. The beagle's nasal sinus floor was histologically similar to the human maxillary sinus. The authors reported a mean apical root resorption (standard deviation) of 0.18 ± 0.18 mm after seven months of intrusion. The sinus floor was maintained intrusively 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 pulp involvement, the outer root and periodontal ligament may demonstrate complete repair in three to four months.

**Stationary anchorage failure.** TADs may become loose tip and extrude under orthodontic load. Microsuave screws that become mobile will not regain stability and may need to be replaced and reimplanted. Inadequate primary stability on initial placement likely is a result of inadequate cortical bone thickness. Delayed mobility that occurs several days or months after placement likely is a result of inadequate cortical thickness and excessive force load.

**Tissue irritation TADs placed in the oral mucoalveolar region may result in soft-tissue irritation, tissue overgrowth, and mucus ulceration.**

More irritation. Placement of TADs in the maxillary palatal sinus bone tips risk injury to the greater palatine nerve. The greater palatine nerve exits out its foramen, which is located laterally to the second or third molar, and it travels anterily along the palatal slope 5 to 15 mm from the gingival border.

**Sinus perforation.** Small (<2 mm) perforations of the paranasal sinus wall would heal by themselves without complications. Larger perforations may result in sinusitis or a chronic oroantral fistula. TADs diameters 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.

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. Restoration dentists, periodontists and surgeons would ensure that they have a clear understanding of the following orthodontic TADs when presenting patients with options for correcting occlusal problems.

**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. Restoration dentists, periodontists and surgeons would ensure that they have a clear understanding of the following orthodontic TADs when presenting patients with options for correcting occlusal problems.
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 duration of overall treatment time.

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 steel brackets (Synergy® Classic, RMO, Denver CO), 36 Friction Selection Control (FSC) stainless steel 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 -7º, angulation 0º, and rotation 0º (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 (4) (Figure 4). Correct brackets were selected 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 0.014" (Thermaloys®, 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 (ICPF) 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 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 stepper motor. The step motor drove the moving carriage at a constant speed of 4-6mm/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 friction 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 properly interpret and analyze 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.
sliding and do not restrict movement in the arch slot. These characteristics leave 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 on average 30% and 50% better 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 Chimici Fisici (IPCF) of the Consiglio Nazionale delle Ricerche (CNR) in Messina (Italy) and Rocky Mountain Orthodontics for supplying materials.

DISCUSSION

There are a large number of variables that influence the friction forces generated by fixed orthodontic appliances. In order to focus on a single 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 brackets (Mini-Taurus, Signature III and LUX) were more advantageous than twin brackets due to the type of misalignment. In regards to movement, we evaluated those related to the horizontal vector for stainless steel wires. The differences between triple wing brackets and other bracket types were even greater for the vertical component of frictional force. While simultaneous 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 custer 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.

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Synergy Lux combines the revolutionary control of RMO’s® Synergy bracket with the aesthetic quality of RMO’s® LUX II bracket.

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REFERENCES

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 sliding object. These 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 clinicians to achieve two important goals:

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   - Preserve anchorage systems (Figure 1).
   - Exploit more predictable and more efficient orthodontic movements.

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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 ligation of 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 consequentially 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 0.014” Thermal NiTi wire (RMG) and both the experimental models were evaluated by using a 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 elastomeric only to the central wings of the bracket (‘C’ configuration), and ligating the elastomerics conventionally around all wings of the bracket (‘O’ configuration). The normal 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<0.05) 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.

This outcome illustrates the impact that Synergy’s rounded arch-slot edges have regarding frictional forces. In the horizontal experiment, significant differences (p<0.05) 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 69% 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 ligament. Nevertheless the orthodontic literature does not clarify what is suitable force to generate dental movement. Reni 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 Oppeenhoven2, 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 (0.030” 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-elastic (red) and thermal-activated (yellow) .014” NiTi arch-wire.

REFERENCES


NEW!

RMO® elastomeric ligature ties have excellent stretch and rebound. The tear resistant design features rounded edges and a flat top, which makes RMO ligatures extremely strong and holds the wire lighter and longer. These ties provide a high resistance to staining. Absorb very little water, and will not irritate the gingiva. Available in bright vibrant colors that resist fading and are closely matched to RMO Energy Chain™.

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(Check kit---K00340) (Clear case only--J00780)
RMO’s new Ligature Kit Box features 22 different colors in 24 individual compartments of 1,000 ligatures (double quantities of Gray and Clear). Each box provides secure and efficient storage of 24,000 ligatures, and comes complete with a laminated color wheel that patients can use to select their desired colors. Clear plastic storage case with compartment separators also available separately (no ligatures, compartment ID, or color wheel).

