CLINICAL REVIEW

Orthodontic

DENTAL AND ORTHOPEDIC CHANGES
CLASS II CORRECTION

EDUCATIONAL TOOLS
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THE BIOPROGRESSIVE THERAPY
A WAY OF LIFE

NICKEL-TITANIUM WIRES:
How to Explain it to Your Mother

THREE-DIMENSIONAL CONTROL & RAPID PALATAL EXPANSION

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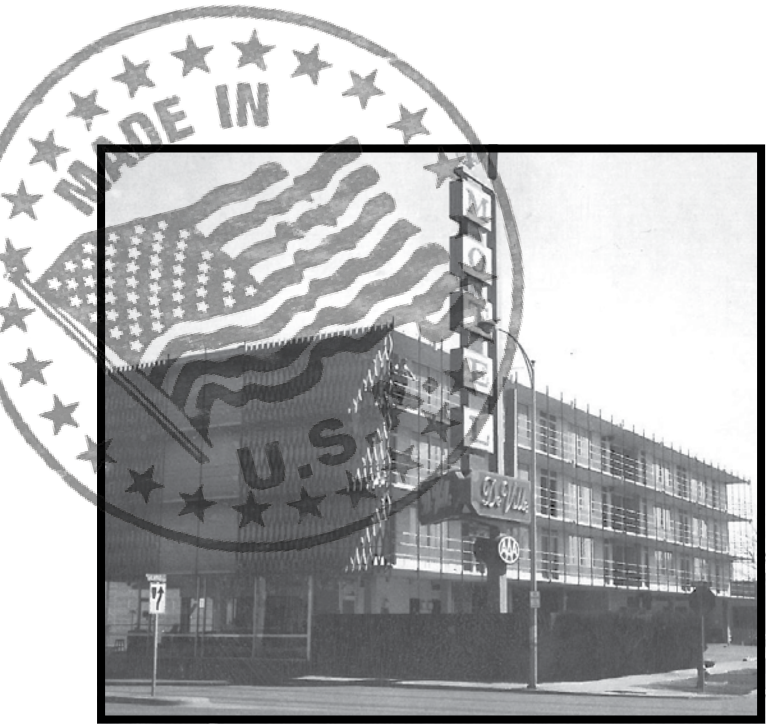

Dear Industry Partner,

At Rocky Mountain Orthodontics® we have many reasons to be blessed and thankful. We just celebrated our 80th Anniversary as a privately owned company who still manufactures the majority of our products in Denver, CO, USA. To become and stay one of the leaders in the orthodontic industry, it takes continuous innovation of products and services, foresight, and persistence. That is what Dr. Archie Brusse, the founder of RMO, based the company on in 1933. His son, Martin Brusse, took over in 1949 and grew the company to what it is now with over 75 worldwide distributors, a subsidiary in Strasbourg, France and a joint venture with J. Morita in Japan. It is a legacy we're taking into the future.

Dr. Brusse and his son Martin, embraced the importance of education and was one of the founding pillars of RMO. They believed a strong base in creative thought and education is the foundation of any great company and such has been a strong pillar in our business operation ever since. Our pillars focus on Early Treatment, Interceptive, and Preventive Orthodontics that our founders were so passionate about. Dr. Brusse was so committed to these pillars that he started gathering clinicians to share their ideas and stories of success and failure in the early 1940's. It was through this exchange between doctors that new ideas and products were developed that have benefited countless patients. RMO has continued to do this by hosting seminars worldwide.

As we continue to move forward at RMO, we cherish the past, learn from it and use it to our advantage. History repeats itself, therefore we learn and appreciate from it so we don't repeat the same mistakes.

We look forward to the future embracing the challenges and opportunities that lay ahead. We have reinvented the image of RMO worldwide and introduced the most innovative products along with an improved overall service. We've received two prestigious awards for excellence in exporting from two different United States Presidents and the Colorado Governor's award. It is a demonstration of who we are and the level of excellence we operate at and will continue to strive for in the future. Our current customers share this with others in the industry, boasting about our performance and how they are proud to be a part of RMO; in which we are so grateful for accolades and business.

The future is bright at RMO, we are so proud and honored yet humbled for our role in the orthodontic industry. We look forward to our continued involvement in our partnerships already established and those yet to be discovered.

Tony Zakhem

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Dr. Mauricio Oliveira Von Zuben is a well practiced and accomplished orthodontist in Campinas, Brazil. He is the coordinator of the post graduate course on Orthondontics at the Campinas Association of Dental Surgeons (ACDC). He also works with San Leopoldo Mandic Unversity and Research Center to coordinator post graduate courses on Orthodontics.

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As a published researcher, Dr. Evans frequently lectures around the world on orthodontics, periodontics and dental implants. At home, she co-founded the OrthoPerio Institute, that provides courses on developments in orthodontics, periodontics and dental implants to both clinicians and their staff.

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Leon's major focus at RMO is to advance RMO's Intellectual Property portfolio through writing or facilitating new patent applications and trademarks. Leon promotes RMO's education and teaching initiative as a lecturer at Orthodontic Residency programs in the U.S. and Canada. Several programs invite him back yearly to lecture on orthodontic materials (UIC, Stony Brook, Tufts, Montefiore, U of Alberta). He actively assists Orthodontic Residents set-up research studies and theses protocols. Leon has presented courses internationally in Europe, Asia, and Latin America.

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DENTAL AND ORTHOPEDIC CHANGES

MAURÍCIO OLIVEIRA VON ZUBEN, DDS, MS

ABSTRACT

Angle Class II malocclusion is common in both children and adults. The objective of this study was to evaluate the tooth and bone changes caused by distalizing molars when correcting Class II malocclusions. 31 patients were selected having Class II malocclusions and needed orthodontic treatment. Lateral radiographs were taken before and after treatment (averaging 31 months). A literature review shows that a large number of different appliances and techniques have been used to treat Class II malocclusions; in every case there is a need for jaw anchorage. Results showed facial axis stability and a decrease of convexity, with improved facial aesthetics (aesthetic plane) as well as reestablishment of the occlusion plane below Xi. A major conclusion from this study is that teeth and bone changes stayed within normal cephalometric standards with the reestablishment of normal jaw growth, and no unfavorable orthopedic alterations were seen on craniofacial growth and development.

[1] Based on thesis: MO von ZUBEN, "Bone and dental changes caused by Wilson's bimetric appliance in correcting Angle's Class II, Postgraduate Program, Centro de Pesquisas Odontológicas São Leopoldo Mandic

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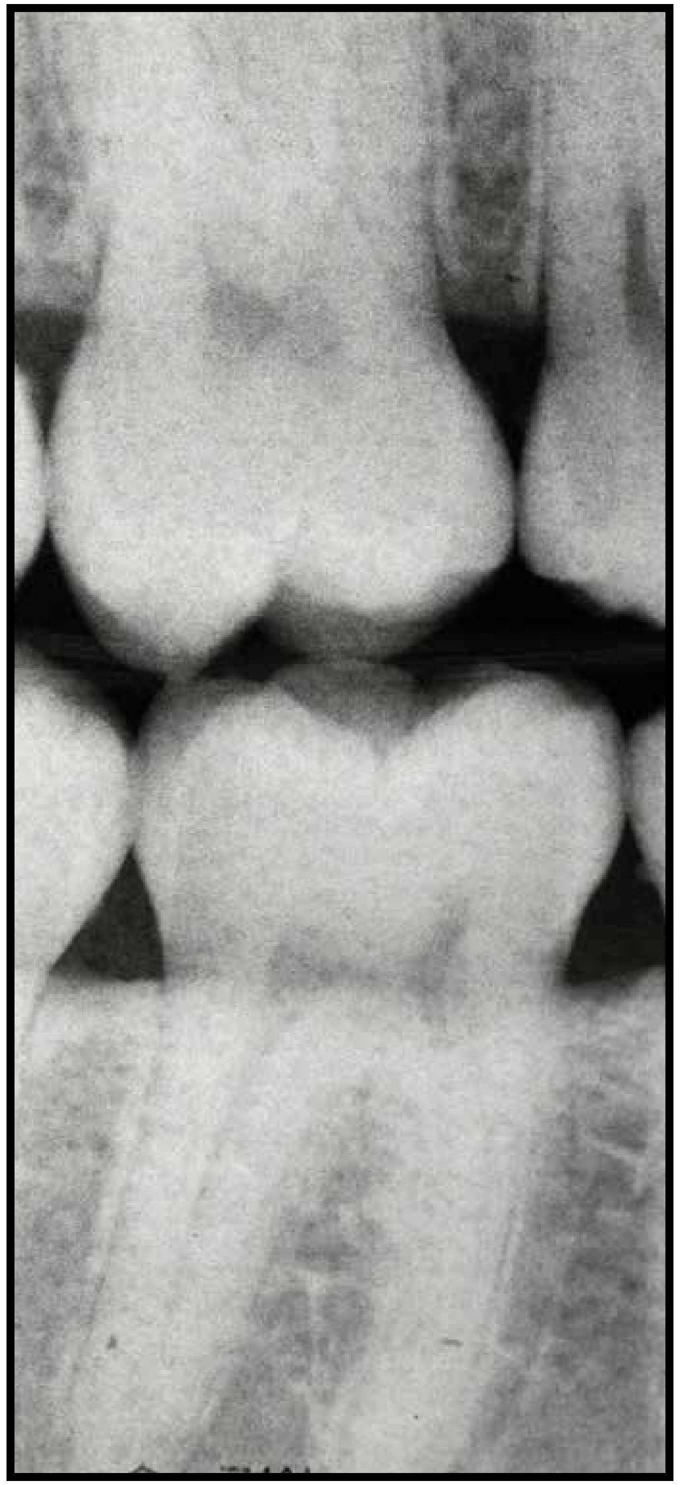


KEYWORDS:

MALOCCLUSION

ANGLE CLASS II

TEETH AND BONE CHANGES

INTRODUCTION

Angle's Class II malocclusion can be corrected by targeting and preventing the growth of the maxilla, by the direction of mandibular growth through archaeal growth[53], by mesial mandibular growth, and by vertical and distal growth of the first molars. Among patients having Angle Class II malocclusion, there are a large proportion of cases with a lack of mandibular growth and well positioned maxillas. To obtain an Angle Class I molar relationship without dental extraction in these cases, orthodontists commonly use extraoral appliances; extraoral forces are applied to achieve distalization of the first upper molar and orthopedic effects on the maxilla and mandible. Thus, much of the therapy is based on the use of devices which cause changes in the maxilla. The main focus in treating this type of malocclusion is growth of the mandible, which would occur even without treatment.

IN THE ORTHODONTIC LITERATURE, THERE ARE SEVERAL STUDIES SHOWING THE EFFECTIVENESS OF OTHER DEVICES FOR THE CORRECTION OF CLASS II MANDIBLE MALOCCLUSION.

Orthodontists use intraoral appliances to correct this type of malocclusion, such as: Jones Jig[59], Magnetos[29,30], Nickel Titanium Coil Springs[28], Wilson's Bimetric Arch[69] and Pendulum Appliance[36]. Wilson & Wilson[68] designed a bimaxillary appliance to correct Class II malocclusion. It restores physiological growth conditions and craniofacial development while contributing decisively towards improving aesthetic, functional, and facial harmony.

The aim of this study is to assess the orthopedic and dental changes using Class II corrector and intraoral appliances.

MATERIALS AND METHODS

Dental records maintained in the von Zuben Institute were reviewed. Case records from one orthodontist were identified; they consisted of 62 lateral radiographs from 31 male and female Brazilian patients during mixed and permanent dentition. The average patient age was 11 years old, with a range from 9 to 15. Treatment duration was 15 to 60 months. Patients were diagnosed as Class II, Division 1 associated with mandibular retrognathia and had no mismatch in the transverse dimensions of the dental, maxillary or mandibular arches, allowing adequate tooth intercuspal alignment.

Initial (T1) and final (T2) radiographs were analyzed. T1 was the start of treatment; patients selected for this study did not have prior orthodontic work. T2 was taken at the end of treatment, when Class 1 occlusion was achieved. Rickett's cephalometric analysis was performed and the following measured: Convexity, Facial Axis, Occlusal Plane and Aesthetic Plane.

CEPHALOMETRIC MEASUREMENTS:

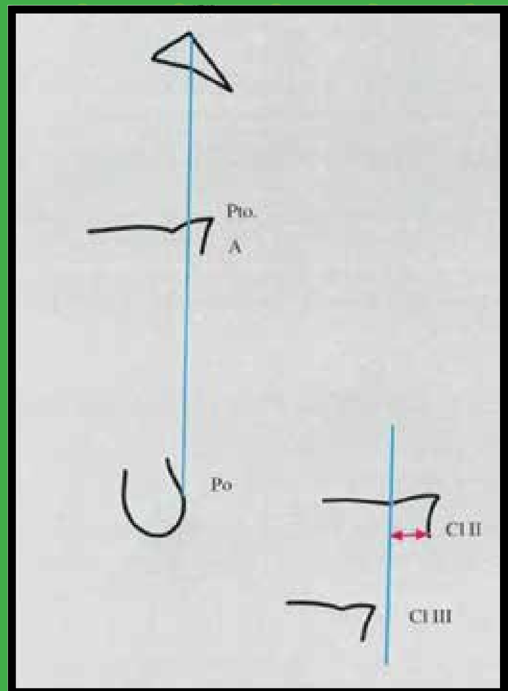


FIGURE 1. CONVEXITY

DEFINITION:
Convexity defines the skeletal pattern. It is a relative measure, relating point A to the facial plane.

