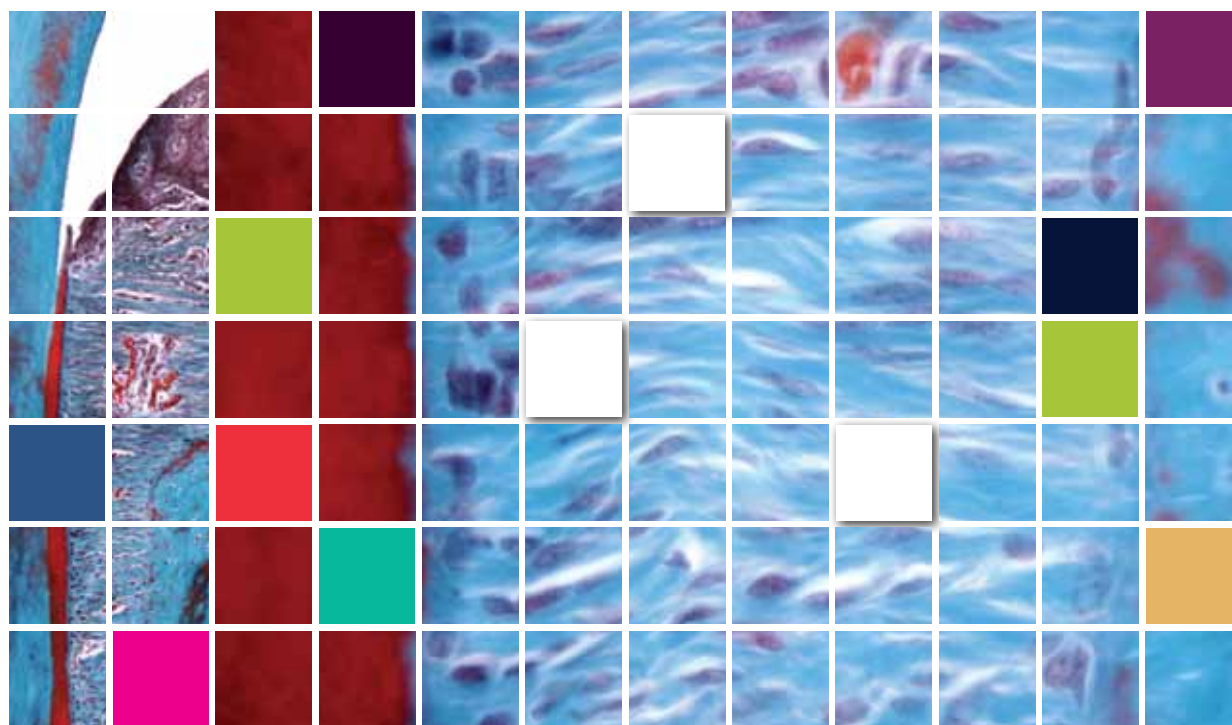


Dental Press Journal of

ORTHODONTICS

Volume 15, Number 2, March / April 2010



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Dental Press Journal of
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v. 15, no. 2

March/April 2010

ISSN 2176-9451

Dental Press J. Orthod.	Maringá	v. 15	no. 2	p. 1-160	Mar./Apr. 2010
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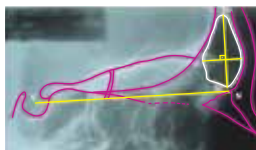
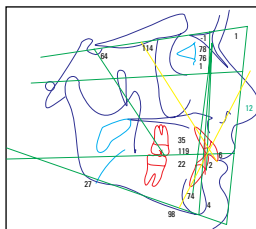
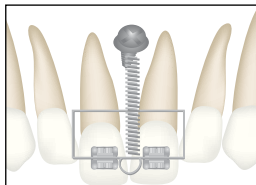
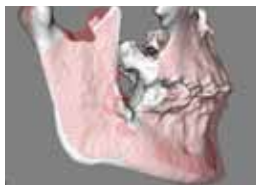
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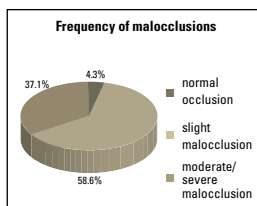
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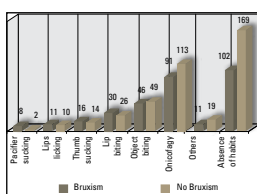
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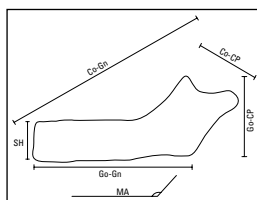
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VARIABLE	n	%
I enter information about damage to orthodontic accessories into the dental records		
Yes	65	94.20
No	4	5.80
I have patient sign a document when orthodontic accessories are damaged		
Yes	16	23.19
No	53	76.81

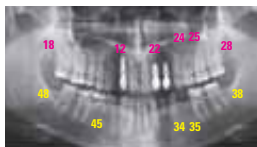
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Orthodontics of the future: From fiction to reality

Renowned science fiction author Isaac Asimov once asserted that "whoever writes science fiction cannot help making predictions—not of what will happen but of what may happen". In fact, since researchers are often required to scan the present in order to shed light on the future, we could modestly compare ourselves to science fiction writers. This is the outlook I intend to adopt from now on in this editorial. I will try to answer a question someone recently posed to me.

What will orthodontics be like in 30 years?

In 30 years, the World Federation of Orthodontists (WFO) will have established guidelines for the course content of graduate orthodontic programs around the world. The number of courses comprising only a handful of credit hours in educationally developed countries will have fallen dramatically. In these countries courses will tend to last 2 to 3 years full time. Organizations such as the Brazilian Board of Orthodontics and the American Board of Orthodontics will be crucial in the process of professional quality assessment. The orthodontic community will become more globalized. Students worldwide will be able to simultaneously attend interactive classes.

Increased Information Technology skills will prove essential in daily practice. Study models will be digital, not only to speed up preparation and analysis but also because the cost of storing plaster models will become unreasonably high in major cities around the world. Three-dimensional printers will be used whenever physical models are needed. But there will be other reasons behind the need for increased Information Technology capability.

Three-dimensional image superimposition methods will be commonplace. Students of Orthodontics will have access to better designed

studies and evidence-based practice will be a routine. As a consequence, we will rationalize the use of X-rays in imaging exams.

Technological advances will enable convenient custom-designed treatments and thus we will be able to see more patients in less time and with a high level of excellence. This will mean greater access to treatment by the population. It will also demand some obvious adjustments. Countries such as Brazil, which already has more dentists than required to meet its population's oral health needs will see the size of its dental educational system shrink.

Orthodontic practice will undergo changes as well. Information Technology will bolster patient care by assisting the work flow. Tooth movement control systems will alert orthodontists whenever they divert from the treatment goals or delay in taking the necessary therapeutic measures. Patients, in turn, will interact more with the treatment, making even more informed decisions about what the treatment plan has in store for them.

All issues discussed here will lead to a single outcome, i.e., the quality of orthodontic services will rise as well as their beneficial impact on the global population.

Many of you may be wondering now what the relationship is between this fiction and today's orthodontics. The answer is that they are deeply entwined. Obviously, I only described one among many possible future scenarios. However, my vision is already materializing as you read this editorial and the fact that many young professionals are not aware of it should give us reason for concern.

Digital models are now a tangible reality at affordable prices. Furthermore, professionals are

incorporating them into clinical practice, making set-ups and increasing the quality of their presentations for both patients and dentists. Methods like the one presented by Motta et al in this issue of the Journal—for superimposing tomographic images—are part of a technology available to all interested parties.

The movement in search of evidence-based dentistry is irreversible and so is the need for a solid education capable of producing qualified professionals. Young dentists, newly undergraduated from schools of dentistry, should apply for a graduate course with an extensive workload that can endow them with the skills needed to enter the market with their heads held high. These truths can be found in the content of the interview featured in this issue. Our interviewee,

Dr. Turpin, editor-in-chief of the American Journal of Orthodontics and Dentofacial Orthopedics, also underscored the relevance of the Boards of Orthodontics for public recognition of orthodontists as successful professionals.

Thus, in line with Asimov, the predictions I made may not be what will happen, but what is likely to happen. Whatever the future may bring, preparing for it entails proper training and adequate continuing education.

Young dentists, brace yourselves for the future by attaining excellence in your training for you are the lead characters of my fiction.

Jorge Faber
Editor-in-chief
faber@dentalpress.com.br



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Brackets



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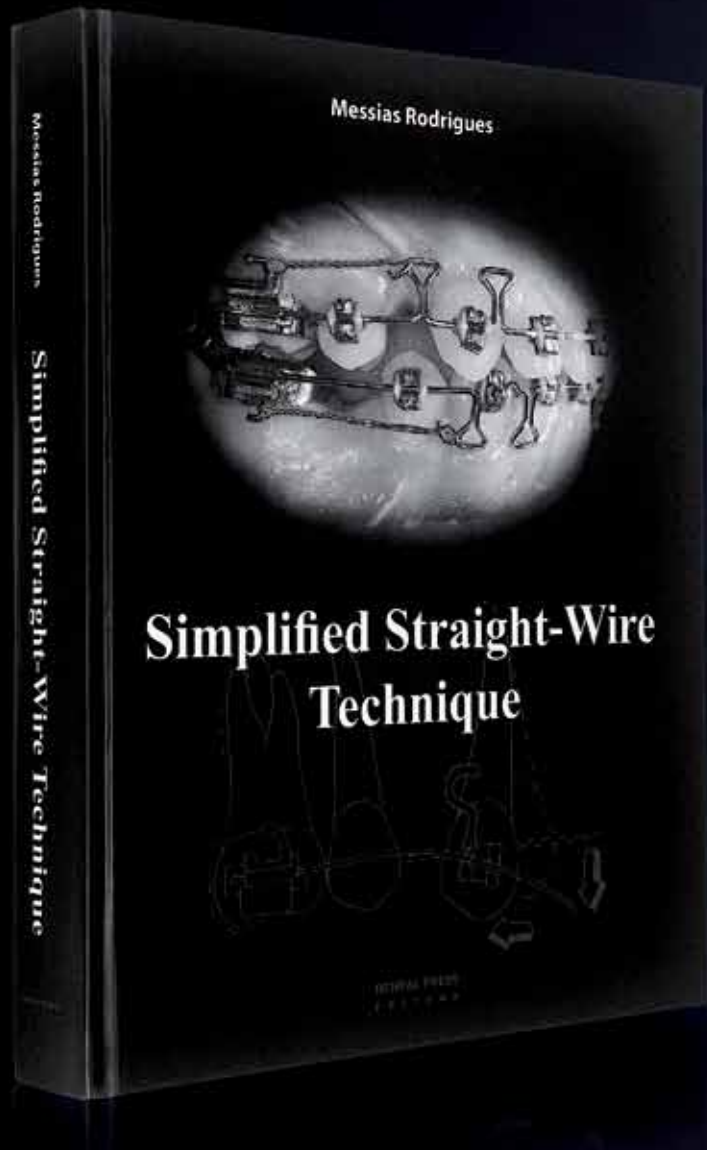