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Flour Green (J00342)
Fire Eng. Red (J00343)
Orchid (J00344)
Clear (J00345)
Smoke (J00346)
Sky Blue (J00347)
Orange (J00348)
Navy Blue (J00349)
Gray (J00350)
Blue (J00351)

Separator Sticks
(Lt. blue--J00177) (Radiopaque--J01451)
Individual patient separators eliminate cross contamination. Available in radiopaque for x-ray detection (dark blue) or light blue for visibility. Packaged in bags of 100 dispensers, 10 separators each stick (1,000 separators per package).

Rotation Wedges (J00174)
Tooth rotation is easier and faster with this unique design that provides complete contact with the tooth surface, allowing more force to be transmitted to the tooth. 5 sticks per package, 10 wedges each stick (50 total).

Synergy® Low Friction Ligatures
(J00151)
Silicone injected · Reduced friction. Ideal for Synergy brackets · Stain resistant - Low profile · Excellent for RMO ceramic brackets also ·10 sticks per package, 100 ligatures each stick (1,000 ligatures per package) - available in opaque white.

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The World’s Oldest Synergistic, Bioprogressive® Breathing Enhancement Orthodontic Company™
A narrow maxilla is a common problem in orthodontics. Approximately 80% of the orthodontic patients need some type of arch expansion. The incidence of posterior crossbites 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 these cases.

A narrow upper arch can produce undesired occlusal and facial disharmony (asymmetries). The cross-bite can not be corrected without treatment, regardless of the etiology and modality of clinical occurrence. Early cross-bite corrections lead to a stable and normal occlusion pattern, and contribute to symmetrical condyle growth, harmonious TMJ, and overall growth in the mandible. 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 abnormally developing and growing skeletal system. Waiting until after 9 years old can lead to TMJ problems and future relapse.

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. The conventional Rapid expansion device is used using a combination of movements such as: buccal tooth version (A), alveolar bone opening and buccal molar translation (C), and molar buccal translation combined with molar rotation control, and torque control. It can also produce molar torqueing. These features make the Quad-Helix an extremely versatile appliance.

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. 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.

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 “shearing action”). Furthermore, the practitioners don’t need the patient’s or parent’s cooperation to reach the set objectives.

Transverse maxillary expansion is achieved using a combination of movements such as: buccal tooth version (A), alveolar bone opening and buccal molar translation (C), midpalatal suture opening and buccal molar translation (C), midpalatal suture disrupting (D), and a combination of two or more of these factors. These findings also coincide with what Cotton concluded after his work with monkeys. Hicks reported substantial skeletal changes with slow expansion, especially in younger children. 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 and Stroey.

The conventional Quad-Helix is typically installed pre-activated with a certain amount of expansion. When the case being treated needs additional activation, the clinician 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.

The 3D Quad-Helix very precisely allows the orthodontists to control the amount of forces employed and control molar in all three planes of the space, strongly increasing overall movement control.
**CASE 1**

Figure 16. Beginning of treatment.

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

Figure 7. Expansion case 1 sample after 6 months - note molar rotation.

**CASE 2**

Figure 17. After 2 months.

Figure 18. After 4 months.

Before Treatment

Figure 8. Pictures taken before treatment on Case 2.

Figure 9. Occlusal view before treatment on Case 2.

Figure 10. Occlusal view before treatment on Case 2.

Figure 11 - Models before treatment on Case 2.

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.

Figure 14. Patient’s anterior X ray image - T1.

**CASE 2 (Continued)**

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

Figure 19. Measured values/variables

**SIGNIFICANT CONSIDERATIONS**

**TRACING**

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

Beispiel: Figure 16. Beginning of treatment.

Figure 17. After 2 months.

Figure 18. After 4 months.
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 total of molar expansion. The FA tracings showed 2.3mm increasing of J-J width, 8.6mm on upper molar width, and 3.1mm enlargement on Nasal Cavity width.

Dr. Wilson recommends installing the appliance during the patient's first visit in an absolutely 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 2 mm 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 laboratory 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 full 3D system kit includes a variety of additional applications the orthodontist can choose according to the needs for each case. The ability to exchange appliances during unloading of 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!