• Norm: 2 mm at the age of 9. Change: 1mm every 3 years.
• Clinical Deviation: ± 2 mm

Convexity defines the skeletal pattern. It is a relative measure, relating point A to the facial plane.

Values that are greater than the norm define a Class II standard; smaller values a Class III standard. The extent of convexity may be modified by growth or by changes that result from orthodontic treatment.

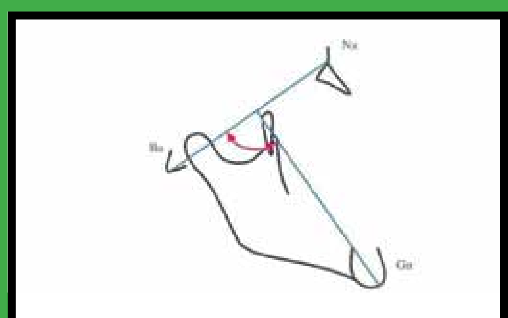


FIGURE 2. FACIAL AXIS

DEFINITION:
Facial axis: the angle between the facial axis and the Ba-Na plane. Facial axis indicates chin growth and is important in determining the facial pattern.

• Norm 90° ± 3mm

• Clinical Deviation: ± 3mm; no change with age.

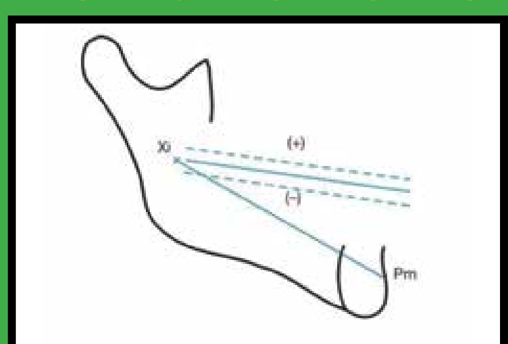


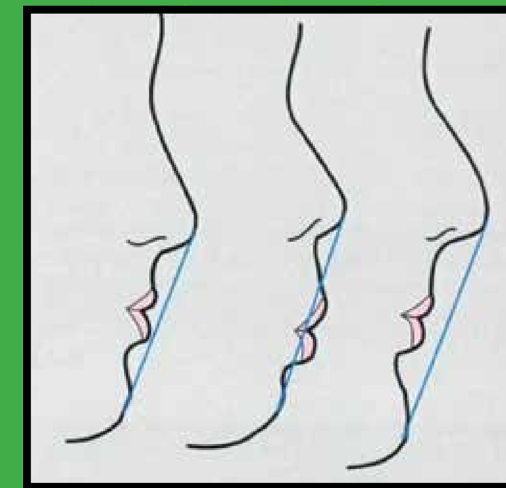
FIGURE 3. OCCLUSAL PLANE

DEFINITION:
Occlusal Plane to the center of the mandible (Xi): it is the distance between the occlusal plane and the geographic center of the ramus (Xi). A positive value indicates that the occlusal plane is located superior to the Xi point; a negative value indicates that the occlusal plane is located inferior to Xi.

An occlusal plane with a high value at the Xi point indicates the extrusion of the lower molars. On the opposite direction, an occlusal plane with low value indicates extrusion of the upper molars.

The occlusal plane decreases half mm a year in relation to the Xi point

• Standard: 0 mm at 9 years old • DP ±3 mm



Aesthetic Plane (Lip protrusion)

FIGURE 4. AESTHETIC PLANE

DEFINITION:
It is the distance from the most anterior portion of the lower lip to the aesthetic plane.

• Norm: 2mm at 9 years old decreasing 0.2 mm per year (less protrusive with growth)

• Clinical Deviation: ±2 mm

Aesthetic Plane indicates the relationship between the lips and the profile. The lower lip rests on the buccal surface of the incisors; consequently, the protrusion of these teeth produce a protruded lower lip. Negative values indicate that the lip is located posterior to the aesthetic plane.

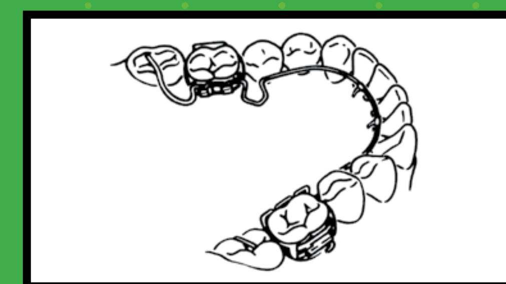


FIGURE 5. WILSON'S LINGUAL ARCH. (RMO)

• Easy vertical placement and removal
• Mandibular anchorage
• Holding arch for extraction and non extraction cases
• Mandibular arch length increase, including sight molar distalization, one side at a time
• Lower molar rotation, torquing and tipping
• Second molar control

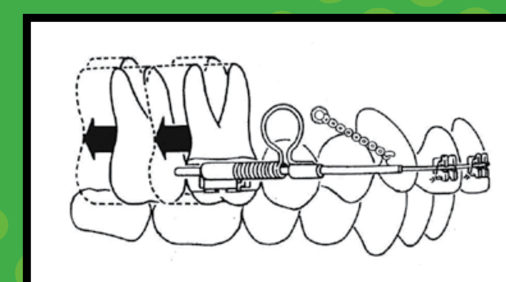


FIGURE 6. WILSON'S BIMETRIC APPLIANCE. (RMO).

• Rapid molar distalizing (no headgear required)
• Rapid anterior retraction (no headgear required)
• Rapid anterior intrusion (no headgear required)
• Functional arch increase
• Release of post-lock mandible to allow forward growth

RESULTS

Results will be presented separately for each of the craniometric adopted measures. Data were analyzed statistically by comparing the proportions, chi-square test and Student's t test ($p < 0.05$).

CHART 1
CONVEXITY

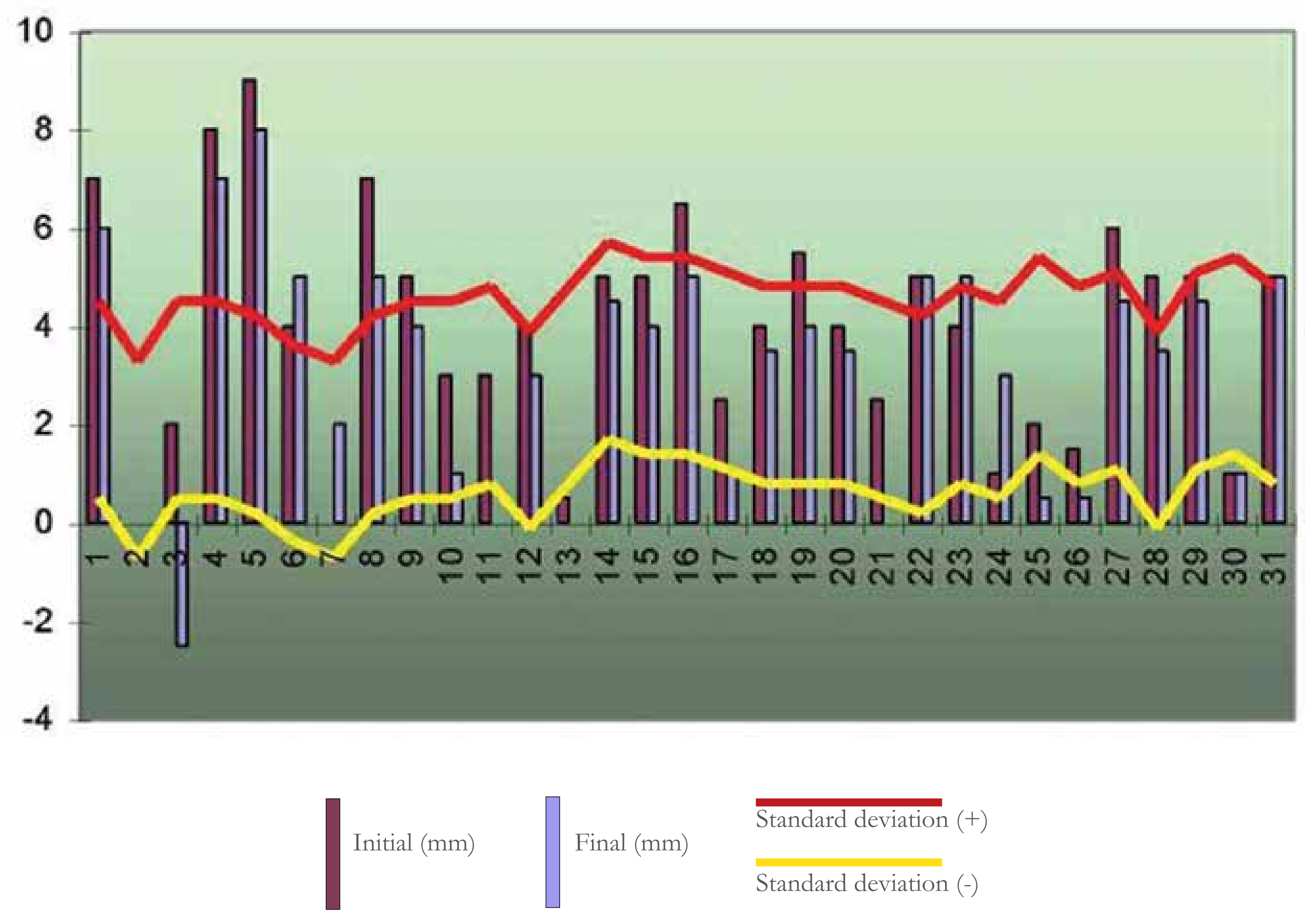


CHART 2
FACIAL AXIS

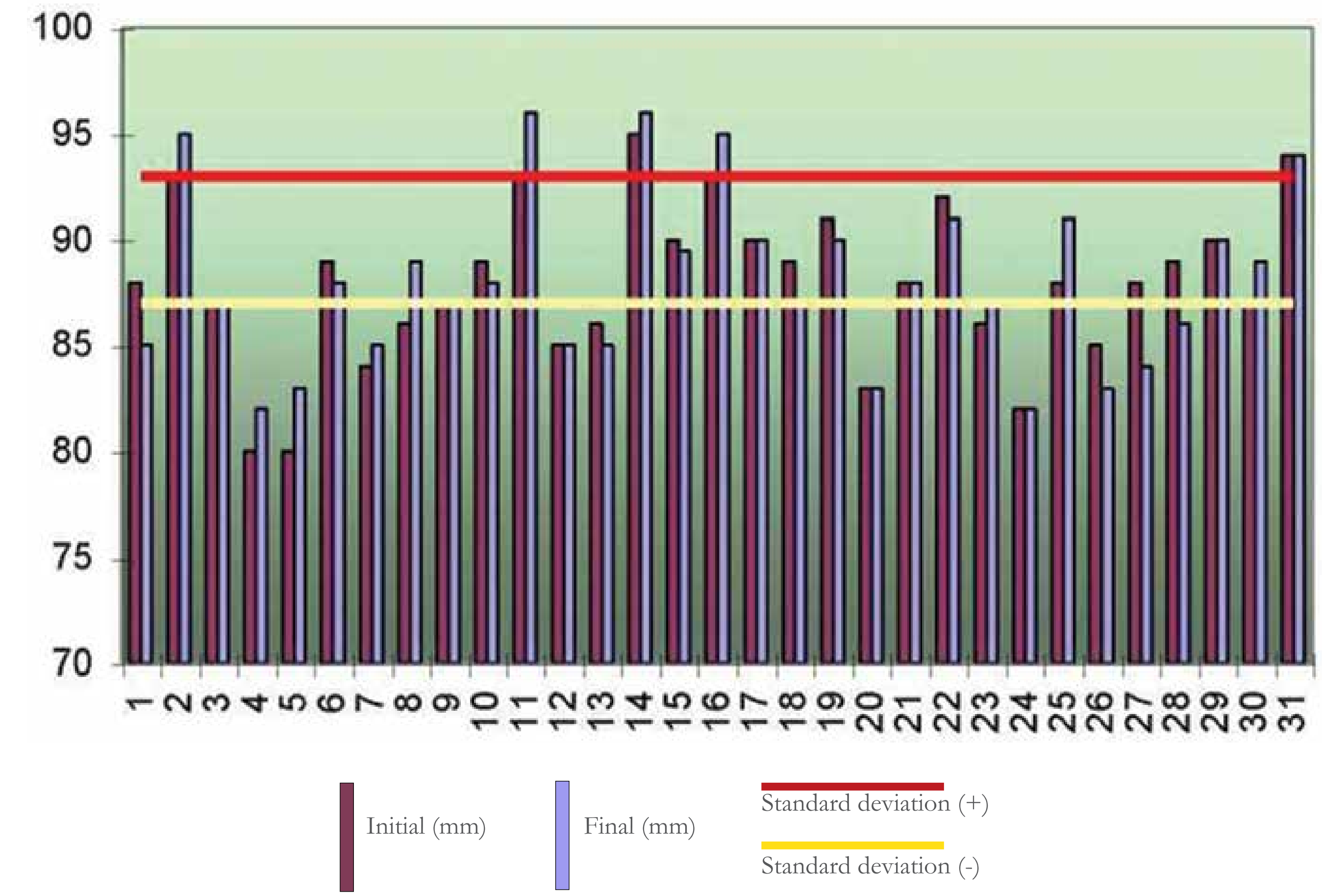


CHART 1
Comparison of Convexity measures (mm)

The convexity data can be observed in CHART 1; there is a wide range of data with a large ± Standard Deviation.