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Simplified Straight-Wire Technique



The development of the pre-adjusted appliances, by Andrews, was a significant progress for the orthodontist, especially in the finishing of orthodontic treatments. A recent research shows that 71% of the orthodontists utilize one of the several types of pre-adjusted systems available. This type of appliance was developed to reduce the bends in the wires and, therefore, making the results more predictable. However, the slot designs of the pre-adjusted brackets can cause difficulties at the beginning of the treatment, especially the bracket slots of canine teeth.

The replacement of the conventional pre-adjusted brackets on canine teeth for pre-adjusted Tip-Edge brackets conceived by the author, has solved problems in Straight-Wire conventional mechanics.

From this new differentiated bracket indication on canine teeth, the author developed the Simplified Straight-Wire Technique. His 10 years experience developing this new proposal was reported in this work with more than 1000 pictures and 20 clinical cases described in detail and refinement in all the stages of the treatment, following a method proposed in the individual planning for each case.

The described clinical procedures are an essential guide for the orthodontist for the understanding and utilization of this new proposed technique.

Hardcover: 556 pages - 78 illustrations

Coated paper matte 115gsm

Book dimensions: 11.12 x 8.6 inches

Publication date: 2006

ISBN: 85.88020-35-1

SUMMARY

CHAPTER 1

DEVELOPMENT OF SIMPLIFIED STRAIGHT-WIRE MECHANICS

- Using Tip-Edge brackets on canines in the Straight-Wire Mechanics
- The canine bracket
- Uprighting springs (Side-Winder)
- Retraction techniques
- Controlling posterior anchorage

CHAPTER 2

BIOMECHANICS OF THE SIMPLIFIED STRAIGHT-WIRE TECHNIQUE

- Notions of facial analysis
- Face proportions
- Vertical direction
- Sagittal direction
- Exposure of upper incisors
- Causes of gingival smile
- Clinical planning beginning with the soft tissue
- Clinical cases (diagnosis and planning)

CHAPTER 3

ASSEMBLY

- Choosing accessories
- Teeth separation
- Adapting bands
- Cementing bands
- Molar tubes
- Choosing brackets
- The Twin Tip-Edge bracket
- Aesthetic brackets
- Bonding protocol
- Pliers

CHAPTER 4

PHASE I

- Alignment and levelling
- Levelling and alignment

CHAPTER 5

PHASE II

- Correction of overjet and overbite
- Australian type archwire
- Anchorage bend
- Class II elastics
- Elastics colors and force
- Premolar bonding in phase II
- First molar tubes
- Sliding movement
- Most common mistakes in the placement of archwire
- Levelling and alignment concomitant to bite opening and retraction

CLINICAL CASE

- Rotation and uprighting springs
- Root uprighting springs (side-winder)
- Placement

Activation

- Torque with tip-edge brackets
- Using rectangular archwire in phase II
- Diagram for archwires construction and coordination
- Initial visit – phase II
- Revision visit – phase II

CHAPTER 6

PHASE III

- Closure of spaces remaining from extractions
- Torque adjustment of the anterior teeth
- Uprighting canine roots
- Archwire in phase III
- Phase III with round archwire
- Phase III with rectangular archwire
- Diagram for archwires in phase III

CLINICAL CASE

- Bonding upper premolars in phase III
- Elastics for closing spaces
- E-link placement through vestibular and palatine
- Activation frequency

CLINICAL CASE

- Phases II and III carried out simultaneously

CLINICAL CASE

- Initial visit – phase II

CHAPTER 7

PHASE IV

- Levelling upper premolars and second molars
- Maintaining the goals achieved in previous phases
- Final torque adjustment of anterior teeth
- Installing the rectangular archwire
- Phase IV diagram
- Final mesiodistal adjustment of canine roots
- Initial visit – phase IV
- The four phases of the Simplified Straight-Wire Mechanics treatment

CHAPTER 8

TREATMENT MECHANICS WITHOUT EXTRACTIONS

- Treatment of Class II malocclusion without extraction
- The growth pattern
- Jarabak percentage
- Posterior cranial base and ramus height relationship
- Upper gonial angle
- Biomechanics
- Position of lower incisors

CLINICAL CASES

CHAPTER 9

EXTRACTION OF MOLARS

- Treatment with extraction of second molars
- Third molar conditions
- Orthodontic mechanics
- Appliance assembly
- Archwires and elastics

CLINICAL CASES

CHAPTER 10

EXTRACTIONS OF FIRST MOLARS

- Clinical characteristics suggesting extraction of first molars
- Facial analysis
- Multi-restorations in molars
- Previous absence of one or more molars
- Early loss of one or two lower molars, provoking extrusion of the upper correspondent
- Extensive decays on teeth
- Simultaneous resolution of lack of space in both anterior and posterior sectors
- Problems in the endodontal treatment
- Significant deviation of the median line
- Severe overjet
- Indications

CLINICAL CASES

CHAPTER 11

USING DOUBLE-KEY-HOLE ARCH IN THE SIMPLIFIED STRAIGHT-WIRE MECHANICS

- The retraction mechanics
- Retraction mechanics with Double-Key-Loop (DKL)
- Considerations on pre-adjusted brackets
- Characteristics
- Activation
- Anterior bite opening
- Activation magnitude
- Activation frequency
- Clinical protocol
- Levelling and alignment
- Caution regarding anchorage
- Clinical sequence
- Conclusion

CLINICAL CASES

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THURSDAY - JUNE 24, 2010

Time	ROOM 01 THEME: PREPARATION IN ORTHOGNATHIC SURGERY	ROOM 02 THEME: DIAGNOSIS AND BIOMECHANICS
8 - 10 am	PREPARATION IN ORTHOGNATHIC SURGERY: YES OR NO? Jorge Faber	OCCCLUSION, TMJD AND ORTHODONTIC TREATMENT: WHAT DOES THE ORTHODONTIST NEED TO KNOW? Paulo Conti
10 - 12 pm	PREPARATION IN ORTHOGNATHIC SURGERY IN CLASS II MALOCCLUSION Ana Maria Bolognese	ORTHODONTICS AND IMPLANTS Laurindo Furquim
1:30 - 3:30 pm	PREPARATION IN ORTHOGNATHIC SURGERY IN CLASS III MALOCCLUSION Carlos Alberto Tavares	SEGMENTED ARCH OPTIMIZING THE MECHANICS OF CONTINUOUS ARCH WIRE Arno Locks
4 - 6 pm	PREPARATION IN ORTHOGNATHIC SURGERY FOR COMBINED SURGERIES Marco Antônio de Almeida	THE BIOMECHANICS OF MINI-IMPLANTS Carlo Marassi
6 - 8 pm	THE ORTHODONTIC-SURGICAL TREATMENT ACCORDING TO BELL Mário Gabrielli	THE TREATMENTS THAT CHALLENGES US Jonas Capelli Jr



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* Brazilian currency (R\$)

FRIDAY - JUNE 25, 2010

Time	ROOM 01 THEME: ORTHOGNATHIC SURGERY	ROOM 02 THEME: INTERDISCIPLINARITY
8 - 10 am	ORTHOGNATHIC SURGERY Paulo José Medeiros	SKELETAL ANCHORAGE João Milki Neto
10 - 12 pm	 WORLD CUP  BRASIL X PORTUGAL	Come watch the game of soccer world cup Brazil vs. Portugal with us. A big screen will be available for everyone to cheer for Brazil!
1:30 - 3:30 pm	THE PHILOSOPHY OF ORTHOGNATHIC SURGERY ACCORDING TO LARRY WOLFORD Marcos Pitta	ESTHETICS IN ORTHODONTICS Carlos Alexandre Câmara
4 - 6 pm	ORTHOGNATHIC SURGERY Roberto Macoto	TRANSDISCIPLINARY APPROACH: ORTHODONTICS AND PERIODONTICS Roberto Carlos Brandão
6 - 7:45 pm	SYMPOSIUM 1 - PREPARATION FOR ORTHOGNATHIC SURGERY Coordination: Mário Gabrielli Speakers: Carlos Tavares / Jorge Faber / Aleysson O. Piza Invited Speakers: Ana Maria Bolognese Marco Antônio de Almeida Marcos Pitta Paulo José Medeiros Roberto Macoto	SYMPOSIUM 2 - DIAGNOSIS, BIOMECHANICS AND INTERDISCIPLINARITY Coordination: Roberto Rocha Speakers: Arno Locks e Roberto Brandão Invited Speakers: Carlo Marassi Laurindo Furquim João Milki Neto Carlos Alexandre Câmara Jonas Capelli Jr