REFERENCES


I strongly recommend orthodontists use the vertical insertion 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!
INTRODUCTION

In this preliminary research\(^\text{1}\), 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)
- SLIDE ligatures medium (Leone) (Figure 7)
- Self-ligating TIME 2 .022" x .028" (American Orthodontics) (Figure 8)
- Wire ligatures .010" (American Orthodontics) (Figure 9)
- Elastomeric ligatures (American Orthodontics) (Figure 9)
- Silicone ligatures (American Orthodontics) (Figure 9)

\(^\text{1}\) 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).

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). Test materials are:

- SYNERGY Brackets .022" x .028" (Rocky Mountain Orthodontics) (bonded on standard model) (Figure 2).

In this preliminary research\(^\text{1}\), three low-friction systems were tested, comparing them with straight wire twin brackets. The different systems which were tested are:

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**TABLE 1**

<table>
<thead>
<tr>
<th>Arches</th>
<th>C Ligatures</th>
<th>Silicone C Ligatures</th>
<th>O Ligatures</th>
<th>8 Shape Ligatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS .016&quot;</td>
<td>93</td>
<td>87</td>
<td>1000</td>
<td>995</td>
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<tr>
<td>Ni-Ti .016&quot;</td>
<td>32</td>
<td>35</td>
<td>871</td>
<td>1142</td>
</tr>
<tr>
<td>SS .016&quot; x .022&quot;</td>
<td>286</td>
<td>294</td>
<td>1612</td>
<td>1269</td>
</tr>
<tr>
<td>Ni-Ti .016&quot; x .022&quot;</td>
<td>274</td>
<td>79</td>
<td>1806</td>
<td>1346</td>
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**TABLE 2**

<table>
<thead>
<tr>
<th>Arches</th>
<th>SW STEP + Elastomeric Ligatures</th>
<th>Self Ligating TIME 2</th>
<th>SYNERGY + C Shape Ligatures</th>
<th>SW STEP + Silicone Ligatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS .016&quot;</td>
<td>794</td>
<td>70</td>
<td>34</td>
<td>121</td>
</tr>
<tr>
<td>Ni-Ti .016&quot;</td>
<td>918</td>
<td>18</td>
<td>35</td>
<td>43</td>
</tr>
<tr>
<td>SS .016&quot; x .022&quot;</td>
<td>1021</td>
<td>402</td>
<td>286</td>
<td>397</td>
</tr>
<tr>
<td>Ni-Ti .016&quot; x .022&quot;</td>
<td>1167</td>
<td>364</td>
<td>274</td>
<td>211</td>
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</tbody>
</table>

**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 250 gm (B-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.
Using 0.016” x 0.022” β-Ti wire, reduced friction was recorded with the C ligature (ligating on the center tie wings) (320 gm) vs. Time 2 (2006 gm), ligating with the ligature in the 8 form, friction rises to 4268 gm (Table 5).

- 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 0.022” 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 0.022” 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 (153 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 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 bumps 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, each have specific differences which will affect their results. New studies should be carried out in order to better understand clinical indications and targets.

**Table 3**

<table>
<thead>
<tr>
<th>Arches</th>
<th>C Shape Ligature</th>
<th>C Shape Silicone Ligature</th>
<th>O Shape Ligature</th>
<th>B Shape Ligature</th>
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</thead>
<tbody>
<tr>
<td>SS .016”</td>
<td>63</td>
<td>87</td>
<td>1000</td>
<td>995</td>
</tr>
<tr>
<td>Ni-Ti .016”</td>
<td>32</td>
<td>35</td>
<td>871</td>
<td>1142</td>
</tr>
<tr>
<td>SS .016” x 0.022”</td>
<td>286</td>
<td>204</td>
<td>1612</td>
<td>1326</td>
</tr>
<tr>
<td>Ni-Ti .016” x 0.022”</td>
<td>274</td>
<td>79</td>
<td>1456</td>
<td>1386</td>
</tr>
<tr>
<td>β-Ti .016”</td>
<td>350</td>
<td>97</td>
<td>2591</td>
<td>1994</td>
</tr>
<tr>
<td>β-Ti .016” x 0.022”</td>
<td>350</td>
<td>297</td>
<td>2669</td>
<td>4269</td>
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**Table 4**

<table>
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<th>Arches</th>
<th>C Shape Ligature</th>
<th>C Shape Silicone Ligature</th>
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</thead>
<tbody>
<tr>
<td>SS .016”</td>
<td>63</td>
<td>87</td>
</tr>
<tr>
<td>Ni-Ti .016”</td>
<td>32</td>
<td>35</td>
</tr>
<tr>
<td>SS .016” x 0.022”</td>
<td>286</td>
<td>204</td>
</tr>
<tr>
<td>Ni-Ti .016” x 0.022”</td>
<td>274</td>
<td>79</td>
</tr>
<tr>
<td>β-Ti .016”</td>
<td>106</td>
<td>97</td>
</tr>
<tr>
<td>β-Ti .016” x 0.022”</td>
<td>350</td>
<td>297</td>
</tr>
</tbody>
</table>