The measurement based on normal growth also tends to move closer to the norm, with exceptions; but in most patients, the final result was within the range of standard deviations for the age group.

The study of the measurements through tests for paired data allows comparison of the measurements obtained in the experiment.

For visualization of this data, we present the averages of the initial and final measurements and alterations that would occur due to normal growth. We can conclude that on average, there was a reduction from the beginning of the experiment from what would be observed due to growth alone.

For the Student's T test, results can be separated into two parts: the variables (initial difference, final difference and growth difference) allow one to compare the averages of standard clinical measurements. We conclude that there is a significant difference between the averages observed in the final period ($p < 0.05$) and that resulting from growth ($p < 0.05$). The initial-final, final-growth and initial-growth variables allow one to compare differences in initial, final and growth conditions relative to the norm. A difference between these measurements and the standard is not observed ($p > 0.10$).

CHART 2
Comparison of measures of Facial Axis (mm) in relation to Clinical Standard

Chart 2 shows a diversity of situations in facial axis data that is objectively tested in the following study. It is observed that the initial and final measurements may be higher or lower than the clinical standard. However, there is a small variation in the values of Facial Axis.

One conclusion from this study is there is no difference between the Facial Axis measurements observed before and after treatment.

With the application of the Student T test comparing the initial and final measurements of the Facial Axis, results can be separated into two parts: the initial difference and final difference, which allows us to compare means with the clinical standard.

A second conclusion is there is strong evidence for a difference between the true mean of the Facial Axis measurement and the Clinical Standard for this measurement. One also concludes that there is evidence for a difference ($p < 0.05$) between the true mean and the clinical standard at the end of the experiment.

Finally, by analyzing the final-initial variable, one observes no evidence ($p > 0.10$) of a difference between the true mean and the clinical standard.

CHART 3
OCCLUSAL PLANE/XI

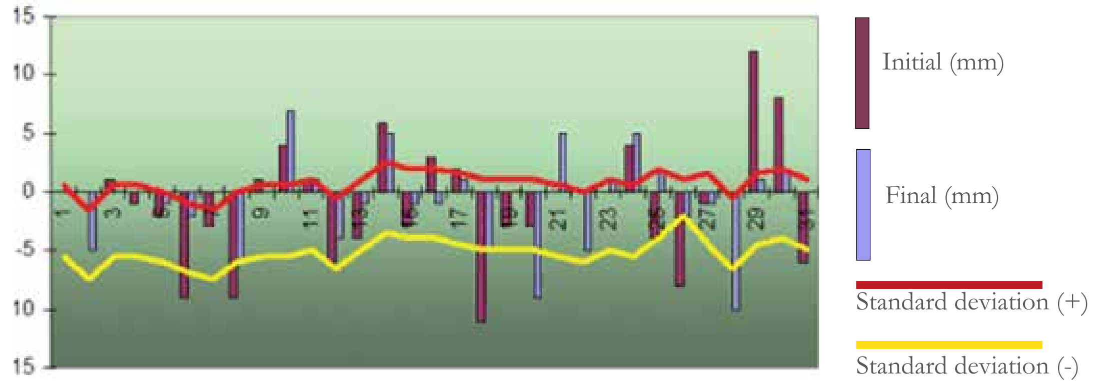


CHART 3
Comparison of occlusal plane measures (mm) relative to Clinical Standard.

The occlusal plane to Xi point data is shown in Chart 3. There is a large deviation of measurements with respect to the clinical standard. In general, measurements taken based on growth also tend to move closer to the standard.

By applying the Student T test to compare the initial mean as a baseline with respect to the standard; statistically ($p < 0.05$) the true mean of the initial value is significantly lower than that of the standard. A similar conclusion is made when comparing the average of the final value and the standard; statistically ($p < 0.05$) the true standard value is higher than the average true mean value after treatment.

Finally, statistically ($p < 0.01$) the average value of natural growth is significantly higher than the standard. As for the Occlusal Plane, results show there is no statistical difference ($p > 0.10$) between initial and final deviations although minor deviations have been observed.

CHART 4
Comparison of Aesthetic Plane measurements (mm) in relation to the Clinical Standard.

Aesthetic Plane data observed in Chart 4 show a wide variation in relation to the standard as well as measurements that are above and below 0 mm.

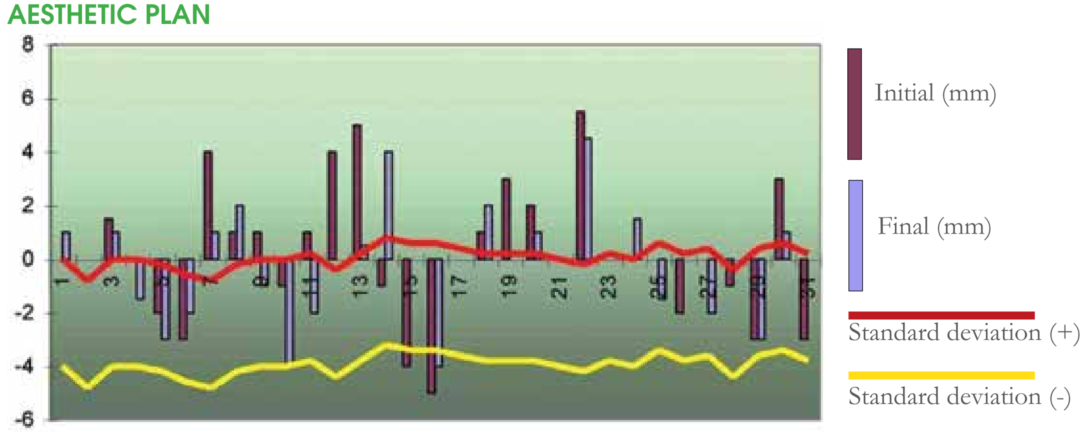
Analysis of tests for paired data concludes that the sample mean shows a reduction at the beginning of the experiment relative to the end, or that would be observed due to growth.

The Student T test allowed us to compare the means of different measurements obtained in the experiment.

The study reveals that the measurements observed at the beginning and end of the test significantly differ from the standard ($p < 0.05$).

In the case of all other variables, no statistical difference is observed relative to the standard ($p > 0.10$).

CHART 4
AESTHETIC PLAN



DISCUSSION

Dental and convexity corrections in Class II cases were studied in patients treated using the Wilson Bimetric Arch. Before and after results were compared using Ricketts cephalometric analysis, differential diagnosis and VTO (visual treatment objective). Beneficial changes in normalization of malocclusions were found. Application of cephalometrics in planning case treatment includes consideration of facial growth, anchorage, and patient cooperation[53, 52-64].

RESULTS FROM THIS STUDY WERE DIVIDED INTO FOUR CEPHALOMETRIC MEASUREMENTS:

- CONVEXITY
- FACIAL AXIS
- OCCLUSAL PLANE TO XI POINT
- RICKETTS AESTHETIC PLANE

FACIAL CONVEXITY

Convexity is defined as the linear distance between Point A and Downs' facial plane (Na-Po), and is directly connected to the base of the skull and mandible; its distance, when increased, defines discrepancy between the bone bases (mandibular retrognathia). If decreased, it becomes negative and produces a mandible prognathism. Caucasians with dolichocephalic tendency feature mandibular retrognathia and Class II; Asians, featuring a brachycephalic tendency, have features of mandibular prognathism and Class III.[44]

An effective way to correct convexity in dolichofacial patients is to promote mandibular growth forward and upward, causing the closure of the facial axis, displacement of the occlusal plane down (Xi), and consequently correcting the profile.[42]

However, the normal mandibular growth, between 9 and 15 years of age in both genders contributes decisively to improving facial aesthetics and convexity. Observing the treatment for Class II and normal patients, growth trends are similar in several parameters studied, and shows that the convexity is greater in Class II Division 1 patients, than in the group of Class II patients treated; where convexity and skeletal relationships were normalized .[4,5,6]

However, the Class II malocclusion is not only characterized by an underdeveloped mandible and its posterior positioning, but also with excessive length of the anterior cranial base that can be a contributing factor in a Class II malocclusion.[54]

In our sample, the results of using the Wilson Bimetric Arch with respect to convexity showed that on average there was a reduction of the initial measurements of treatment compared to the final measurements. But without using 5/16" Class II elastics, and lack of patient cooperation during treatment, the result would be different from our sample. When Class II elastics are not used, one cannot reduce the convexity; also the upper teeth and upper lip are vestibularized.

The elastics should be worn 24 hours a day to achieve the intended result[7], which demonstrates that distalization of the first molars, using the Wilson Bimetric Arch, will occur if space is available. Results of using 5/16" Class II elastics in a sample of 42 Class II patients show that convexity is reduced and posterior growth of the mandible is enhanced in counterclockwise rotation during treatment causing an increase of the SNB plane and, consequently, opening of the facial axis.[41] Other appliances improve facial morphology mainly due to mandibular growth.

For Class II malocclusions, Herbst appliances increase the length and movement of the mandible. For Class III [58, 17, 9] malocclusions the use of reverse headgear reduces negative convexity, causing the development and growth of the anterior maxilla. [31]

FACIAL AXIS

The facial axis indicates mandibular growth and due to its stability during growth and development it is a reliable parameter for evaluating facial changes.

Mandibular anchorage, using the Wilson Lingual Arch was instrumental for stability when using Class II elastics, avoiding any tooth extrusion that would cause changes in facial axis.[41,16,3,57]

The use of 5/16" Class II elastics has no orthopedic effect on the maxillary when applied with the Wilson Lingual Arch (RMO) to correct anterior open bite, as the extraoral appliance would. It is important to reduce any mandibular rotation in the treatment of skeletal Class II preventing the opening of the facial axis.

In our sample the initial and final facial axis was within the standard deviation of the clinical norm, which means that the performance of the Wilson Bimetric Arch was clinically and cephalometrically successful in all treated subjects. Dental occlusion was normalized and so was the occlusal plane, enhancing mandibular growth.[41,48]

OCCLUSAL PLANE / XI

The previous studies have shown that the use of elastics can cause changes in the axial inclination of the upper incisors[63], causing extrusion and deep bite, and the opening of the Facial Axis and Occlusal Plane above Xi (positive) which would prevent normal growth of the lower mandible forward and upward. In our sample this did not happen due to the mandibular anchorage, which preserved the Occlusal Plane in its development process and no disorders in the temporomandibular joint occurred.

The occlusion of molars and premolars and the mandibular rotation and a multifactorial process, interacting during the growth phase and intrinsic factors that act in the alveolar complex, but in our sample it behaved within the normal patterns.[8]

The use of superelastic orthodontic wires provides a light force so that the continuous physiologically effective dental movement is performed or stabilized.

A comparative cephalometric study with BEGG fixed orthodontic appliance and the use of Class II elastics concluded that mandibular and occlusal stability can be achieved in the vertical plane, reaching the expected change by normal growth.[41]

Dental TADs are fundamental to prevent dental and bone rotation during orthodontic mechanics, damaging the Occlusal Plane. [67, 10]

The normal positioning of the mandible can be modified with orthopedic activator appliances and even by the Wilson Bimetric Arch (RMO). However, normal mandable positioning usually occurs when braces are worn or orthodontic procedures are used to preserve the Occlusal Plane near normal (below Xi) . There are reports that there is remodeling of the glenoid fossa during functional therapy. [60, 70]

The result obtained cephalometrically in our sample in relation to the Occlusal Plane to Xi point shows the efficiency of the mandibular anchorage (Wilson Lingual Arch). In all cases the final average was within the normal range (below Xi), and below average growth, which would occur without anchorage. As a result, we would preserve mandibular growth, obtain stability, temporomandibular joint health, and aesthetics, [53, 52, 38] which was established by the visual treatment objective (VTO).

AESTHETIC PLANE

Aesthetic plane measurements show that at T1 the initial average was positive (protruded lip). At T2 the measurement turned negative, remaining within the norm, and naturally occured due to mandibular growth, decreased convexity and maintenance of the physiological occlusal plane.[4]

We must be cautious in the correlation studies of facial and aesthetic development[62], because there are limitations of the cephalometric analysis in measuring points, which do not show what actually occurs in the craniofacial complex. Therefore, finite element analysis is proposed to supplement the cephalometric analysis.[7, 11] Radiographic superimposition of five areas of growth shows us how the face develops during the application of the orthodontic mechanics we used in our sample, with marked improvement in the profile of the treated subjects.

Through normal growth, the angle of Holdaway soft tissue progressively decreases from the age of five to the age of forty-five, and that the upper and lower lips retract in relation to the aesthetic line from the age of fifteen to the age of forty-five[55, 56, 4], but one needs to eliminate bad habits to obtain post-treatment stability[26,65].

When using the Wilson Bimetric Arch (RMO) without Class II elastics, there is no control of the forces applied to the appliance. When patients do not cooperate in using elastics, the upper incisors and lips protrude causing unfavorable aesthetics[47].

CONCLUSION

Based on the sample analysis using the Wilson Bimetric Arch (RMO): Cephalometric values (convexity, facial axis, occlusal plane to Xi point and aesthetic plane) did not change unfavorably (skeletal and dental), results staying within the normal range for mandibular growth.