SATURDAY - JUNE 26, 2010

Time	ROOM 01 THEME: ORTHODONTICS FOR ADULTS
8 - 10 am	ORTHODONTICS FOR ADULTS Speaker: Silvia Braga Reis
10 - 12 pm	ORTHODONTICS FOR ADULTS Speaker: José Nelson Mucha
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Ricardo Machado Cruz, MS, PhD
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Marcos Janson, MS
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Jorge Faber, MS, PhD
Orthodontist



Rogério Zambonato, MS
Maxillofacial Surgeon



Schedule

Friday – 06/11/10

8:30 - 10 am ➤ Marcos Janson
10 - 10:30 am ➤ Intervalo
10:30 am - 12 pm ➤ Marcos Janson

2 - 4 pm ➤ Ricardo Machado Cruz
4 - 4:30 pm ➤ Intervalo
4:30 - 5:30 pm ➤ Ricardo Machado Cruz

Saturday – 06/12/10

8:30 - 10 am ➤ Jorge Faber
10 - 10:30 am ➤ Intervalo
10:30 am - 12pm ➤ Rogério Zambonato

➤ Limited availability

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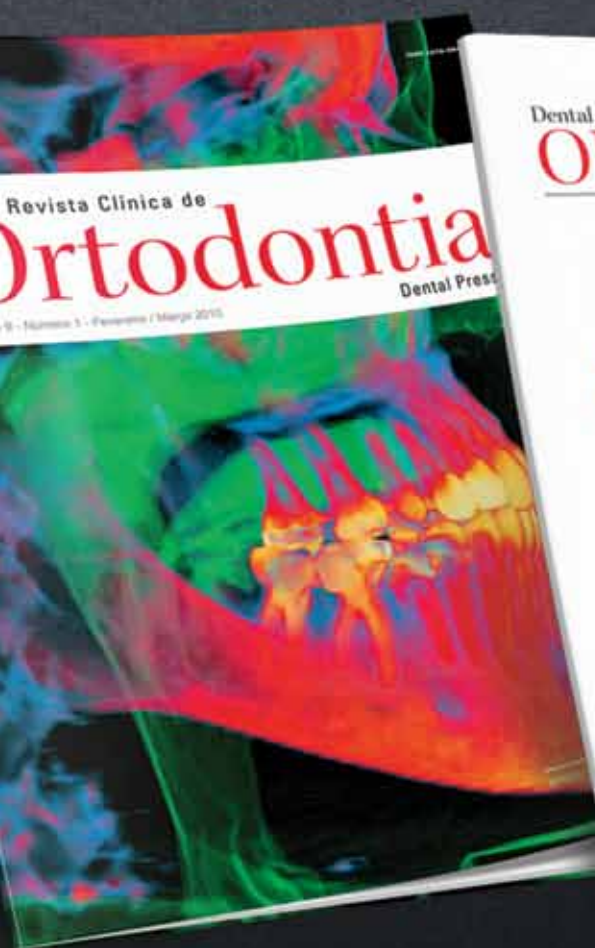
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October 20-22, 2010

Oct, 20th
9:00-10:30**"Understanding the biochemistry of Dental Erosion"****Domenick Zero** (Indianapolis, USA)Oct, 20th
11:00-12:30**"Chemical factors influencing erosive potential and strategies for making beverages less erosive"****Peter Shellis** (Bristol, UK)Oct, 20th
16:00-17:00**"Diagnosis of erosion: overview, criticism and new perspectives"****Carolina Ganss** (Giessen, Germany)**Adrian Lussi** (Bern, Switzerland)Oct, 20th
17:00-18:00**"Is dental erosion a problem for Brazilian children and teenagers?"****Maria A.A.M. Machado** (Bauru, Brazil)**Silvia H.C. Sales-Peres** (Bauru, Brazil)**Marcelo Bônecker** (São Paulo, Brazil)Oct, 21st
8:00-9:00**"Impact of mechanical forces on dental erosive wear"****Annette Wiegand** (Zurich, Switzerland)**Adrian Lussi** (Bern, Switzerland)Oct, 21st
9:00-10:30**"The impact of behavioural factors and systemic diseases on prevalence of dental erosion"****Domenick Zero** (Indianapolis, USA)Oct, 21st
11:00-12:00**"Role of fluoride and fluoride compounds in the management of dental erosion"****Annette Wiegand** (Zurich, Switzerland)**Carolina Ganss** (Giessen, Germany)**Ana Carolina Magalhães** (Bauru, Brazil)Oct, 21st
16:00-18:00**"Biological factors for dental erosion: enzymes (MMPs), salivary pellicle and Saliva"****Marilia A.R. Buzalaf** (Bauru, Brazil)**Heitor M. Honório** (Aterros, Brazil)**Walter Siqueira** (London, Canada)Oct, 22nd
8:00-10:00**"Laboratory measurement of dental erosion and abrasion"****Thomas Attin** (Zurich, Switzerland)Oct, 22nd
10:30-11:30**"New methods to prevent dental erosion"****Marilia A.R. Buzalaf** (Bauru, Brazil)**Daniela Rios** (Bauru, Brazil)Oct, 22nd
11:30-12:30**"Dentin erosion and hypersensitivity: diagnostic and treatment"****José Carlos Pereira** (Bauru, Brazil)Oct, 22nd
16:00-18:00**"Rehabilitation of the worn dentition: challenges for the dentist"****Gerson Bantante** (Bauru, Brazil)**Regina G. Palma-Dibb** (Ribeirão Preto, Brazil)

Poster Presentation

Submission by e-mail (erosion_2010@yahoo.com.br). The abstracts must be original paper related to noncarious lesions (erosion, abrasion, attrition, abfraction/ in vitro, in situ and clinical studies). Submission must be done from January 2nd to April 30th, 2010. For more information access: www.fob.usp.br/erosion2010

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THURSDAY

Room 01 - Seminar 8:30 am to 12:30 pm Drª Benícia C. I. Ribeiro - MS State <i>Dental Bleaching: Actions and Risks</i> 2p m to 4 pm Drª Benícia C. I. Ribeiro - MS State <i>Hands-on: Cosmetic Resources available to the clinician pursuing restorative aesthetics</i> Ultradent 4:30 pm to 5:30 pm Drª Fábio Chiarelli - ES State <i>Risk factors in dental implantology: Influence of peri-implant microbiota: Where are we headed?</i> 5:30 pm to 6:30 pm Drª Robson Rezende-ES State <i>Maxillary sinus elevation: approach, materials used and associated pathologies</i>	Room 02 - Meeting 8:30 am to 10:30 am Drª Felipe Assis Rocha - ES State <i>Platform Switching</i> Emflis 10:30 am to 12:00 noon Drª Ricardo Gapski - EUA State <i>Soft tissue manipulation in dental implantology</i> Systhex 2 pm to 4 pm Drª Sérgio Rocha Bernardes - PR State <i>Zirconia Abutment</i> Neodent 4:30 pm to 6:30 pm Drª Livingston Rocha-ES State <i>ROG (Banco de Ossos): De Casos Unitários a Totais</i>	Room 03 8:30 am to 9:15 am Drª Rachel Cortinhas Toribio-ES State <i>Ophthalmologist</i> <i>What professionals and patients should require during check-up and prevention</i> 09:15 am to 10:00 am Drª Paulo Ricardo de M. Brandolt NLP Drª Lúcia Lopez <i>Psychologist</i> <i>Stress management in dentistry</i> 10:30 am to 12:30 pm Drª Paulo Rückert <i>Psychoanalyst and Philosopher</i> <i>The human being caught between two extremes: alienation and transcendence</i> 2 pm to 6:30 pm Drª Marcela Cavalcanti - SP State <i>Interpretation of Cone Beam Imaging</i> Digiface and Odonto Scan	Room 04 Free discussions 16 topics Registration open <i>Send topic and summary to secretaria@abovilavelha.org.br - Free Discussion Title - Deadline: April 5, 2010</i> 2 pm to 3:00 pm Drª Aguiar Bourguignon - ES State <i>Autogenous bone graft: biological foundations and surgical technique</i> Hall 2 pm to 6:00 pm Ricardo P. de Freitas Elaine C. Freitas Fernando C. P. Vieira <i>Physiotherapists</i> <i>Shiatsu and Auriculotherapy</i>
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FRIDAY

Room 01 - Seminar 8:30 am to 12:30 pm Drª Roberto Caproni-MG State <i>Marketing applied to dentistry</i> <i>How to improve your financial life, quality of life and reputation in the community</i> 2:00 pm to 4 pm Drª Rogério de F. Góes-SP State <i>Impression Materials</i> 3M 4:30 pm to 6:30 pm Drª Eduardo Fregnani-SP State Drª Marcelo Tavares-SP State <i>Current vision of endodontics and dentistry regarding coronal sealing after root canal treatment</i>	Room 02 - Meeting 8:30 am to 10:30 am Drª Livingston Rocha-ES State <i>Planning in dental implantology: Scientific foundations and clinical applications</i> Biomet3i 10:30 am to 12:30 pm Drª Jan Peter Ilg-SP State <i>Graftless solutions for the totally edentulous The All-on-4 System</i> 2 pm to 4 pm Drª Albert Barbara-RJ State <i>Determinants of peri-implant aesthetics</i> CEPIO 4:30 pm to 6:30 pm Drª Raul Gomes Júnior-PR State <i>Prosthesis on anterior teeth with immediate load</i> Systhex	Room 03 8:30 am to 10:30 am Mesa redonda de saúde coletiva <i>Roundtable on public health</i> <i>Coord.: Dr. Edson Teodoro dos S. Neto, Mayara L. Viana Netto, Carolina Dutra D. Esposti and Márcia B. Reis</i> 10:30 am to 12:30 pm Roundtable on aesthetics <i>Coord.: Dr. Glaucio Rangel / Table: Benício Ribeiro, Dr. Marcelo Tavares, Dr. Sérgio Domingos da R. Pereira</i> 2 pm to 4 pm Roundtable on orofacial pain <i>Coord.: Dr. Francisco Martinelli / Table: Dr. Paulo Roberto Emmerich Oliveira, Dr. Getúlio Campos (ENT specialist) and Dr. Antônio Carlos Cardoso</i> 4:30 pm to 6:30 pm Periodontics Roundtable <i>Coord.: Dr. Eduardo Gomes Perez / Table: Dr. Lenize Zanotti Soares Dias, Dr. Carlos Eduardo Ferreira, Dr. Albert Barbado and Dr. Alfredo Felisio</i> 2 pm to 6 pm Hall Maria Cassia Prados Ferreira <i>Body Therapy / Biodynamics</i>	Room 04 8:30 am to 10 am Drª Rogério de Freitas Góes-SP State <i>Adhesive X Non-adhesive Cementation</i> 3M 10:30 am to 11:30 am Sérgio Barreto (DPT)-ES State <i>Metal free porcelain: The importance of DPT's in interdisciplinary planning</i> 11:30 am to 12:30 pm Drª Elizabeth Rossetti-ES State <i>Predictability of root coverage with gingival grafts</i> 2 pm to 6:30 pm FREE DISCUSSIONS
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SATURDAY