**Table 5**

<table>
<thead>
<tr>
<th>Arches</th>
<th>STEP + Elastomeric Ligatures</th>
<th>Synergy + O Shape Ligatures</th>
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</thead>
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<tr>
<td>SS .016”</td>
<td>674</td>
<td>1000</td>
</tr>
<tr>
<td>Ni-Ti .016”</td>
<td>908</td>
<td>871</td>
</tr>
<tr>
<td>SS .016” x 0.022”</td>
<td>1024</td>
<td>1612</td>
</tr>
<tr>
<td>Ni-Ti .016” x 0.022”</td>
<td>1167</td>
<td>1406</td>
</tr>
</tbody>
</table>

**Table 6**

<table>
<thead>
<tr>
<th>Arches</th>
<th>Wire Ligature</th>
<th>Elastomeric Ligature</th>
<th>Silicone Ligature</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS .016”</td>
<td>524</td>
<td>674</td>
<td>600</td>
</tr>
<tr>
<td>Ni-Ti .016”</td>
<td>372</td>
<td>908</td>
<td>787</td>
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<tr>
<td>SS .016” x 0.022”</td>
<td>525</td>
<td>1021</td>
<td>837</td>
</tr>
<tr>
<td>Ni-Ti .016” x 0.022”</td>
<td>450</td>
<td>1167</td>
<td>1031</td>
</tr>
</tbody>
</table>

**Figure 10:** Synergy bracket: Patented arch slot shape and flared openings.
Are your patient’s teeth having relationship problems?

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- Independently tested and clinically proven performance may reduce appointment intervals and save valuable chair-time
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Orthodontic techniques are continually improving through advances in research, new technology, and society’s changing expectations. New approaches to biology, the biomechanics 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, specialists are obliged to use reliable and efficient. The SWLF would be of little interest to them 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 technique. 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 the skeletal outlined problem 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 relationship and the other variables are normal, the patient is undoubtedly skeletal Class II, both qualitatively and quantitatively. 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 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 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 dental occlusion. It would be a qualitative rather than quantitative Class II, and might improve with antiloccusive 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 compensation (ANB < overjet) are easier to resolve than those cases, as in many Class II examples, which exhibit prior natural destro-antero-skeletal 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 incisors 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
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 Compostela (Spain) and the Rocky Mountain Department of the University of Santiago de Compostela (Spain) and the Rocky Mountain Orthodontic Department and Mathematics Laboratories in Denver (USA), we are developing the brackets, wires and elements of the SWLF technique.

Orthodontic laboratories in Denver (USA), we are developing the brackets, wires and elements of the SWLF technique. 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. The Synergy bracket’s unique design, Torque had a less dramatic effect on frictional forces.

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

**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 an 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 1-9

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 90° angles is the biomechanical difficulty of inserting rectangular wires at the beginning of treatments and the need to employ "lace-back" 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. 1-3

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 want maximum sliding and 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 inner/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 ‘torque in play’ between a ‘thick’.019” vs .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: such a great difference in the outcomes of treatment. The evident commercial side to prescriptions (their use to differentiate the ‘torque in play’ between a ‘thick’.019” vs .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:

- 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.
- 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.

**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 find an effective, efficient and safe treatment for 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 these 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 (SWLF Thermal NTi), Stainless Steel, and Beta Titanium (Bentaloy). All three have highly dependent mechanical qualities and taken together, are sufficient to ‘cover the entire spectrum of current orthodontics (Fig. 7, 8 & 9)’.

The SWLF Technique employs Thermal Nickel-Titanium (SWLF Thermal NTi) 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 on deformation of the arch wire, and it generates intermittent forces upon changes to the intra-oral temperature, be they spontaneous (e.g. during 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, Rambler’s elastic appliance, the Occlusal Hinge, etc.) provides excellent results in the treatment of Class II and III cases (Fig. 3, 4, 5 & 6).

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 biopsy to radicular resorption 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 (Bentaloy) as final arch wires.

According to Berti 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 hysteresis.
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,stuff Stainless Steel (Tru-Chrome) for space closure, and the excellent Beta III Titanium (Bendaloy) for final finishing and detailing. 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,stuff Stainless Steel (Tru-Chrome) for space closure, and the excellent Beta III Titanium (Bendaloy) for final finishing and detailing.