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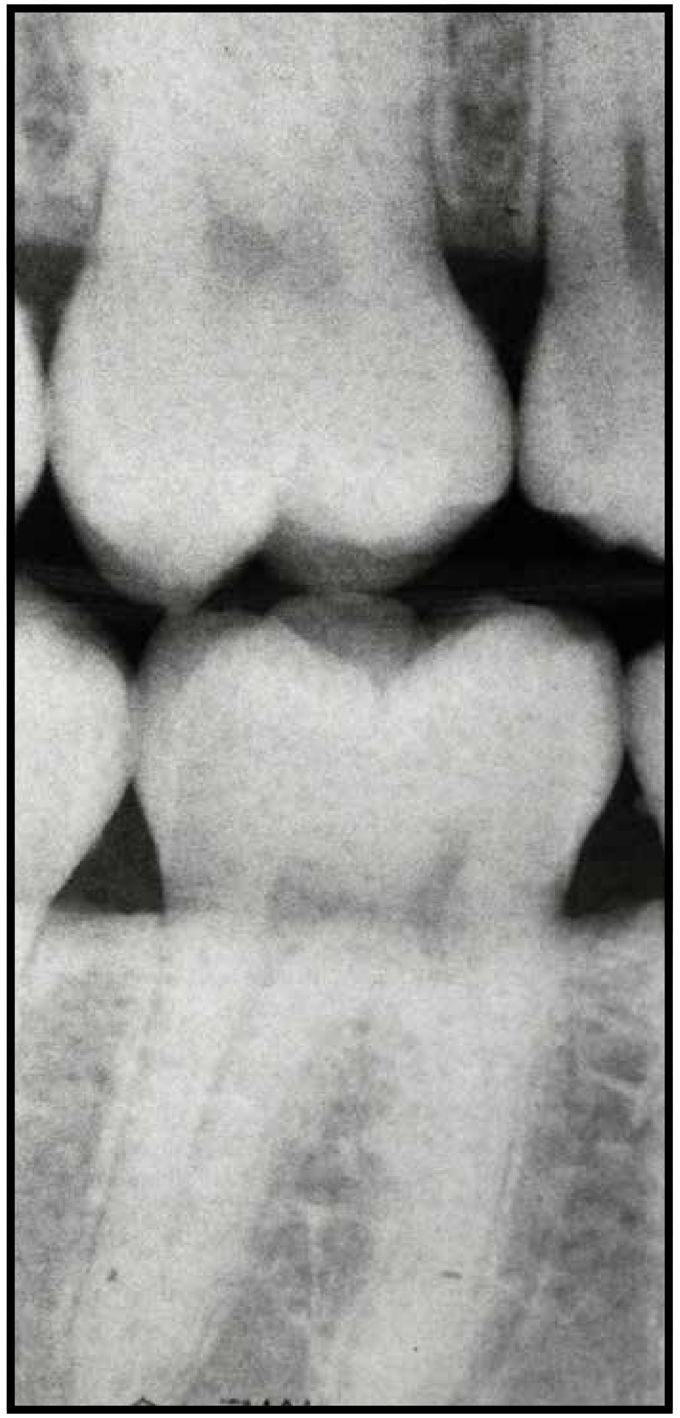
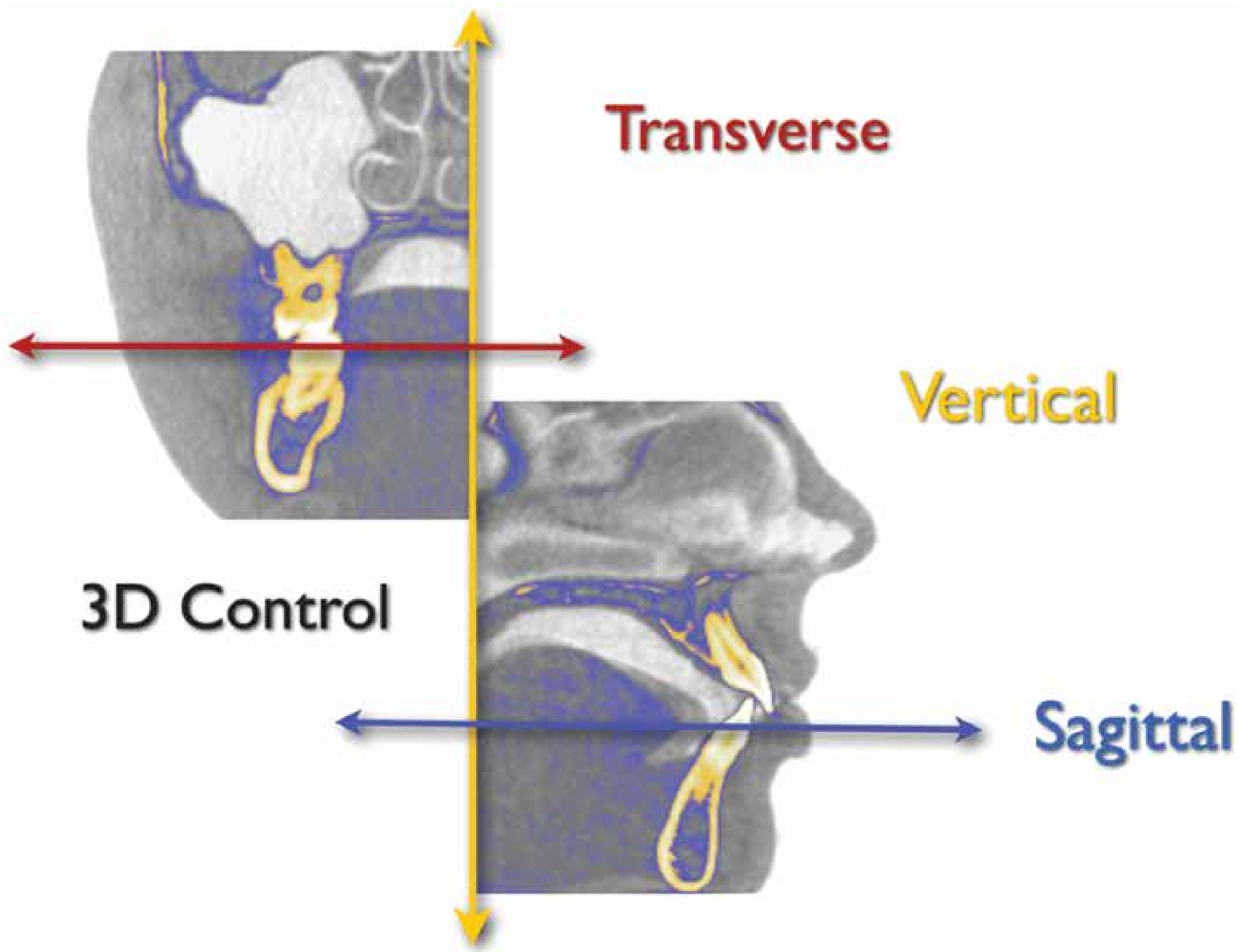




THREE-DIMENSIONAL CONTROL WITH TAD-TISSUE SUPPORTED RAPID PALATAL EXPANDER:

AN OVERVIEW OF CLINICAL APPLICATIONS AND BIOLOGICAL ADVANTAGES

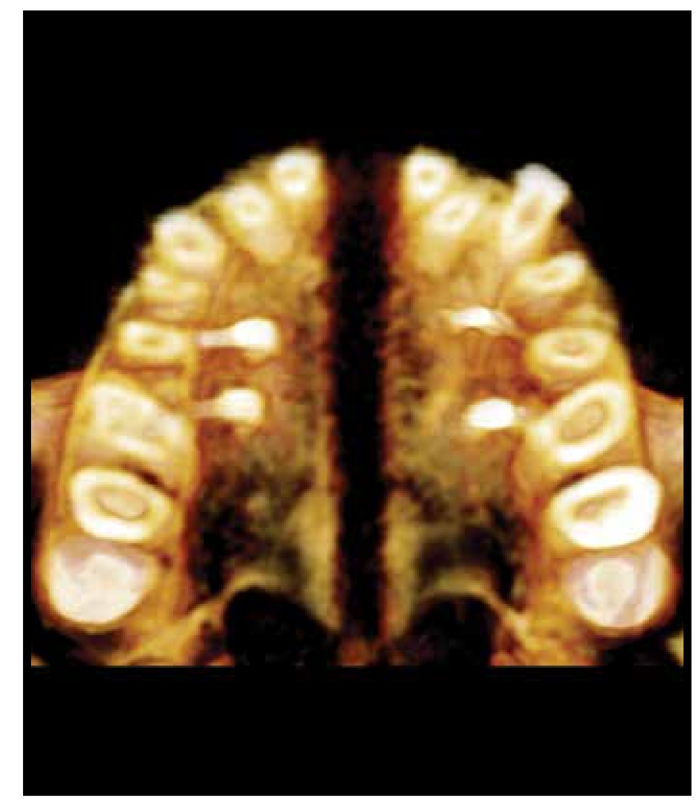
MARIANNA EVANS, DMD

Rapid palatal expansion is a well-accepted treatment modality in orthodontics, addressing maxillary transverse hypoplasia. This technique is based on the phenomena of an incremental mid-palatal suture opening with the application of orthopedic forces to both halves of the maxilla. A mid-palatal suture opening during rapid palatal expansion is age dependent [1]. Sutural resistance to orthopedic forces increases with skeletal maturation due to increased interdigitation [2]. This results in more dento-alveolar expansion, rather than skeletal expansion, in older patients, as was reported with the use of conventional tooth-borne and tooth-tissue supported palatal expanders [1, 3, 4, 5]. Dento-alveolar expansion is not only detrimental to periodontal health [4, 6], but is also responsible for significant orthodontic relapse and may cause an unfavorable bite opening in patients with vertical skeletal patterns [7, 8].

The introduction of temporary skeletal anchorage into rapid maxillary expansion appliances, allows us to eliminate orthopedic forces applied directly to the teeth [9]. In doing so we avoid adverse periodontal effects, achieve required skeletal maxillary expansion and control dento-alveolar and skeletal post-expansion movements in three dimensions [17].

Different TAD-supported expander designs have been described in the literature, with [9, 10, 11, 12, 13] and without [14, 15] surgically assisted palatal expansion. In a recent finite-element study, Lee reported that the most favorable force distribution, without change in tooth angulation, is achieved when temporary anchorage devices are placed on palatal slopes and secured with acrylic pads [16]. On the other hand, significant dento-alveolar tipping, with stress concentration around anchors and adjacent teeth, was found in the design when TADs were directly connected to a Hyrax screw. This finding might explain why no difference was found in skeletal and dento-alveolar expansion between Hyrax and bone-anchored expanders in a recent study done by Lagravere [14].

The purpose of this report is to review the biological and biomechanical advantages of TAD-tissue supported palatal expanders used in my practice.



APPLIANCE DESIGN:

A TAD-tissue supported expander consists of two or four RMO TADs with a bracket-top design placed along palatal slopes between the roots of the upper 1st and 2nd premolars and 2nd premolars and 1st molars and acrylic pads, secured to TADs with light-cure composite (Fig.1). The length and diameter of the TAD depends on palatal soft tissue thickness, inter-radicular space and minimal bony engagement of 3 mm to allow good primary stability (Fig.2). It is strongly recommended to use a contra-angle automatic driver during insertion, in order to achieve an optimal 90-60 degree TAD angulation to palatal slopes and good primary stability. Acrylic pads have to be placed 3-4 mm away from free gingival margins to prevent gingival impingement. The expander can be fabricated before or after insertion of the TADs. Depending on skeletal maturation and severity of the transverse discrepancy, two or four TADs are necessary to achieve required skeletal correction.

FIGURE 1

Figure 1. Components of TAD-tissue supported RPE. Two(1a) or Four(1b) Tads placed along palatal slopes between 1st and 2nd premolars and 2nd premolars and 1st molars to support acrylic pads (1c, 1d) with light activated composite material.

FIGURE 2

Figure 2. CBCT coronal cross-section with TAD placed in the palatal slope to support RPE.

CLINICAL INDICATIONS:

A TAD-tissue supported RPE is the appliance of choice in patients with permanent dentition, fragile periodontium, and missing teeth. It allows us to achieve skeletal, non-surgical expansion with minimal dento-alveolar effects and offers three-dimentional control of tooth movement in post-pubertal adolescents and young adults (Fig. 3, Fig. 4). Skeletal expansion, possible with this device, can exceed what is commonly achieved with conventional tooth-borne appliances. Christie et al., reported basal bone expansion with bonded RPE of 40.65% of the mean jackscrew opening at the levels of the first permanent molars, in patients with a skeletal age of 9.9 [18]. In a recent case report on adolescent twin patients, 3 mm more expansion was achieved with bone-tissue anchored RPE design as compared to bonded RPE [17]. We achieved a 63% skeletal expansion of the jackscrew opening at the level of the first permanent molars in a 14 year old male patient and 50.5% in 22 year old female respectively - without the need for orthognatic surgery (Fig.3(D), Fig.4). These findings will be verified on large sample groups in subsequent publications, supported with the CBCT data.