Room 01 - Seminar 8:30 am to 12:30 pm Drª Antônio Carlos Cardoso-SC State <i>Occlusion for you and me</i> <i>Occlusion/Aesthetics/Prosthetics</i>	Room 02 - Meeting 8:30 am to 12:30 pm Drª Arturo Meijueiro-México <i>International Course: Alternativas Quirúrgicas Para La colocacion de implantes en situaciones complejas y SUS alternativas pretiseicas</i> Titanium Fix	Room 03 - ABOR Symposium 8:30 am to 12:30 pm Respiratory sleep disorders <i>Table: Dr. Crayley Maia Junior (author of the book: Dentistry in Sleep Medicine, Doctor of Orthodontics), Maria Salim (Professor, CTBMF), Jessica Polese (physician), Fabiana de Sá Almeida Ruelo (ENT), Juliana Spetta Velhoso (Speech therapist). Moderator: Rodley Robert Rossi (Prof. Orthodontics UFES)</i> Hall Yogatherapy	Room 04 Free Discussions
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"The role of electronic journals"

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"Authorship of papers"

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Telma Martins de Araujo is the new President-elect of BBO

Telma Martins de Araujo, Associate Editor of the Dental Press Journal of Orthodontics, is the new President-elect of the Brazilian Board of Orthodontics and Dentofacial Orthopedics (BBO). The election was held at the General Meeting of BBO, in São Paulo/Brazil on December 5, 2009.



Participants of the Annual General Meeting of the BBO. From left to right: Dr. Roberto Rocha, Dr. José Nelson Mucha (Past President), Dr. Luciano da Silva Carvalho (Vice-President of ABOR), Dr. Ademir R. Brunetto, Dr. Roberto Rocha, Dr. Deocleciano da Silva Carvalho, Dr. Telma Martins Araujo, Dr. Carlos Alberto Tavares, Dr. Jonas Capelli Jr., Dr. Carlos Jorge Vogel (Past President) and Dr. Sadi Horst.

The new directorship of the entity, for the year of 2010, is composed as follows: President-elect, Dr. Telma Martins de Araujo; Director-Elect, Dr. Ademir R. Brunetto; Chief Secretary, Dr. Deocleciano da Silva Carvalho; Treasurer, Dr. Sadi Flavio Horst; 1st Director, Dr. Eustáquio A. Araújo, 2nd Director, Dr. Roberto Rocha; 3rd Director, Dr. Carlos Alberto Estevanell Tavares; 4th Director, Dr. Jonas Capelli Junior. According to the directorship, they will continue fighting for continuing education and excellence in clinical specialty.

Jorge Faber will receive award from the American Board of Orthodontics

Jorge Faber, editor-in-chief of the Dental Press Journal of Orthodontics, is the winner of the next "CDABO Case Report of the Year, for the best case report published during 2009". His work published at the American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO) was elected by the journal's editorial board as the best case report published in 2009. The award is given by the College of Diplomates of the American Board of Orthodontics.

"I was really happy with the award for several reasons. The first is that I can bring this award to Brazilian orthodontics. The second is the fact that this prize proves the capacity of the Dental Press' editor to write an article and the third one is that it recognizes many years of dedication. This is one of the largest—or the most large—clinical premium of the world," notes Faber.

Jorge Faber will receive the award during the 110th AAO Annual Session, to be held in Washington DC, between April 30 and May 4, and he will also attend the meeting of the editorial board of the AJO-DO. "This is an excellent opportunity to disseminate our work from Brazil, especially since I will have the magazine in English in hands. It seems that things are conspiring in our favor," celebrates Prof. Faber.



Jorge Faber speaks to the audience at the 6th Dental Press International Congress, held in Maringá-PR, Brazil, in April 2009.

What's new in digital photography?

Andre Wilson Machado*

Digital photography has become ubiquitous in modern society and its importance in dentistry is unquestionable.^{3,4,5,9} This assertion is confirmed by the fact that the 2009 Nobel Prize in Physics was awarded to the inventors of the charge coupled device (CCD).¹⁰

Although this technology dates back to the 1970s and the first digital camera was launched in the market in the 1990s, the clinical use of this tool in dental offices has become a reality in the early 21st century.^{5,11} CCD allows users to view photographs on the spot, eliminating film and film development costs while systematic image management can be performed in the clinic. These features have combined to make this novel digital system extremely attractive.^{3,6} Another advantage lies in CCD's image manipulation and editing capabilities, which streamline interpersonal communication, ensuring successful results.^{2,8} Figures 1 and 2 show examples of digital manipulation assisting in outcome prediction and clinical procedure planning, respectively.

Although historically the introduction of this resource in dental practice is a recent phenomenon, digital cameras have become commonplace in most orthodontic offices. However, increasing market pressures to sell modern cameras with higher resolutions pose some important questions: What's new in digital photography? Are the "latest" cameras that boast more and more megapixels (MP) our best

choice? What's the best suited resolution for orthodontic photography?

Due to the lack of literature in this area, it might prove convenient to provide some clarification so that orthodontists can learn about the technical and scientific reasons for taking advantage, as much as possible, of the benefits of digital photography.

WHAT'S NEW IN DIGITAL PHOTOGRAPHY?

For a "recent" technology, the development of digital photography has been overwhelming. Today's professional cameras can shoot and show you the scene just photographed on a liquid crystal display, features not available prior to 2009. Another innovation are cameras that transfer data wirelessly and some can even access the Internet. It is noteworthy that since this technology is under constant development, new camera models with different features are launched in the market on a weekly basis.^{7,8}

Of all technological innovations built into these new devices, manufacturers particularly emphasize resolution,^{4,7} i.e., "more and more megapixels!". Currently, there are digital cameras with resolutions of up to 28MPs, enabling users to print images as large as 52 x 39 cm¹ in high resolution (300 dpi). This may be vital for photographers who are constantly working at high magnifications, but can dentists benefit from such high resolutions?

* MSc in Orthodontics, Pontifical Catholic University of Minas Gerais (PUC Minas). PhD in Orthodontics, São Paulo State University (Unesp/Araquara) and Professor of Orthodontics, Specialization Course, Bahia Federal University (UFBA).



FIGURE 1 - Example of image manipulation as a resource to assist in interpersonal communication: **A)** before, **B)** manipulated image and **C)** after restoration with resin.



FIGURE 2 - Example of image manipulation as an auxiliary resource in planning: **A)** before, **B)** study of the gingival area to be removed in periodontal plastic surgery and **C)** after the surgical outcome.

ARE THE “LATEST” CAMERAS THAT BOAST MORE AND MORE MEGAPIXELS (MP) OUR BEST CHOICE? WHAT’S THE BEST SUITED RESOLUTION FOR ORTHODONTIC PHOTOGRAPHY?

Resolution is directly related to final image quality and depends on the camera’s ability to capture pixels (tiny squares that make up the image).^{4,5} However, it is essential to understand that resolution, or rather, that many megapixels (MP) are not synonymous with quality.^{4,7}

Let’s envisage the following scenario: A friend returns from a trip abroad and tells you that she bought a digital camera. After hearing the news, what would your first question be? Probably: – How many megapixels is it? This word refers to how many million pixels the camera can record in one snapshot. Some 2004

publications showed that at that time cameras had a standard resolution of 3 to 5MP.^{4,7,8} Currently, you may not be able to purchase a camera with such “low” resolution because the current standard is 10 to 15MP. So what has changed? Have these cameras turned obsolete despite such high resolution numbers? Is it necessary to upgrade these cameras to have higher resolutions? Are the newer cameras any better?

To answer these questions I should start by explaining that digital camera resolution measured in MPs—the main target of manufacturer advertising—is much more related to maximum printing size than image quality *per se*.⁴ In orthodontics, most tasks involve viewing digital photos on computers and multimedia projectors and printing them with conventional equipment, specialized laboratories and scientific articles.^{2,4}

Accordingly, 3 to 5MP quality photographs would be enough to meet all these needs. For example, if two images are displayed side by side on a computer screen or multimedia projector, one with 1MP and one with 10MP resolution, they will exhibit the same quality. To give a practical example, figure 3 has 4 images, with 10, 8, 5 and 3MP and were developed in the same size on paper and using the same system. Which one has better quality? There is no difference! In fact, they have different MPs. However, when they are printed on paper they will appear in the same 300 dpi (dots per inch) resolution. The moral of the story is that: "Size does not matter", or rather, resolution is not synonymous with quality.

This can be very confusing, even for the scientific community. Some journals mistakenly require in their information for authors that digital images be submitted from maximum resolution digital cameras. Others specify values like "a minimum of 8MP". Unfortunately, this is a huge mistake because the default resolution standard for print images should be given in dpi, not MP. As an example of appropriate characterization of these images, Dental Press Journal requires 300 dpi images, which can have 3, 5, 7, 10, 15 or more MPs. However, when printed on paper, all will now have 300 dots per inch.