The team of engineers at RMO-Denver has developed new high-tech arch wires for the SWLF technique, particularly for the alignment stages (thermoelectric in stainless steel) 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 0.013", 0.015", and 0.017" dimensions which are better adapted to the requirements of alignment, both for 0.018" and 0.022" 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 bracket and during 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, 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 radial 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 whilst 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 0.019" x 0.025" stainless steel arch wires in a 0.022" slot after the use of just one or two prior arch wires.

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 36.5º C, the greatest technical advantage is in 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 and 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.

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.

**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 0.019" x 0.025" 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) may 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.
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 way we plan and manage anchorage and simplify the conventional orthodontic treatment. The biomechanics are greatly simplified, as 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) in circumstances in which the incisor-canine group ‘en masse’ and the incisor-protrusion mandibular systems (maximum posterior anchorage in periodontal 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.

Unlike earlier systems based on osseointegration or miniplates, there are almost no anatomical limits to the locations 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 in conjunction with rapid maxillary expansion systems, and as the screws are self-tapping and self-drilling, 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 RMQ Dual-Top Anchor System microscrews we have inserted require very little local anesthesia (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 small driver (screwdriver) both to insert and remove the TADs. Inserting and removing a TAD is actually a much simpler process than that associated with the use of rapid palatal expansion, the adhesion of direct bonding tubes on second molars, or permanent lingual retainers 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 extrapalatal 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 the apparatus required in prophodontic orthodontics and in cases concerning impacted teeth or orthodontic surgery. In addition to its very significant biomechanical role in 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 elestomeric 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.

ARCHIWE 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 Caroit, 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 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 or as an auxiliary element as part of intrusion in permanent dentition, and we use a preformed tube of Super nickel titanium arch wires in the remaining patients where we need to level due to an excess of overbite or overjet. Super nickel titanium wires are controlled by the simple use of intermaxillary elastics: posterior when we require distalization and anterior when we require anterior intrusion, with openbite cases.

- Space Closure Phase. We must combine sliding and canines and premolars shifting en masse with friction and the retention of space. There is no need for the orthodontist to use rectangular steel due to the ability to combine rigidity for achieving and maintaining a smooth arch wire 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 two-wire systems and sliding, with the resulting obstructed movement and loss of anchorage, led to several variations on the original Straight Wire technique. To date there are numerous designs of wires used in the different stages of treatment.

The SWLF Technique tries to ensure that the only limit is the practitioner’s imagination. 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 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 extrapalatal 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 the apparatus required in prophodontic orthodontics and in cases concerning impacted teeth or orthodontic surgery. In addition to its very significant biomechanical role in 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.
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 cramped 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 intrarural 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 maxilomaxillary and mandibular growth tendency, 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 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.

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.

Arch wires:

We require superelastic wires generating light, constant, and prolonged forces. We use the Thermal NiTi (Thermaloy), a nickel-titanium thermomechanical 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 (0.013”, 0.015”, and 0.017”). The dimension is chosen in accordance with the slot (0.018” or 0.022”), 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 hereby guarantee maximum sliding. On those teeth furthest away from the arch we recommend using metallic ligatures. As the wire is thermomechanical, 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 bipherotusion, 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

ALIGNMENT

Aims:

- Initial periodontal awkening 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 caliper 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 the use of rectangular wires. It must be considered whether the irregularity is localized or generalized.
- Skeletal-dental discrepancy (SDD) or crowding.
Differential use of elastics. Incisor extrusion and molar intrusion by the intrusion and molar extrusion from that of a preformed curve of Spee arch wires. We use nickel-titanium Elgiloy utility arches by R. M. Ricketts. For mixed dentition we employ the traditional Arch wires: For permanent dentition we use nickel-titanium 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.

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 levelize molar (Coil Spring with Crimpable Hooks, Wilson 3D Maxillary Biometric Distalizing Arch, HP Spring-Gear or Ortixflex-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.

Arch wires: For mixed dentition we employ the traditional Elgado 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.

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 parallelized 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 Orthotrosetting. 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.

- 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. Intraaxially and interaxially, 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.

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 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 Orthotrosetting. 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.

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APPOINTMENTS AND EXTRCTIONS 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 ‘maraculous’ 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 crosbylate in conjunction with functional shift.

From Dr. E. Angle to Dr. Archie Brusie, 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 orthodontists 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, compatible 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 Typosdon) 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!