ORTHONIA

FIGURE 3A

Case 1. Pre-treatment records

THREE-DIMENSIONAL CONTROL WITH TAD-TISSUE SUPPORTED RPE REDUCES TREATMENT TIME TO 12 MONTHS

FIGURE 3B

Case 1. Post-treatment records

FIGURE 3C

Case 1. Treatment Progress

NON-SURGICAL EXPANSION WITH MINIMAL DENTO-ALVEOLAR EFFECTS

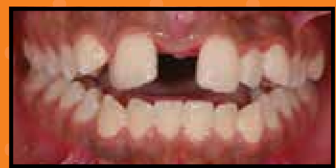
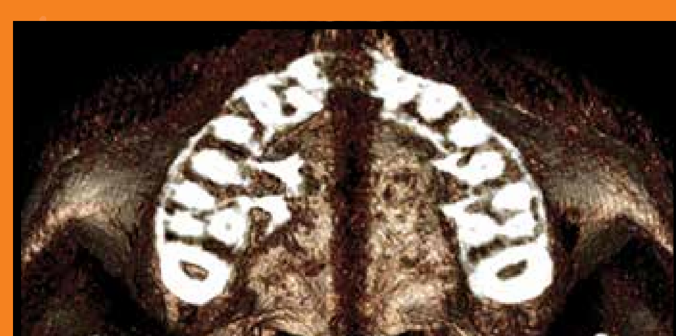



FIGURE 3D

Case 1: CBCT before and after expansion - 63% basal bone expansion achieved

14 YEAR OLD MALE

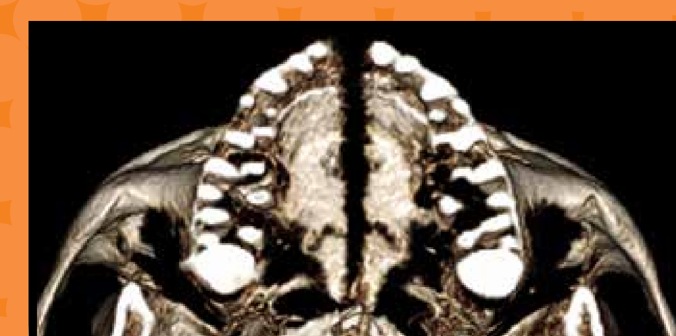
22 YEAR OLD FEMALE

FIGURE 4

CBCT before and after expansion - 50.5% basal bone expansion achieved





CLINICAL APPLICATIONS:

A TAD-tissue supported expander allows us to obtain not only required skeletal expansion but also to control tooth movement in three planes of space:

1. Tooth-free design prevents dental tipping and extrusion and allows maximum vertical control (Fig. 3D)
2. It is the expander of choice in cases with lingual braces or Invisalign (Fig. 5)
3. It can be utilized as indirect anchorage to control posterior or anterior tooth movement (Fig. 6)
4. It can facilitate orthodontic eruption of the palatally impacted anterior teeth prior to bracketing or during leveling and alignment with Ni-Ti wires (Fig. 7)
5. It can be used in conjunction with tooth anchorage for maxillary protraction (Fig. 8)

FIGURE 5

TAD RPE is ideal expander for lingual cases

FIGURE 6

Indirect anchorage with TAD RPE to control posterior/anterior tooth movement

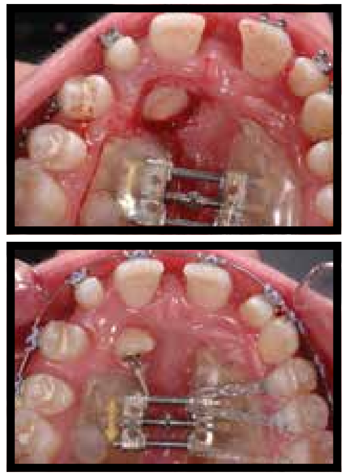


FIGURE 7

Facilitated eruption of the palatally impacted canine with TAD RPE

FIGURE 8

TAD-tooth supported RPE with maxillary protraction hooks

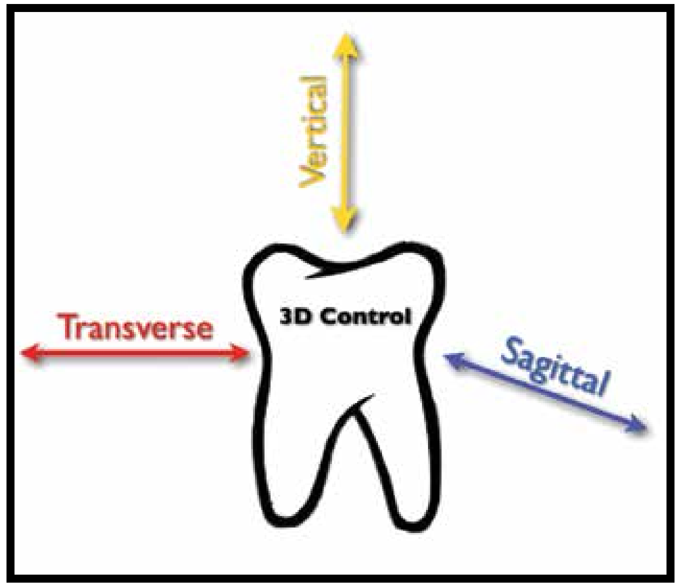
CONTRAINDICATIONS:

A TAD-tissue supported RPE should not be used in mixed dentition due to the risk of damaging follicles of the permanent teeth, when primary stability of the TADs is not achieved, or acrylic pads are not securely attached to TADs.

CONCLUSIONS:

This invisible tooth-free expander fulfills aesthetic, functional and hygienic patient requirements. Total treatment time can be significantly reduced as brackets can be placed and arch wires engaged during the expansion stage. (Figure 3(A, B, C, D))

A simple appliance design appears to offer significant skeletal, periodontal and biomechanical advantages, which will be verified with clinical studies.



"A SIMPLE APPLIANCE DESIGN"

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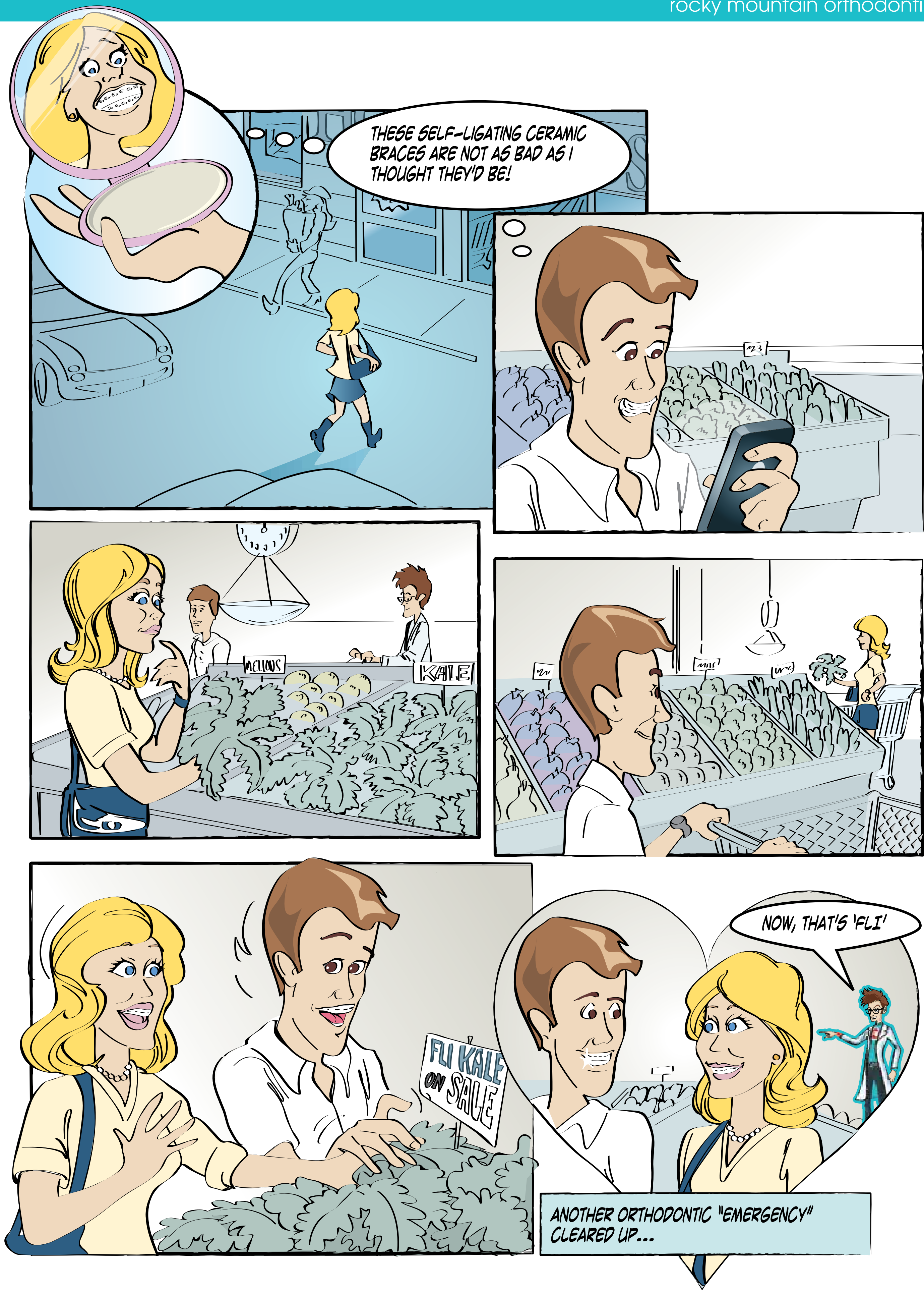

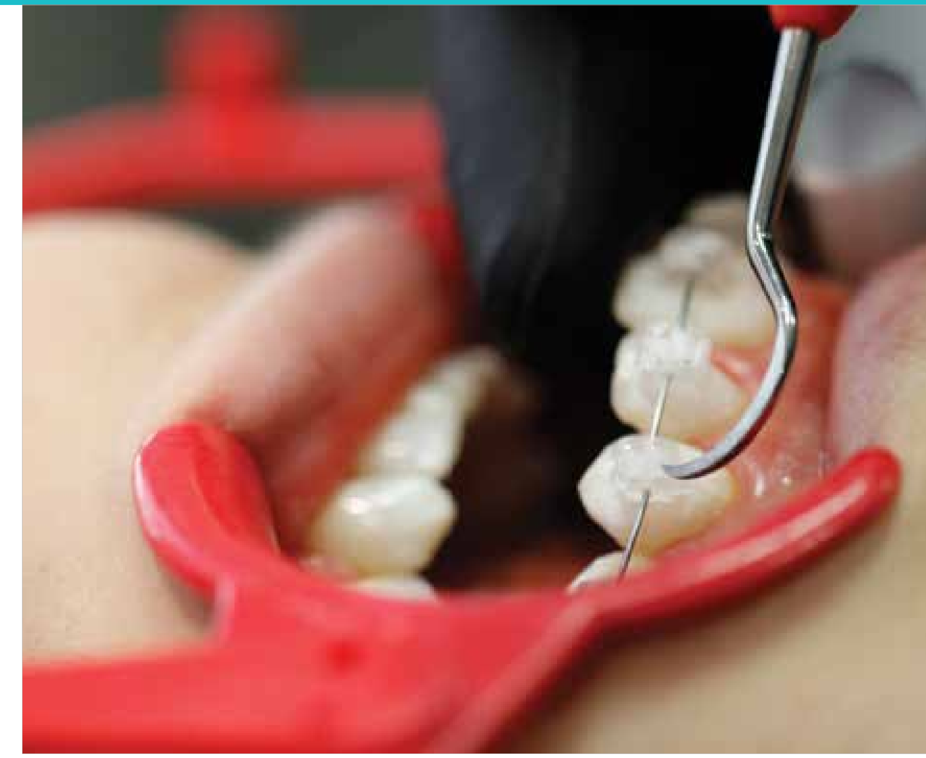

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Dr. Robert Murray Ricketts entered the Orthodontic environment in January 1943 in Indiana. The world had been affected by two World Wars; many young doctors served in the Army and were influenced by this experience, including Dr. Ricketts. Money was hard to come by; it was very difficult to afford a graduate program. Dr. Ricketts' first contact with orthodontics occurred when he was a dental student in Indiana. Dr. Thomas Spiedel presented a lecture on orthodontics, using Dr. Jacob Salzmann's textbook. At that moment, Dr. Ricketts became fascinated with the specialty and started his mission to become a post-graduate student in Orthodontics. He went to the University of Indiana Dean, William Crawford, for advice and he was immediately recommended to the program at the University of Illinois at Chicago (UIC), under Dr. Allan G. Brodie.