To simplify this concept we can use the following analogy.⁴ Picture yourself in a car in a bumper-to-bumper traffic jam. The maximum speed feasible at this time is 20 mph but you are driving a vehicle that can reach a top speed of 160 mph (a Ferrari, for example). What is the advantage of such potential staggering speed in these circumstances? None other than the fact that you're driving a Ferrari, of course! Unfortunately, despite the car's speed capabilities you cannot use this feature at this time. The same applies to image resolution. A 10MP photograph has thousands of pixels but just as the car cannot exceed 20 mph the image will not show

10 million pixels but only the maximum computer screen resolution, which varies between 1 and 2MP. On the other hand, just as a car can reach higher speeds on a racetrack you can use higher resolutions in other situations.

In such cases, if you own a 12MP camera for example, you can cut up an image into small pieces and magnify them while still maintaining its original high quality. It should be underscored, however, that high resolution photos may seem "heavy" or "slow", hindering computer performance, especially during multimedia presentations.⁴ For example, the image shown in Figure 3D is eight times smaller (in bytes) than 3A, although both exhibit the same standard of quality.

The ideal would be to use images with a good quality/file size ratio.⁴ To do this, I suggest the purchase of a digital camera compatible with the current standard market, typically featuring 10 to 15MP. However, the device should be adjusted to work at lower resolutions (5MP, for example) to meet the needs of routine orthodontic practice with a high standard of quality. In some specific situations, such as when you need to develop larger sized photos, e.g., a poster or banner, the camera can be once again adjusted to take higher resolution pictures.

What about the question posed earlier? Have "older", lower resolution devices been rendered obsolete in view of the resolution power of "recent" DSLR cameras? Technically and scientifically, the answer is no. The analysis shown in Figure 3 demonstrates the high applicability of resolutions lower than the current 10 to 15MP standard, provided that they conform with the 300 dpi specification.

The truth of the matter is that manufacturers need to sell their products. In their view, it is convenient to create a number system whereby consumers are led to believe that "the higher the number the better the quality", and just keep on buying.

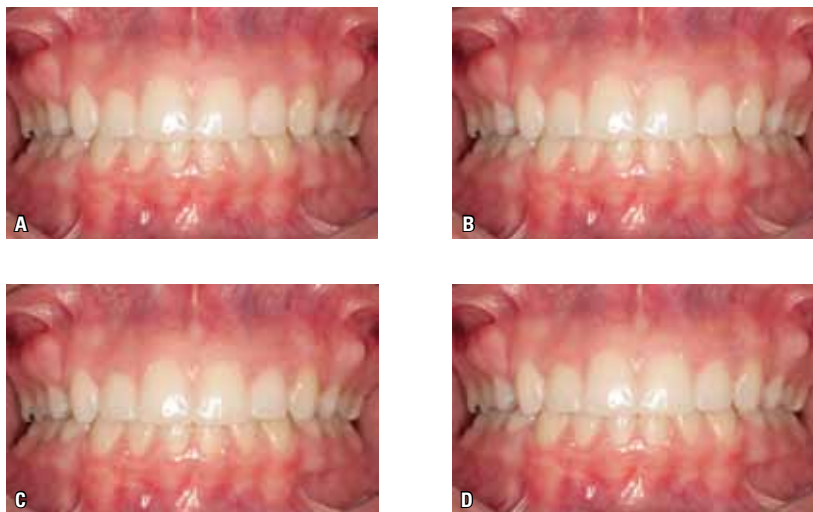


FIGURE 3 - Example of using the same image with different resolutions and therefore different file sizes: **A)** 10 MP (3,869 Kbytes), **B)** 8 MP (3,239 Kbytes), **C)** 5 MP (667 Kbytes) e **D)** 3 MP (483 Kbytes).

FINAL CONSIDERATIONS

“Novelty” is an essential component of society’s evolution. Nevertheless, it is important to remember that behind any “novelty” the ultimate goal is not always “to make something better” or “to improve the quality of something”. The major goal, more often than not, is profit. In digital photography, companies are not concerned with the needs of orthodontists when they launch new

digital cameras. Their actual focus is on photographers, whose market is always hungry for innovations. The 21st century orthodontist should possess not only scientific and technical knowledge but also the insight to discern when “novelty” is likely to bring tangible benefits.

On a final note, here is my appeal to the readers: Go on taking photos! Take full advantage of these resources! They will surely prove invaluable!

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ERM functions, EGF and orthodontic movement

or

Why doesn't orthodontic movement cause alveolodental ankylosis?

Alberto Consolaro*, Maria Fernanda M-O. Consolaro**

Can orthodontic movement induce alveolodental ankylosis? This question is often asked and the answer involves further questioning: *Why don't the teeth naturally evolve to alveolodental ankylosis if they are separated from the bone by only 0.2 to 0.4 mm (the minimum and maximum thickness of the periodontal ligament)?*

The periodontal ligament is richly cellularized and vascularized, featuring numerous elastic and reticular collagen fibers, typical of connective tissues (Figs 1, 2 and 3). In between these structures it has a "gel", namely, the extracellular matrix. Among the fibers, fibroblasts, vessels and nerves of the periodontal ligament there is a network of epithelial cords and islands that continuously release mediators, especially EGF, i.e., Epithelial or Epidermal Growth Factor (Fig 2). Areas on the surface of the bone tissue that contain EGF stimulate bone resorption, hindering

the formation of new layers. This epithelium network interposed between bone and tooth in the ligament tissue is known as Epithelial Rests of Malassez (ERM), derived from apoptosis in Hertwig's Epithelial Root Sheath (HERS). Malassez' original drawings (Fig 4) depicted these epithelial cords and islands in the same manner as we analyze them microscopically today.

It was long believed that ERM comprised latent or quiescent cells devoid of structure and function, often associated with the genesis of cysts and tumors. However, these epithelial periodontal components are active, produce mediators and fulfill key functions in maintaining periodontal health and root integrity even during orthodontic movement.

In this paper we will discuss these wonderful structures and their functions to assist us in understanding the relevant responses to the two questions posed above.

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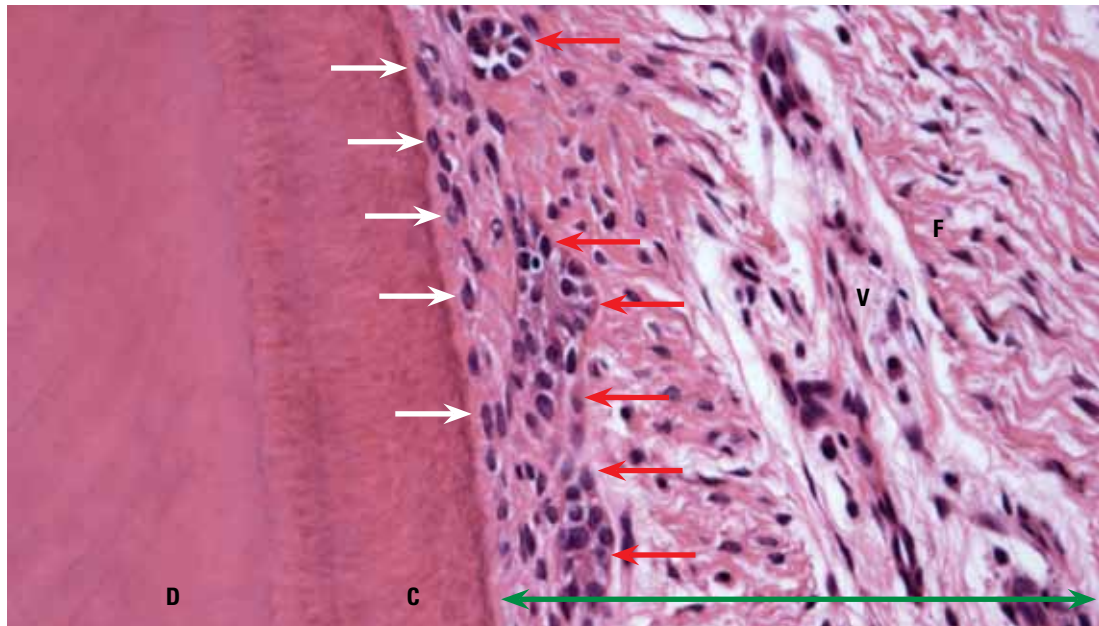


FIGURE 1 - On the root surface the cementum is covered by cementoblasts (**white arrows**). Collagen fibers—called Sharpey's fibers—penetrate amid these cells and attach themselves to the cementum (**C**). In the periodontal ligament (**green arrow**) epithelial cell islands and cords can be observed (**red arrows**) which form a three-dimensional network around the root, like a basketball hoop. This epithelial component of the periodontal ligament, called Epithelial Rests of Malassez (**red arrows**), constantly releases Epithelial (or Epidermal) Growth Factor (EGF), whose molecules diffuse through the cells in the extracellular matrix and stimulate osteoclasia on the periodontal bone surface, thereby promoting the maintenance of periodontal space (**D** = dentin; **F** = fibroblasts; **V** = blood vessels. HE; X25).