After several attempts, Dr. Ricketts was accepted into the program in September, 1947. Since Dr. Brodie had been a student of Dr. Angle, the program focused on Edgewise

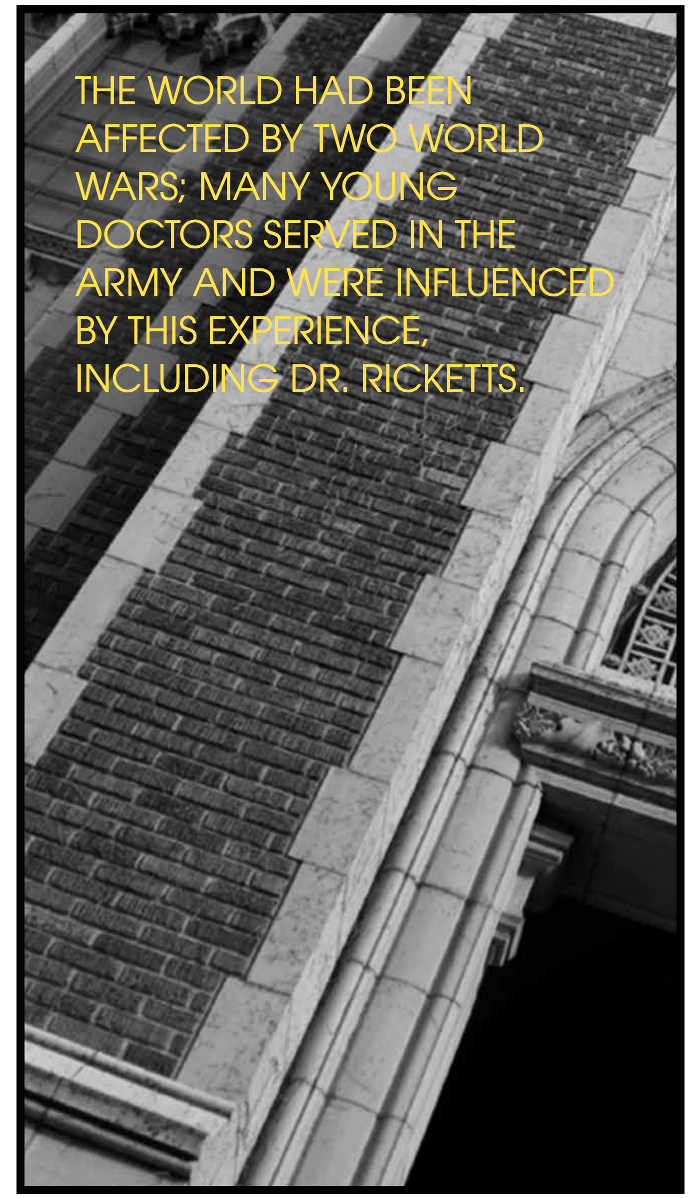
THE BIOPROGRESSIVE THERAPY – A WAY OF LIFE

NELSON OPPERMANN, DDS, MS

To talk about the history of Bioprogressive Philosophy, we must start from the past and analyze the beginnings of Ortodontia. Dr Angle and his colleagues such as: Dr. Calvin Case and Dr. Charles Tweed had one goal in orthodontics, which was to align teeth. Once teeth were in alignment, a comfort zone was achieved since the alignment was top priority, regardless of whether teeth needed to be extracted or arches needed expansion. In the beginning everything was developed by trial and error, all appliances were hand-made until x-rays started to be used. Before RMO® incorporated stainless steel products (iron alloys containing nickel and chromium) into orthodontic appliances, orthodontists had to be skilled craftsman as well as doctors. In fact, much of their time was spent devising, constructing, and maintaining their own oral appliances.

Because those appliances were typically fabricated from dental gold alloys, they tended to distort in a short period of time due to their relatively low strength and softness. A large part of an orthodontist's work was dedicated to repairing and adjusting appliances after they had been put into use. The orthodontist's job demanded mechanical skill, diligence, and even artistry.

All of that changed with the development of versatile stainless steel appliances coupled with the ingenuity and foresight of RMO®'s founder, Dr. Archie Brusse. These innovations were first presented at the AAO Annual Session in Oklahoma City, 1933. At that time the company was called Rocky Mountain Metal Products.



THE WORLD HAD BEEN AFFECTED BY TWO WORLD WARS; MANY YOUNG DOCTORS SERVED IN THE ARMY AND WERE INFLUENCED BY THIS EXPERIENCE, INCLUDING DR. RICKETTS.

Orthodontics. Dr. Ricketts wrote: "Dr. Brodie had the most exceptional proclivity to instill in his students a sense of the importance of orthodontics to their lives and to our whole culture in general. He expressed a love and respect for the profession that I had never experienced before."

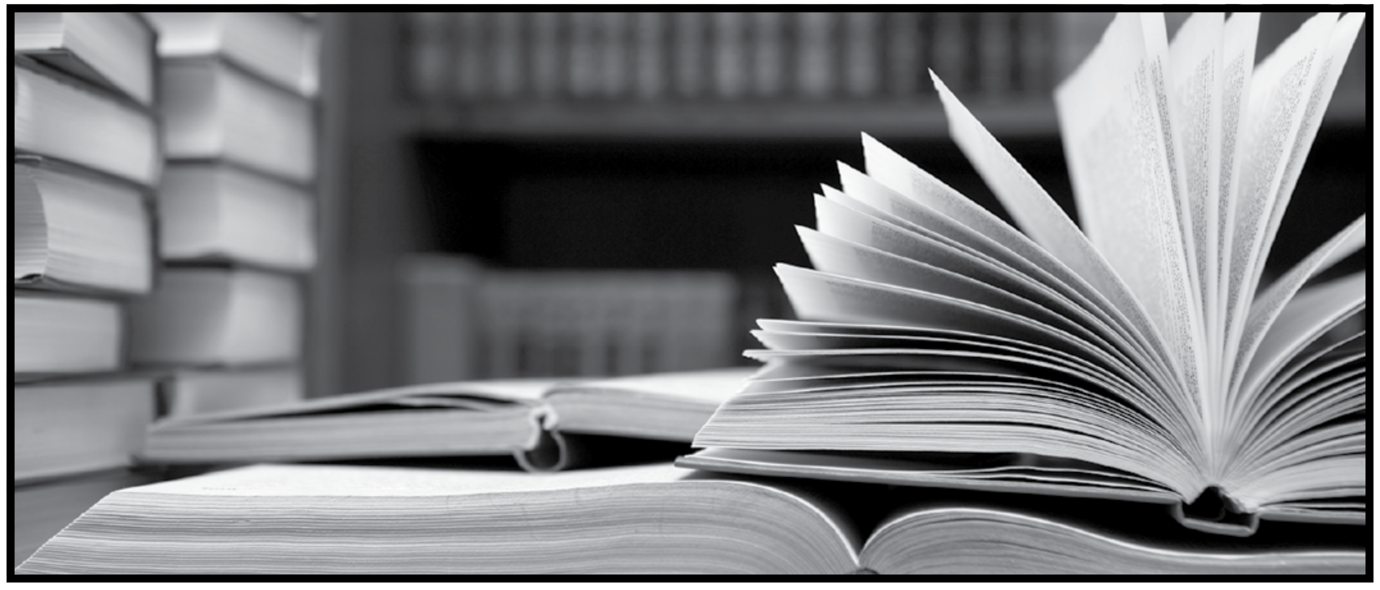
As a student and doing research at UIC, Dr. Ricketts made many important friendships and connections. He had the opportunity to work with his classmate, Dr. Pruzansky; his mentor, Dr. William Downs; and he met Dr. Cecil Steiner and Dr. Silas Klöen. Dr. Steiner encouraged him to move to Pacific Palisades, California, to open an office and start his own practice; Rickettes started his first private case in July, 1952. During his tenure at UIC, Dr. Ricketts wrote his first papers on the temporomandibular joint (TMJ), utilizing laminography. Also, following Dr. Downs' suggestions, he developed a technique for forecasting facial growth for a 2-year period from lateral radiographs. During this time Dr. Ricketts developed the paper known as "The Doctrine of Limitations" which set the stage for what became the "Bioprogressive Therapy." While he was practicing in California, he continued to work on new mechanical techniques and appliances.

After 10 years in practice collecting patient records, Rickettes began to convince many colleagues of his treatment philosophy. In 1959, he accepted a young man under a preceptorship. Dr. Ruel Bench would become one of his most important disciples and a partner in the development of Bioprogressive Therapy Philosophy. During Rickettes' long partnership with Rocky Mountain Orthodontics (RMO®), he helped develop many useful products and appliances, such as pre-adjusted brackets, preformed wires, and Elgiloy wires. Some of these products were presented at the 1962 AAO meeting in Los Angeles.

In 1963, Dr. Ricketts started to teach advanced classes (groups of 15 to 25). In 1968, all his former students were invited to meet in San Francisco to establish the FOR (Foundation for

DR. RUEL BENCH

DR. RICKETTS



Orthodontic Research). In 1966, facial growth from a lateral view was advocated, and in 1968 a radial point was located from which the face grew as sun rays; it was called the polar growth phenomenon. After lecturing around the world, Dr. Ricketts developed a large number of advocates on all continents.

In 1970, Dr. Ricketts and his associate, Dr. Bench, hired a new doctor to join their team, Dr. James Hilgers. This allowed Dr. Ricketts to have additional time to dedicate to research and teaching. The 1970s were Ricketts' most productive years; the arcial growth of the mandible was described in 1971, and first published in 1972. Ironically, he experienced difficulties with clinician acceptance of his new ideas. In the history of the world, it is not uncommon for a researcher to encounter resistance in presenting new directions in science and this was the case. In 1975 alone, Dr. Ricketts published six articles and received the Ketchum Award. At this time, with the assistance of Dr. Carl Gugino, Ricketts' ideas were spread around the world.

In 1977, Dr. Ricketts and Dr. Bench ended their joint practice, but continued to be good friends. In 1979, after some turbulent years, Dr. Ricketts had a renewed start with his scientific productivity by publishing six new papers and a book: Bioprogressive Therapy that was co-authored with Dr. Ruel Bench, Dr. Carl Gugino, Dr. James Hilgers and Dr. Robert Schulhof. This book became the textbook for Bioprogressive Philosophy. It included many of Ricketts' and his collaborators' papers and added detailed information on mechanics and techniques involved in the Philosophy. This book was translated into many languages worldwide.

At the end of the 1970's to the early 1980's, two new clinicians assisted Dr. Ricketts: Dr. Ken Fischer, who became the manager of FOR (Foundation for Orthodontic Research) and Dr. Rick Jacobson, to whom Dr. Ricketts sold his practice. After discovering arcial growth of the mandible, geometrics and mathematics fascinated Dr. Ricketts. To gain a better understanding of this field, he visited Dr. Melvin Moss, in New York. In 1979, Dr. Moss motivated him to conduct research and study the Divine Proportion and Fibonacci numbers.

In the 1980's, Ricketts started to lecture about those principles to orthodontists and plastic surgeons. In 1985 and 1986, Ricketts dedicated his efforts, in collaboration with RMO®, to publish a collection of books that would pull together all his ideas and works from past years with the objective of telling a consistent and complete story. Two books were planned. In 1989, the first of these was called Book One - Part I and II. Book Two was never written.

During the 1990's, he dedicated his career to continue proving his growth prediction system and lectured around the world. He also published several manuals describing and updating his thoughts on many details of Bioprogressive science. Collectively with RMO® Rickettes helped develop an individualized preadjusted bracket / tube system. From

"IN THE HISTORY OF THE WORLD, IT IS NOT UNCOMMON FOR A RESEARCHER TO ENCOUNTER RESISTANCE IN PRESENTING NEW DIRECTIONS IN SCIENCE AND THIS WAS THE CASE."

1997 until 2002, Ricketts compiled 13 manuals on many topics in Bioprogressive Therapy that were published by the Bioprogressive Institute for Bioprogressive Education, Scottsdale, AZ. He didn't stop publishing or lecturing until he passed away in June 2003. After Dr. Ricketts' death, a FOR meeting was organized and held in Orlando, FL (2004), attended by Bioprogressive and Ricketts' followers from around the world. Many subjects were discussed, including a proposal to change the name of Bioprogressive Therapy; this was rejected by the majority of the doctors. Dr. Ricketts' request to all of his friends and family was to hold a big party. Unfortunately, this was the last FOR meeting before the group dissolved.

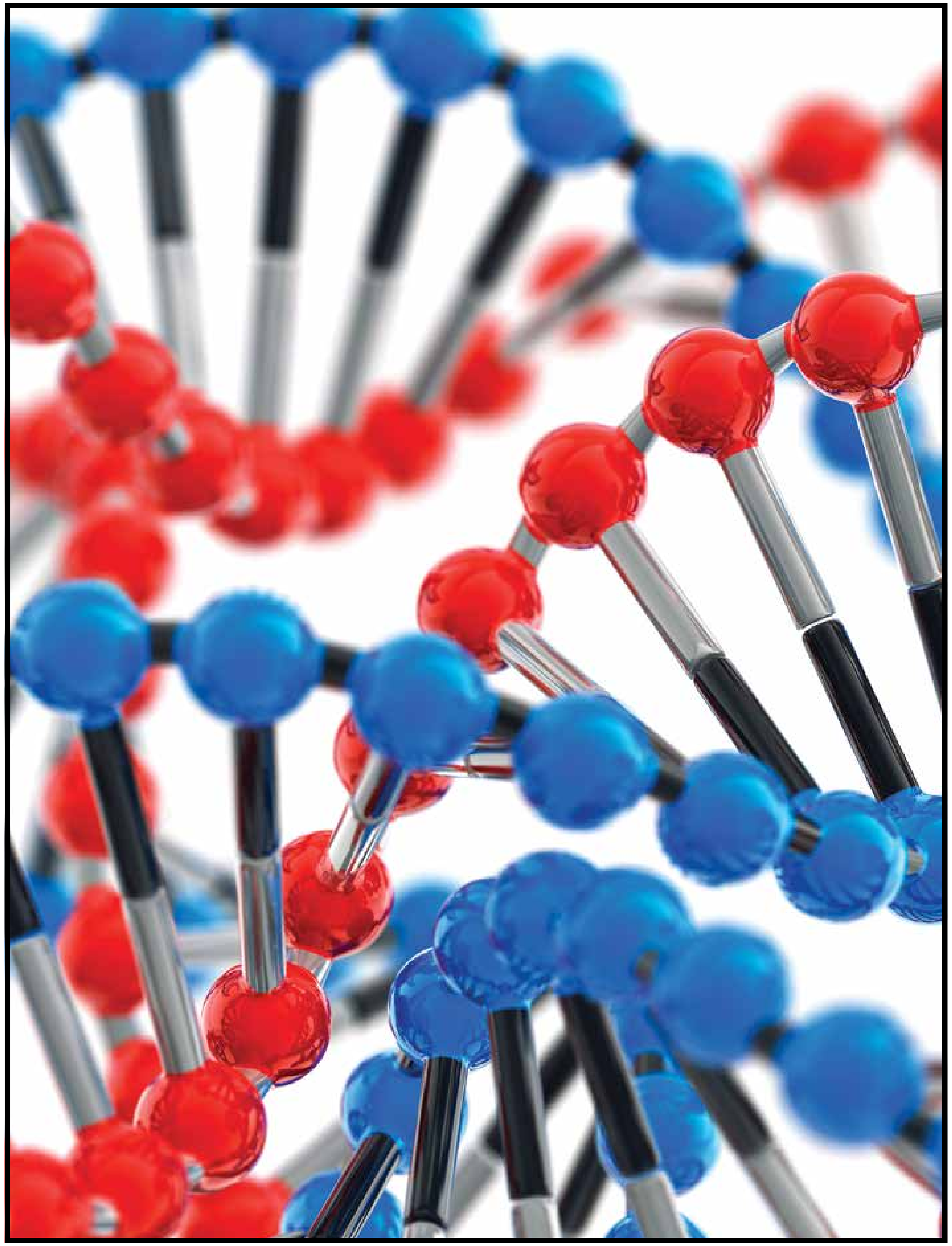
It is easy to understand why Bioprogressive Therapy did not become as popular as some other Straight Wire techniques. Bioprogressive Therapy was developed by Ricketts and his followers, bit by bit, as additional information was aggregated. As new biological findings were discovered, they were integrated as part of the Bioprogressive Therapy; this resulted in Orthodontic and Dentofacial treatment that was customized to each individual.