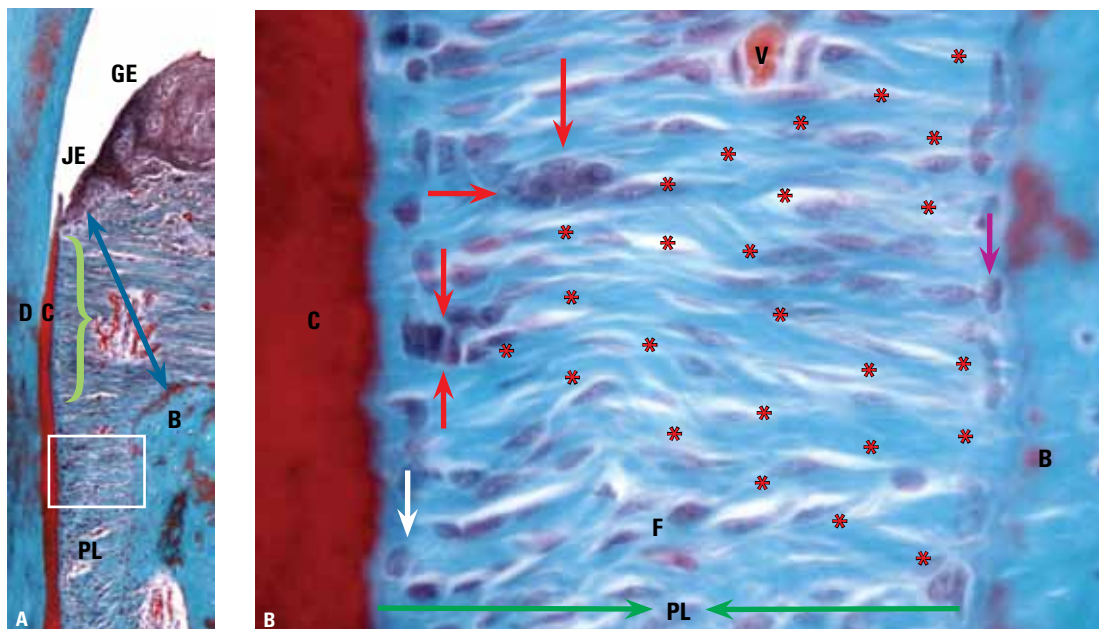


FIGURE 2 - Epithelial Rests of Malassez (**red arrows**) continuously release—for their maintenance and function—EGF molecules (**asterisks**) that diffuse throughout the extracellular matrix among the fibroblasts (**F**) and upon reaching the bone surface (**B**), stimulate osteoclasia to maintain the periodontal ligament (**PL**). **A** highlights the distance from the gingival (**GE**) and junctional (**JE**) epithelium to the alveolar bone crest (**blue arrow**), showing enough space for the EGF molecules to diffuse and be metabolized without causing underlying bone resorption. The **green curly brace** encompasses the connective attachment (**white arrow** = cementoblasts; **purple arrow** = osteoblasts; **C** = cementum, **D** = dentin; **V** = blood vessel. Masson's Trichrome Stain, X10).

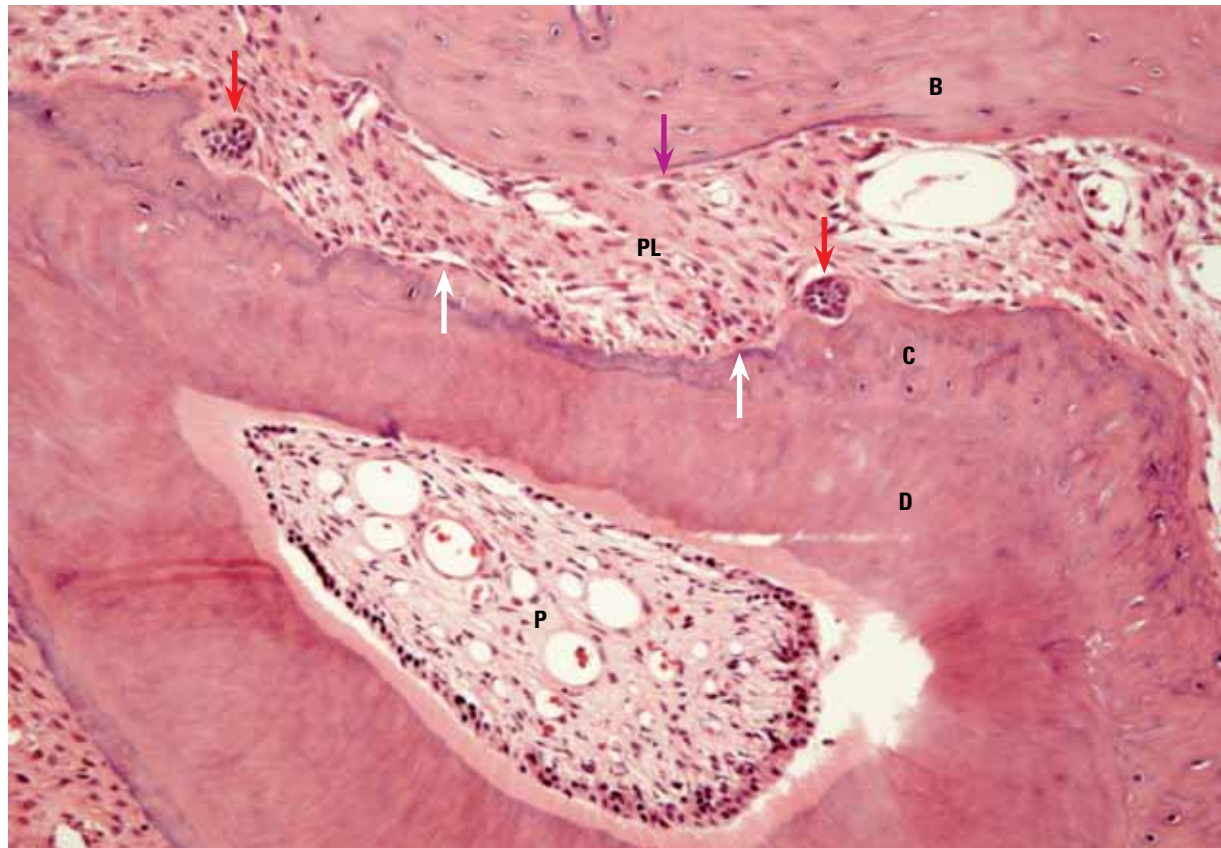


FIGURE 3 - Epithelial Rests of Malassez (red arrows) stand out throughout the process of periodontal ligament (PL) reorganization during induced tooth movement and are usually associated with the repair of resorbed areas and with cementogenesis. This tooth appears as shown here after 7 days of experimental induced tooth movement in murines (white arrows = cementoblasts; purple arrow = osteoblasts; C = cementum; D = dentin; B = alveolar bone, P = pulp. HE; X10).

Epidermal Growth Factor (EGF)

History and functions

Cells release EGF mediators to regulate and stimulate proliferation and differentiation, especially in epithelia.^{10,11,15} EGF's presence in the body and in various body fluids is ubiquitous. It is found in urine (100 µg/ml), milk (80 µg/ml), saliva (12 µg/ml), plasma (2 µg/ml) and amniotic fluid (1 µg/ml). The gene that controls EGF production in humans is on chromosome 4 and its molecule contains 53 amino acids with a molecular weight of 6,045 daltons. This molecule remains stable even in hot environments.

The specific receptors for this polypeptide (EGFr) consist of transmembrane proteins divided into three parts: extracellular, transmembrane and intracellular.^{15,16} When EGF binds to the extracellular part of the receptor, the intracellular portion activates tyrosine kinase and triggers cascading events that culminate in mitosis.^{10,11,12} EGFr is present in epithelial cells of sites with high and low cell proliferation, high or low degree of differentiation.²⁵ Other mediators also bind to EGFr but induce different effects than those of EGF such as, for example, transforming growth factor alpha or TGF- α . EGF receptors are part

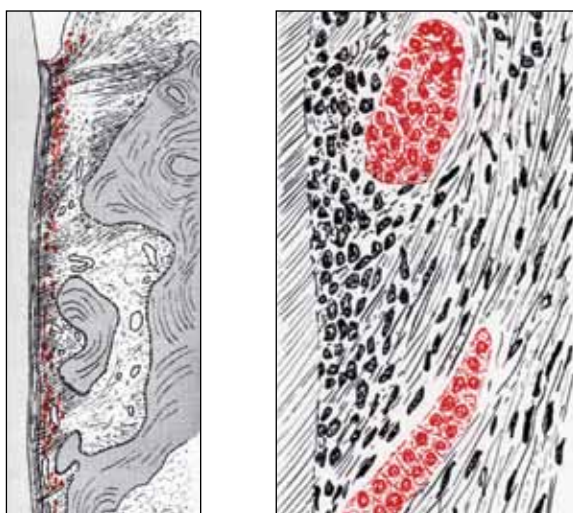


FIGURE 4 - Epithelial Rests of Malassez (in red) in the periodontal ligament, redrawn from the original L. Malassez drawings (published in Arch Physiol Norm Pathol. 1885; 5: 309-340 6: 379-449) and republished by Racadot and Weil⁴⁷ in 1966.

of a family of membrane receptors commonly referred to as EGFR1 or ERB B1. Receptor ERB B2, also known as HER-2/Neu, has attracted considerable attention because it is overexpressed in breast cancer and has been considered a therapeutic target.⁴¹

EGF receptors are present in all oral tissue epithelia,⁵⁸ including the junctional epithelium.⁴⁵ In other cells such as fibroblasts and endothelial cells EGF also appears to act as a mitogen. However, EGFR has not been detected in pulp and periodontal tissues,⁵⁸ but EGF molecules have been detected in the interstice of oral submucous connective tissue.⁴²

Since it was first reported in 1962, EGF has played a role in regulating dental eruption and development.^{34,35,49,51} The first description of EGF was provided by Stanley Cohen,¹⁵ who identified it in the submandibular glands of rats, aiding in the acceleration of incisor eruption and the opening of newly-born rats' eyes. Cohen was awarded the Nobel Prize in Medicine and Physiology in 1986.²⁰ In 1989, Greg Brown patented EGF for cosmetic use.^{8,53}

The physiological importance of EGF in maintaining the integrity of oral tissues, both esophageal and gastric,¹⁹ is substantial. By way of the saliva it helps to repair esophageal and gastric ulcers, inhibits gastric acid secretion and also stimulates DNA synthesis while protecting the mucosa against aggressive factors such as gastric acid, bile, pepsin and trypsin and against physical and bacterial agents.⁵⁴ EGF stimulates mitosis in a variety of cell lineages such as the epithelium, fibroblasts, chondrocytes, endothelium, smooth muscles and hepatocytes. Fibroblasts have 40,000 to 100,000 EGF receptors per cell. EGF stimulation requires the activity of at least 25% of those receptors.