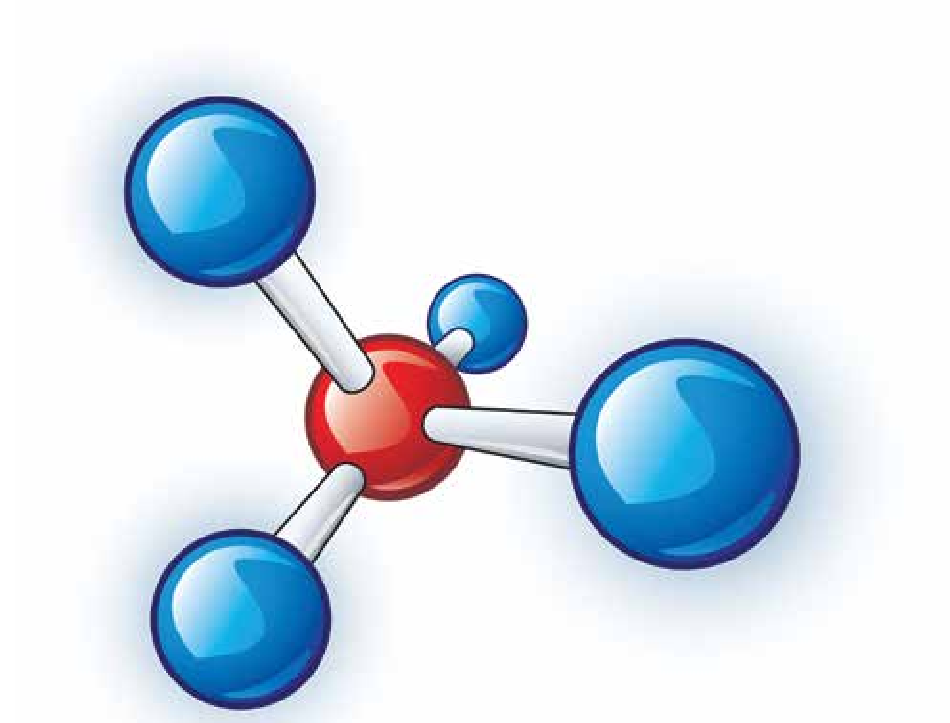
Those findings and customizations increased the learning curve; orthodontics was not simply tooth alignment any longer. Now biology needed to be considered, and diagnosis and treatment planning became more complex. Orthodontists like to keep things simple; they search for ways that can make their lives easier, without cutting earnings. Treatment protocols are easy to teach to post-graduate students, but what happens when these graduates encounter their first problems in their offices? If the treatment protocols do not give them answers, what should they do?

What do we observe in the specialty of orthodontics today? The major changes are focused on bracket prescriptions and design. Many clinicians believe that by changing torque, angulation and tip, by using a contemporary prescribed technique, they can now have a perfect system. There is no doubt that the addition of new technologies and new materials can reduce the number of treatment steps, but it will never change the biological principles. These principles, described in Dr. Ricketts' 1979 text book as guidelines for any orthodontic treatment, are:

1. A SYSTEMS APPROACH TO DIAGNOSIS AND TREATMENT BY APPLYING VISUAL TREATMENT OBJECTIVES IN TREATMENT PLANNING, EVALUATING ANCHORAGE, AND MONITORING RESULTS.
2. TORQUE CONTROL THROUGHOUT TREATMENT.
3. MUSCULAR AND CORTICAL BONE ANCHORAGE.
4. MOVEMENT OF ALL TEETH IN ANY DIRECTION WITH PROPER APPLICATION OF PRESSURE.
5. ORTHOPEDIC ALTERATION.
6. CORRECTION OF OVERBITE BEFORE OVERJET.
7. SECTIONAL ARCH THERAPY.
8. CONCEPT OF OVERTREATMENT.
9. UNLOCKING MALOCCLUSION IN A PROGRESSIVE SEQUENCE OF STEPS IN ORDER TO ESTABLISH OR RESTORE MORE NORMAL FUNCTION.
10. EFFICIENCY IN TREATMENT WITH QUALITY RESULTS, UTILIZING A CONCEPT OF PREFABRICATED APPLIANCES.

Although we lost our mentor and the FOR group has dissolved, many doctors continue to practice Bioprogressive Therapy principles worldwide. With the recent establishment of the Foundation for Modern Bioprogressive Orthodontics, we once again have a focus. The hope is to use this portal as a focus for research, publications, education, debates, and suggestions. Why call it "Modern Bioprogressive Orthodontics?" Because, apart from the need to keep the principles alive, we also need to keep making improvements to our treatment methods, materials, and protocols, which will ultimately benefit our patients. Can Modern Bioprogressive Orthodontics be fashionable in the world of Orthodontics techniques? Maybe, maybe not. But this is not our main goal. What we want to do is to create an environment which will stimulate ongoing progress to achieve better orthodontic treatments. In this way we can affirm that respect for the BIO and PROGRESSIVE will be fashionable with our patients.





NICKEL-TITANIUM WIRES:
HOW TO EXPLAIN IT TO YOUR MOTHER

LEON LAUB, PH.D., MBA, MS

Nickel-Titanium alloys (developed by U.S. Naval Ordnance Lab. & Battelle Memorial Institute in 1962) have been in and out of my life since the 1960's when one of my materials science professors showed me a "magic" trick. He made some intricate bends in a new NiTi wire, then submerged it in warm water; the wire straightened to return to its original shape! Then, it was a wire without an application. The "novelty" aspect of this wire lasted for several years until an application was developed for an orthodontic wire around the 1970's.

The alloy itself is a combination of one atom each of Nickel and Titanium (stoichiometric amounts). Because atoms have different weights, the alloy, by weight %, is 55% Nickel and 45% Titanium. One variation of this alloy composition is removal of 5 atoms of Nickel, replaced by 5 atoms of Copper. The resulting wire was called: Copper Ni-Ti. Understanding NiTi wires starts with two measurable concepts: 1) Transformation Temperature and 2) Tooth moving force.

THE INTENT OF THIS ARTICLE IS TO DISCUSS NITI WIRES USING PLAIN ENGLISH AND KEEPING TECHNICAL TERMS TO A BARE MINIMUM

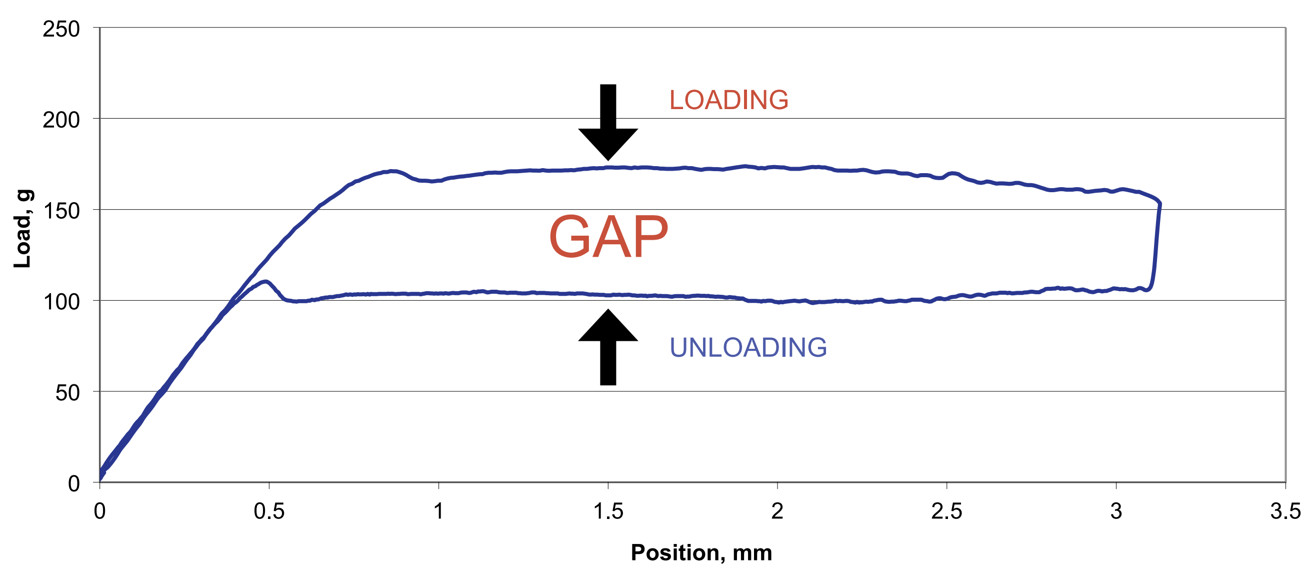
I will use parentheses (…) to enclose technical information – so, unless you are interested in following a technical path, it should not affect my story.

During the manufacturing of NiTi wires, a brand can be processed to set the Transformation Temperature at any point between 0°C and 100°C. For application as an orthodontic wire, useful transformation temperatures are office temperature (20°C) and open mouth temperature (35°C). For NiTi wires, Transformation Temperature has a unique meaning. It separates two structures (also called phases, the internal arrangement of atoms in its lattice). Think of a thermometer; Transformation Temperature would be a constant temperature line drawn on the thermometer. The internal structure of NiTi differs from below the constant temperature line to above the line. The terms: martensite (M) and austenite (A) are simply names given to a structure for a specific material – such as, NiTi. The actual structures differ among alloys. For example, martensite and austenite phases in stainless steel are not the same structures in NiTi. The structure below the constant temperature line (Transformation Temperature) is called martensite (M), and the structure above that line is called austenite (A). The important concept here is that the structure below the line differs from that above the line. Associated with different structures are differences in properties between martensite and austenite.

Bends can be placed in NiTi archwires in the martensite phase; the wire does not return to its original arch form until the temperature exceeds the Transformation Temperature. This is the case for a heat activated NiTi wire (also called: shape memory) as-received by the doctor. Its Transformation Temperature should be close to mouth temperature (35°C), so that the martensite-austenite transition occurs in the mouth, not in the office. However, a NiTi wire in the austenite phase is "springy" – if you try to bend it, it immediately returns to its original arch shape. This is one characteristic of a superelastic (also called: pseudoelastic) NiTi wire. The doctor receives it in its austenite phase; its Transformation Temperature is below room temperature, so that when received in the office it has already transformed.

Tooth moving forces are determined from a three-point bend test at body temperature (ISO International Standard 15841-Wires for use in orthodontics). Nearly every NiTi orthodontic wire will have transformed to the austenite structure at 37°C. The test itself calls for a 10mm length of wire that is supported at its ends. A probe is applied in a downward direction above the midpoint of the wire and then released, causing the wire to bow slightly more than 3mm and recover. The applied and return forces are monitored and graphed as load vs. deflection in the forward (loading) and return (unloading) directions. See Figure 1. The loading force simulates the engagement force of the archwire in the bracket slots. The return force (unloading) is reported as the tooth-moving force. The unique property of NiTi is that

FORCE MEASURED FROM:
THREE-POINT BEND TEST ISO 15841:2006 (E), ORTHODONTIC WIRES



LOADING FORCE: FORCE THE DOCTOR EXERTS TO ENGAGE THE WIRE INTO BRACKET SLOTS IN THE MOUTH.

UNLOADING FORCE: AFTER WIRE PLACEMENT, FORCE THAT HAD BEEN APPLIED TO ENGAGE THE WIRE IS NOW AVAILABLE TO MOVE TEETH; CALLED TOOTH-MOVING FORCE.

FIGURE 1

the curves for loading and unloading are flat, nearly over the entire deflection length. This behavior led to using the term: superelastic (the wire behaves similar to an elastic wire in three-point bend). Clinically, this means that the tooth moving force is constant over a wide deflection range (approximately 1 – 2.5 mm). Brands are compared by tooth moving forces (unloading curve).

Early claims for Copper containing NiTi wires were that the gap (hysteresis) between the loading and unloading curves is very small. This implies that most of the energy applied to engage the wire by the doctor is available to move teeth. Other brands of NiTi wires are now available with small gaps between loading and unloading, so this feature is not unique to Copper containing NiTi wires.

AT FIRST, YOU MIGHT EXPECT THAT THERE ARE ONLY MINOR DIFFERENCES IN TOOTH MOVING FORCES AMONG BRANDS BECAUSE THE COMPOSITIONS ARE BASICALLY THE SAME (OTHER THAN: COPPER NI-TI). THIS IS NOT TRUE.

There are many factors that affect the archwire you receive; all are controlled by the manufacturer. These factors include: purity of raw materials to make the alloy, minor type and amounts of elements in the alloy, whether the alloy is optimized for producing a heat activated or superelastic archwire, mechanical processing and heat treatment.

Manufacturers generally sell 2-3 lines of NiTi wires. About 10 years ago, when I first became involved with wire manufacturing, there was an emphasis among doctors on the heat activation properties of NiTi wires. Doctors like the "feel" of the wire and the ability to pre-bend an archwire before engaging it in brackets; a wire characteristic very useful for a patient that presents a large misalignment of teeth in an arch. Bends can be made and remain (unlike superelastic NiTi) until the wire is engaged in the mouth, where the wire transforms to its original arch shape moving teeth with it.

Typically, heat activated wires deliver low forces (40-100 grams, depending on wire size). Clinicians who follow Dr. Ricketts' philosophy of tooth movement – low, continuous forces to move teeth bodily –use this type of wire. However, some doctors who first started using low force round wires as the initial wire for alignment asked for wires having greater forces as a first wire. RMO® responded by producing a third line of NiTi wires, Thermaloy Plus, having the "feel" of a heat activated wire with higher tooth moving forces. This line delivers moderate forces, between heat activated (low force) and superelastic (high force) wires.

RMO®'s three lines of NiTi wires are: THERMALOY (heat activated; low force); THERMALOY PLUS (heat activated "feel"; moderate force), and ORTHONOL (superelastic; high force). Wires are processed, by design, so that for any wire size, the tooth moving forces delivered increase from: THERMALOY to THERMALOY PLUS to ORTHONOL. This greatly increases the number of choices of NiTi wires available. For a specific wire size, RMO offers three different force levels. A doctor can choose a wire based on the tooth moving force that he/she desires. Forces range from 40 – 500 grams. Today, heat activated wires are often used in clinical situations where low forces are needed, for example, in periodontal-compromised teeth.

How can you compare wires among brands? Brand marketing makes it difficult for the doctor to compare NiTi wires because wires are marketed in several ways:

1) TYPE OF WIRE (HEAT ACTIVATED OR SUPERELASTIC) – RMO®: THERMALOY, THERMALOY PLUS, ORTHONOL; 3M UNITEK: HA, SUPERELASTIC

2) AUSTENITE FINISH TEMPERATURE – ORMCO LABELS ITS BRAND: COPPER NI-TI, WITH THE TEMPERATURE OF THE FULLY CONVERTED AUSTENITE STRUCTURE. THAT TEMPERATURE IS CALLED THE AUSTENITE FINISH TEMPERATURE (WRITTEN A_f). ORMCO'S LABELING SHOWS THE WIRE'S A_f TEMPERATURES: 27°C, 35°C, OR 40°C.

3) FORCE DELIVERED - GAC: SENTALLOY ROUND WIRES - LIGHT, MEDIUM, HEAVY; NEOSENTALLOY SQUARE/ RECTANGULAR WIRES – 80, 100, 160, 200, 240, 300 GRAMS

Marketing according to: 1) & 2) does not indicate actual tooth moving forces; 3) does not indicate heat activated or superelastic wires; Transformation Temperatures are not called-out.

Because the orthodontic literature has very limited reported data on NiTi wire brand comparisons, we did in-house testing to compare tooth-moving forces among brands. Three-point bend test results revealed inconsistencies among brands. For example, results showed some larger wires deliver smaller forces than smaller wires for the same brand. RMO wires are processed so that there is a logical and predictable sequence of forces – within a wire type (THERMALOY, THERMALOY PLUS, or ORTHONOL), a larger wire delivers a larger force. For the same wire size, the low force wire is THERMALOY, the moderate force wire is THERMALOY PLUS, and the high force wire is ORTHONOL.

Brand comparison by tooth moving forces is shown in Figure 2. Both RMO® in-house data and data available in the literature were used to categorize forces delivered by various brands. Figure 2 can be used as a starting point to compare brands. Brand comparison will become easier in the future as manufacturers meet the requirements of the ISO International Standard, which calls for reporting three-point bend data for all wire sizes.

WHAT IS THE DIFFERENCE BETWEEN ORMCO COPPER NI-TI & RMO® FLI® COPPER NICKEL-TITANIUM WIRES?

Copper containing NiTi alloys were patented (Sachdeva et al.: US Patent No. 5,044,947) and assigned to Ormco Corp.; the patent expired in 2010. During the 20-year period of patent protection, Ormco sold and marketed the brand it called: Copper Ni-Ti. Many doctors believed there was nothing either as good as, or better, on the market. When I first learned about the characteristics of NiTi wires, I was influenced by the many doctors who considered Copper Ni-Ti to be the "gold standard" for NiTi wires. However, although these same doctors used the wires effectively, they had a limited understanding of the wire properties. Not all doctors realized the wire packaging has a labeled temperature that has a meaning. Each Copper Ni-Ti wire is labeled by its A_f: 27°C, 35°C, or 40°C, and Damon Optimal-Force Copper Ni-Ti is 25°C. When asked what wire they used, the frequent response was Copper Ni-Ti, without knowing the designated temperature or the force delivered. Copper Ni-Ti 27°C is a high force, superelastic wire; Copper Ni-Ti 35°C is a moderate force wire. Copper Ni-Ti 40°C is a low force wire; however, if its A_f is accurate, the austenite transformation occurs above body temperature. The manufacturer's literature states that this brand delivers intermittent forces, when body temperature spikes above 40°C.

Usually a heat-activated NiTi wire has the lowest relative force for a particular wire size from one manufacturer. The Damon Optimal Force Copper Ni-Ti wire has been described by its manufacturer as a low-force wire. This is not the case. Results from in-house force testing of all sizes of Damon Optimal-Force Copper Ni-Ti wires compared to Copper Ni-Ti 27°C do not show significant differences between corresponding wire sizes. Results imply that Damon Copper Ni-Ti wires are high-force superelastic wires, not low-force wires. Since the manufacturer reports A_f for the Damon wires as 25°C, there is only a 2°C difference between types (superelastic Copper Ni-Ti is reported as 27°C), which is within the experimental variation of measuring transformation temperatures. Results suggest that the only difference between these wires is arch form.

All Copper Ni-Ti wires are labeled with A_f values greater than room temperature (20°C). The question is, shouldn't they all have the same martensite structure at room temperature? Part of the answer to this question is the wide temperature range determined during Transformation Temperature testing (ISO International Standard 15841- Differential Scanning Calorimetry; DSC). Between the austenite start (A_s) and finish (A_f) values; the range could be 20-30°C. At office temperature much of the transformation of martensite to austenite has already occurred, whereas the expectation is that the transformation entirely happens within a couple of degrees in the mouth. Ormco's marketing focus suggests that control of the austenite finish temperature is the major manufacturing criterion. A consequence that arises when processing a wire to control A_f is that the tooth moving forces for these wires are not necessarily consistent.

With the expiration of the Copper containing NiTi wire patent, RMO® initiated a development program to produce a 2nd generation wire. The major development goal was to produce wires with consistent forces, which is not achievable when the manufacturing focus is A_f. See Figure 3.

WIRE BRAND AND FORCE EQUIVALENT

BRANDS	FORCE			
	LOW	MEDIUM	HIGH	EXTREME
RMO	Thermaloy	Thermaloy Plus	Orthonol	
	FLI CuNiTi "40°C"	FLI CuNiTi "35°C"	FLI CuNiTi "27°C"	
GAC	Sentalloy Light	Sentalloy Medium	Sentalloy Heavy	
	Neo Sentalloy 80/100	Neo Sentalloy 160/200	Neo Sentalloy 240/300	
ORMCO	Copper Ni-Ti 40°C	Copper Ni-Ti 35°C	Copper Ni-Ti 27°C	
			Copper Ni-Ti 25°C (Damon)	
3M Unitek		HA	Superelastic	Nitinol Classic
G&H	M5		G4	

FIGURE 2

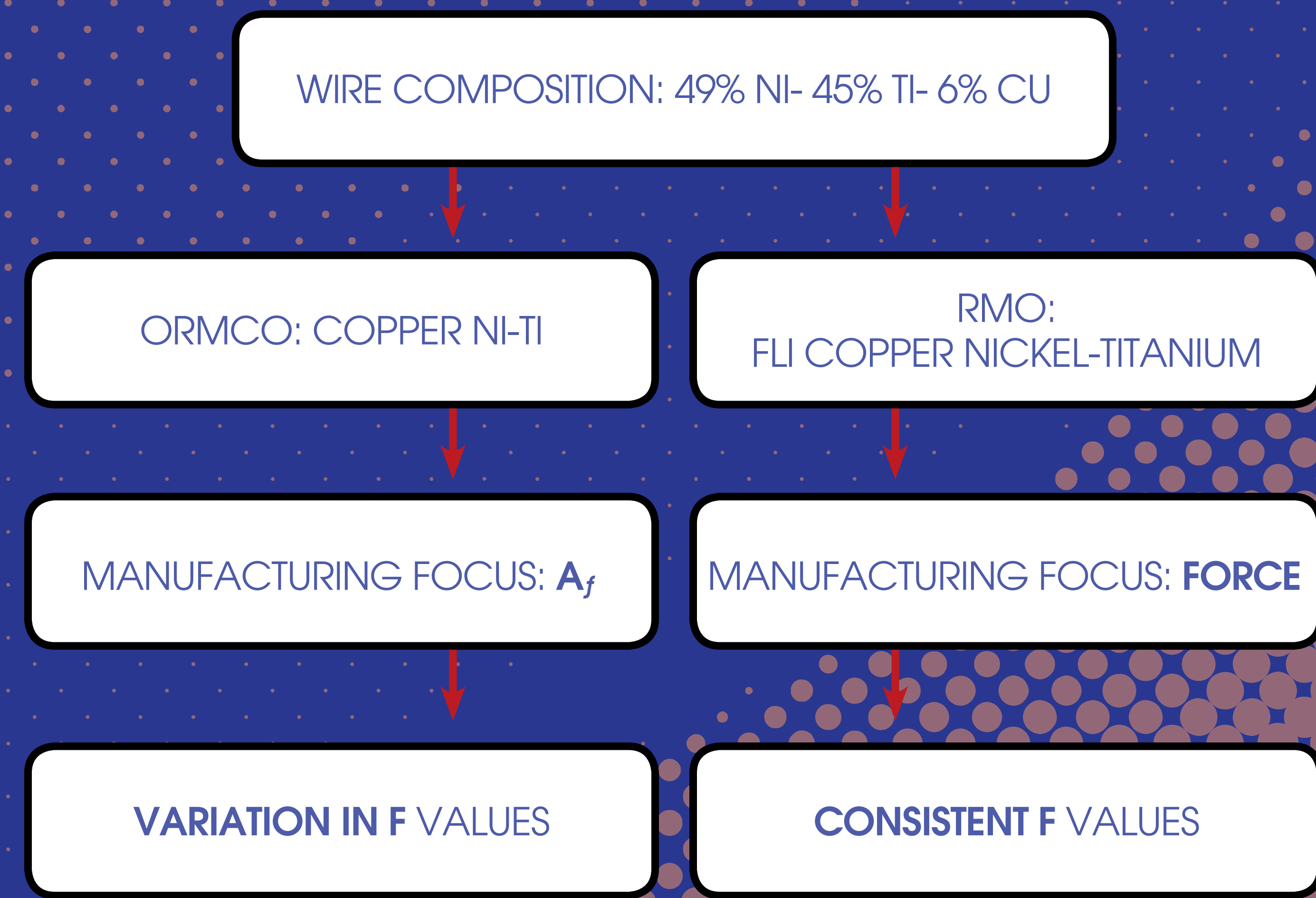


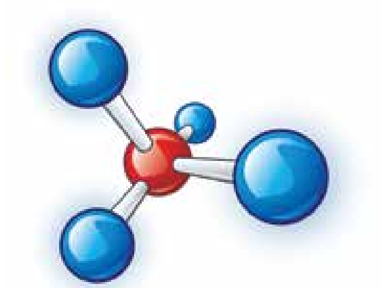
FIGURE 3

RMO® FLI COPPER NICKEL-TITANIUM WIRES

RMO®'s 2nd generation of Copper containing NiTi wires was developed with a specific focus to assure consistency of tooth moving forces. Processes were established to assure manufacturing consistency among wire production lots. The result for the doctor is that all wires within a package deliver the same tooth moving force, and that the force delivered from the wire you use today will be the same as in the future. You can always expect the same force delivery from a specific wire which assures predictability during clinical application.

Three lines of RMO® FLI Copper Nickel-Titanium were developed as consistent force alternatives to Ormco Copper Ni-Ti lines. The temperature designations for RMO® FLI® Copper Nickel-Titanium: 27°C, 35°C, and 40°C are meant to indicate alternative wires to the respective three lines of Ormco Copper NiTi; the temperatures are not the actual A_f values. Actual A_f values of RMO® FLI® Copper Nickel-Titanium wires are within a 4°C difference from the respective Copper Ni-Ti alternatives.

The major outcome from a wire processing focus on A_f is that the forces developed in same size wires are not consistent among production lots. RMO® has overcome this problem by developing manufacturing processes for a 2nd generation of Copper containing NiTi to assure consistency in tooth moving forces.



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