EGF plays an essential role in tissue repair. In humans most of this substance is associated with platelets. It is synthesized by megakaryocytes in the bone marrow³ and released in the process of blood coagulation.²⁹ A large amount of EGF can be recovered from urine but it is almost entirely produced in the kidneys.

The presence of EGF in saliva and its properties may explain some procedures adopted since 2,000 years ago in ancient Greece, when they applied snake saliva to open wounds to promote and accelerate tissue repair.² When EGF is produced in the salivary glands⁵⁰ it is excreted directly into the saliva.^{28,36} On epithelial surfaces it stimulates the proliferation, differentiation, organization and keratinization of the superficial layers in the regenerative process of skin and mucosa ulcerations.^{8,31}

A veritable EGF avalanche flows into the saliva after periodontal surgery and removal of impacted third molars.^{32,33} This EGF increment is a response to the need to increase proliferation and differentiation, both phenomena typical of repair and regeneration. Ohshima et al³¹ also pointed out that salivary EGF stimulates epithelial cells to proliferate and migrate to surfaces that need lining.

EGF is linked to cancer etiology and pathogenesis given its ability to boost DNA synthesis and stimulate cellular proliferation.²⁴ Thus, some medications are primarily aimed at inhibiting EGF receptors in the oncological treatment of certain neoplasias. Monoclonal antibodies are substances used for this purpose.

In particular, EGF has shown a potent activity in inducing bone resorption,^{38,47} including in osteoclastogenesis.⁶⁰ In mice deficient in EGF receptors endochondral ossification proved to be severely altered by a defect in the recruitment of osteoclasts.⁵⁷

EGF and biological distances

Nowhere in the human body is the epithelium a direct neighbor of bone tissue. Between epithelium and bone tissue there is always some connective tissue whose thickness and degree of fibrosis vary according to the different body parts (Figs 1 and 2).

The connective tissue interposed between epithelium and bone tissue may serve as a dilution and metabolism site for EGF, preventing it from reaching bone cell receptors in a high or average concentration, thereby stimulating osteoclastogenesis and the resulting bone resorption^{38,47,60} (Fig 2). Every molecule has an average life and tends to be metabolized by enzymes and other products of cell and tissue metabolism. Molecules remain intact and capable of interacting with their receptors for a few seconds or minutes. Thus, we can explain why the spaces between epithelium and bone are usually constant or stable in the human body such as between the junctional epithelium and the alveolar bone crest or between the gingival mucosa and the alveolar bone cortex (Fig 2).

On the internal contour of the marginal gingival tissue toward the cervical portion of the tooth there are three vertical structures whose

dimensions are known as "biological distances": (a) Sulcus epithelium, (b) Junctional epithelium, and (c) The area of connective tissue attachment located in the root portion, positioned coronally to the alveolar bone crest²¹ (Fig 2).

The junctional epithelium and connective tissue attachment comprise the *dentogingival complex*.⁴³ These structures have a constant mean vertical dimension and were described by Gargiulo et al,²¹ who reported a microscopic analysis of the dimensions and characteristics of the dentogingival junction in humans during the four phases of passive tooth eruption. 325 sound surfaces were obtained from human cadavers and analyzed, showing the following periodontal structure dimensions:

- Mean sulcus length: 0.69 mm;
- Mean junctional epithelium length: 0.97 mm;
- Mean supra-alveolar connective attachment length: 1.07 mm (Mean connective attachment length proved to be the most consistent measure).

When in an operative or restorative procedure the connective attachment—which is the biological distance between the junctional epithelium and the alveolar bone crest—is "encroached upon", after a few days or weeks there will be noticeable resorption and loss of cervical bone level in the apical direction. This surgical encroachment of the biological space induces the junctional epithelium to proliferate and grow hyperplastically in order to keep the dentogingival junction cervically at a more apical level. In other words, the junctional epithelium will move closer to the bone crest, and as it continuously produces EGF to maintain its structure under constant cell renewal, the concentration of this polypeptide increases to nearly bone level, stimulating bone resorption and lowering the alveolar bone crest. This mechanism also plays a key role in bone loss during periodontitis in

conjunction with other cellular stress and inflammation mediators.

ERM functions and EGF

EGF's ability to stimulate clast production, bone resorption and epithelial proliferation allows us to understand the function of the epithelial cords and islands that remain in the periodontal ligament (Figs 1 and 2) even after complete root formation. This component of the periodontal ligament is called Epithelial Rests of Malassez (ERM).

The three-dimensional configuration of ERM resembles a basketball hoop embracing the entire root portion of the tooth located inside (Fig 1). These are cords and islands 4 to 8 cells wide by 20 cells long, on average, which release EGF to enable their cells to self-stimulate, proliferate and maintain their structure.^{18,21,52} Additionally, ERM cells release prostaglandins.^{5,6,9,26,56}

When cells release mediators that act on their similar neighbors of the same lineage, this is called autocrine effect. When released mediators act on neighboring cells of different lineage, this effect is called paracrine. EGF produces both autocrine and paracrine effects, i.e., it affects identical, neighboring cells and other nearby cells of different lineages.

In the periodontal ligament there is a constant release of EGF by ERM cells which, given their proximity, will induce resorption of the periodontal alveolar bone surface while ensuring that human periodontal space remains within a range of 0.20 and 0.40 mm thickness, i.e., 0.25 mm or 250 µm, on average.

ERM stem from Hertwig's Epithelial Root Sheath (HERS), arising from the enamel organ when its production ceases in the cervical region of a tooth germ (future tooth). As Hertwig's epithelial root sheath—a true epithelial skirt hanging out on the formed crown—is fragmented by apoptosis, the programmed

persistence of some cells occurs, whereby these cells remain in the form of epithelial islands and cords.

These epithelial islands and cords in the periodontal ligament were first described by Serres, in 1809, who believed they disappeared in adulthood,^{26,27,37,43,55} but in 1885 Malassez insisted that they remained for life,^{26,27,37,43,55} as was later shown to be true.

For many years it was believed that ERM cells were only involved in generating disease mechanisms, such as periodontal pockets and periodontal cysts. EGF receptors were also detected among ERM cells⁴⁸ denoting that these structures are active in the periodontal ligament.

For many decades ERM functions were unknown, but now it has been found that ERM cells:

1. Act in maintaining the periodontal space, avoiding alveolodental ankylosis^{26,27,56} through the continuous release of EGF (Fig 2). It is common for dental traumas to evolve into dental ankylosis due to the destruction of ERM cells. During orthodontic treatment alveolodental ankylosis does not occur because ERM cells are not destroyed during induced tooth displacement.^{21,46,52}
2. Participate in the process of periodontal ligament reorganization (Fig 3) by, among other benefits, protecting the areas where root resorption occurred and stimulating cementogenesis.^{4,7,30,39,55}
3. Participate in the induced tooth movement by increasing EGF production in periodontal tissues and helping to repair root resorption areas while stimulating cementogenesis^{4,7,18,21,30,52,55} (Fig 3). On periodontal bone surfaces during induced tooth movement ERM cells play an active part in osteoclasia as they stimulate the release of EGF and prostaglandins. Studies also show that EGF stimulates osteoclastogenesis.

4. Contain Merkel cells (Friedrich Sig-mund Merkel, 1845-1919, a Germanic anat-omist. The Germanic anatomist that gave the name to the Meckel's Cartilage was Johann Friedrich Meckel, 1781-1833) in their struc-ture and can release neuropeptides endowed with neurosensorial functions.^{44,59}

ERM cells are not quiescent because when placed in cell cultures they secrete various types of proteins, peptides⁹ and prostaglan-dins.^{5,9} The latter are important bone resorp-tion mediators. Experiments show that when placed in cell cultures epithelial cells con-tinue to secrete mediators that induce bone resorption, even when indomethacine—an inhibitor of prostaglandin production—is introduced in the same environment. These results suggest that other factors account for ERM's ability to induce bone resorption,⁵ especially EGF, or Epidermal Growth Factor, as demonstrated *in vivo* by Lindskog, Blomlöf and Hammarström²⁶ in 1988.

Isolated neuroendocrine cells known as Merkel cells are present in the basal layer of skin and mucous membrane epithelia. These cells can secrete specific mediators such as Calcitonin Gene Related Peptide (CGRP), Substance P (SP) and Vasoactive Intestinal Peptide (VIP). Immunocytochemical studies have revealed that ERM also contain Merkel cells that can secrete these mediators locally.⁴⁴

ERM, EGF and Orthodontic Movement

During orthodontic movement intense bone resorption occurs, increasing the amount of EGF and ERM cells.¹⁸ Through-out the orthodontic movement the oral mu-cosa secretes an increased amount of media-tors such as cytokines and growth factors, and especially EGF, presumably to facilitate tooth movement.^{23,52}

Induced tooth movement stimulates ERM cell proliferation, enhancing their proliferative

capacity and size while facilitating periodon-tal ligament tissue renewal (Fig 3) and tooth displacement^{22,46} as a result of bone resorption stimulation. ERM cells are present in orthodon-tic movement in humans and play a part in periodontal ligament reorganization, including in areas where root resorption has occurred.^{7,30} EGF involvement in induced tooth movement has been confirmed by some studies that in-creased the amount of EGF in periodontal tis-sues by drawing it from liposomes.^{1,40}

Mature cementoblasts have been shown to not have EGF¹⁴ receptors. The evidence suggests that progenitor cells in the peri-odontal ligament—when evolving to give rise to fibroblasts—maintain EGF receptors but when progressing to mature cemen-to-blasts they no longer keep such structures in their membrane.¹³

During orthodontic movement ERM cells do not die or disappear but rather remain ac-tive and stimulated to proliferate and produce mediators that assist in tissue reorganization, cementogenesis and repair of any root surface that might have suffered resorption (Fig 3). There are no grounds to support the possibil-ity of alveolodental ankylosis happening as a result of induces orthodontic movement.

Final considerations

Cementoblasts "hide" root turnover be-cause they have receptors for mediators in-volved in bone turnover and ERM cells keep periodontal bone tissue away from the root by releasing osteoclasia inducing mediators—such as EGF. This mechanism for maintenance and functioning of human periodontium can be fractured in cases of trauma when large ce-mentoblasts and a significant part of the ERM network succumb to necrosis. If this happens, alveolodental ankylosis may ensue.

But in orthodontic movement damage to the cementoblast layer and to ERM are

incomparably lower—in both extent and severity—than in dental trauma. Extensive loss of epithelial components has been reported in moderate and severe trauma, whereas in induced tooth movement studies show increased ERM proliferation and secretory capacity. The exuberant and rapid proliferation capacity of epithelial tissues and the spatial configuration of the periodontal epithelial network enable a speedy structural recovery and may explain ERM's major role in periodontal reorganization after minor trauma and, in particular,

during induced tooth movement.

In clinical practice, if a tooth presents with alveolodental ankylosis during or after orthodontic treatment it seems more logical and well grounded in the literature to establish a causal diagnosis of dental trauma—even if the patient is unable to report it during anamnesis—than to ascribe such ankylosis to induced tooth movement. Orthodontic movement does not promote ERM necrosis. On the contrary, the evidence shows that ERM cells are stimulated in this clinical situation.

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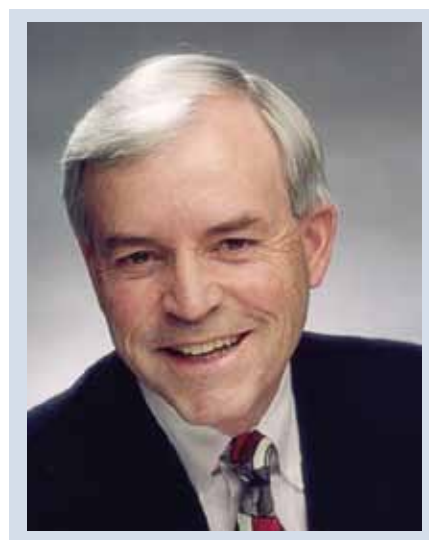
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An interview with

David L. Turpin (editor-in-chief of the AJO-DO)

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- Diplomate from the American Board of Orthodontics.
- Editor of the American Journal of Orthodontics and Dentofacial Orthopedics.
- Editor of the Bulletin of the Pacific Coast Society of Orthodontics from 1978 to 1988.
- Editor of Angle Orthodontists from 1988 to 1999.
- Clinical Professor, Department of Orthodontics, University of Washington – Seattle.
- Author of more than 150 editorials, scientific articles and book chapters.



Dr. Turpin attended dental school at the University of Iowa located in the Midwest, then gained entrance as a resident in orthodontics to the University of Washington in Seattle. His primary goal was to study under the guidance of Alton W. Moore, then Chair in Seattle. Upon graduation in 1966, he started a private practice, returning to the University of Washington 4 years later to teach part time in the clinic. He has been married to Judith Clark Turpin for 48 years. They have three children and three grandchildren, ages 8 to 19. He has spent most of his spare time traveling widely during the past 10 years, so that may qualify as a current hobby. At the moment he is reading a book named, 'The Tipping Point' by Malcolm Gladwell and plan to start Dan Brown's 'The Lost Symbol' shortly.

Dr. Turpin has worked on orthodontic journals for over 30 years—from his early days on the Bulletin of the Pacific Coast Society of Orthodontists, to The Angle Orthodontist, and finally the American Journal of Orthodontics and Dentofacial Orthopedics. He will retire as editor-in-chief of the AJO-DO at the end of 2010 when Dr. Vincent G. Kokich will become the new editor.

Jorge Faber

What, in your opinion, is the direction orthodontics is likely to take in terms of diagnosis in the next 10 years? Flávio Cotrim

I believe practitioners who start with a sound orthodontic education, strive for Board certification and strive to establish an 'evidence-based practice' will be seen by the public as the most successful. Involvement in the community as well as clinical teaching are also attributes that will always improve clinical abilities. I know that when I look for a new specialist in medicine, this is the type of professional I search for.

I enjoyed the private practice of orthodontics in a small town near Seattle, Washington, for nearly 38 years. Throughout my graduate school education and for years after as I taught part-time at the University, I always believed that early orthodontic treatment was good and the longer I treated someone, the more effective I was at correcting almost any malocclusion. Several years ago as Editor of the AJO-DO I started receiving articles relating to the inefficiency of correcting Class II skeletal problems with two-phase treatment over a period of many years. More specifically these were the randomized controlled trials from the University of North Carolina and from Manchester, England. At first I wanted to dismiss them as possibly sensational, not related to the way I treated patients. I was confident that the early interception of Class II malocclusion was effective in reducing overall treatment time, the need for extractions, and it achieved better treatment outcomes. When the skeletal disharmony was great, I promised some patients that we might be able to overcome the need for jaw surgery—even when the patient's mother or father had already experienced orthognathic surgery years earlier.

But as time passed, other studies continued to report similar findings and I began to look more closely at my own treatment outcomes, comparing them more specifically to the UNC study. I began to see that a certain percentage of my Class II patients required a long 2nd phase of treatment and some of the patients I treated the longest did not always have the best results.

Could I learn something from these long-term studies? I began to realize that two-phase treatment for Class II skeletal problems is often effective, but it may not always be the most efficient and may not even be necessary in every instance. I know realize we obviously have a broader range of times when patients can be treated and much of this timing depends upon other factors, such as development of the dentition, the presence of injurious habits, physical maturation, psychosocial factors, etc.

Following up on the previous question, what is the most likely evolutionary path of orthodontic mechanics? Flávio Cotrim

The use of miniscrews will continue to have a major impact on treatment planning for years to come. Based on more recent studies, the use of mini-plates is beginning to show greater change in skeletal relationships than once thought possible. The use of lingual appliances for a specific percentage of the population will also grow in use, especially in the larger cities. My opinion is that those companies that stress shorter and shorter treatment times at the expense of high quality outcomes will not maintain their popularity with the public. In the future patients will be even more demanding of quality than in the past and those who cannot deliver will not remain in business. There are people who claim that much of the published literature is poor and therefore deserves to be ignored... justifying the use of any modern treatment methodology that comes along. I have never gone along with that philosophy, noting that we can learn a great deal from the past. In fact, the highest levels of research findings published today are currently endorsing many of the principles of treatment practiced by orthodontists for the past 50 years. One such example is a meta-analysis published by Burke et al¹ in 1998, where the authors note in summarizing 26 long-term studies of mandibular intercanine width... "Overall, this meta-analysis supports the concept of maintaining initial intercanine width in orthodontic treatment."

From your vantage point, what areas of orthodontic practice are most deprived of in-depth studies? Flávio Cotrim

We need more prospective controlled clinical trials to answer the 'real concerns' of today's practitioners. Some of these studies should be continued for years by a series of investigators with the goal of providing the long-term findings so badly needed. People who have gradually started treating more of their patients nonextraction by expanding the dentition beyond the norm should be first in line to support such research. Plans have been underway to do just this type of research by the Universities of Washington and Oregon in what is called the Precedent Program. Thus far nearly 60 private offices have volunteered to participate in following a protocol set by university biostatisticians for a series of prospective trials to answer the questions agreed to by these involved offices. As digital progress records are gathered and regularly transferred directly to the universities for analysis, sample sizes will increase and potential biases strictly controlled. This is one direction I see as being productive for orthodontic research in the future.

Please envisage the following scenario. A well-designed randomized clinical trial is published in a journal such as the AJO-DO, and this work strongly suggests a paradigm shift in clinical decision-making. What is your perception regarding the difficulties and speed with which such information will reach clinical orthodontists and ultimately benefit patients? Flávio Cotrim and Jorge Faber

It seems that any major change in practice dynamics takes 5 to 10 years to be fully assimilated. For example, the use of miniscrews has been around that long and we finally have the research studies in large enough numbers to support their use by more than 50% of all practicing orthodontists.

According to data provided by CAPES (Brazilian public institution that evaluates

graduate teaching and personnel), Brazil produces 9% of all dental literature in the world. Do you believe this is also the case in orthodontics? In other words, how do you analyze quantitatively and qualitatively Brazilian scientific publications in orthodontics? Flávia Artese

If orthodontic web site hits mean anything, I can believe the influence of Brazil orthodontic research and clinical activity may be in the realm of 9-10%. This is also a reflection of the large number of teaching programs now active in the Brazil.

Communications have changed dramatically after the digital revolution. We have seen a few changes to this effect in the AJO-DO online only publications. How do you see the possibility of a 100% digital journal in the future? Flávia Artese

The answer to your question is basically 'unknown'. It is obvious every year that increasing numbers of our subscribers prefer to search for articles online, and refer to their print journals less and less often. Within 5 years I am quite sure more members will read their journal on an electronic reader, like the Kindle, than will pick up a printed and bound copy to leaf through while sitting in a comfortable chair by the fireplace. But will the hardcopy be gone forever...I simply don't know.

The speed with which new information is produced has also changed in the last decade. Nowadays, in your opinion, what do professionals need in order to keep up to date while practicing efficiently and safely based on evidence? Flávia Artese

To understand the answer to this excellent question, I have always looked to my peers for the secrets of success. I see them joining and actively participating in study clubs as soon as they start practice. If the members continually challenge each other to improve many of these study clubs remain active for years and years.

If the members continually challenge each other to improve. I see them studying to become Board certified as soon as it is possible. Then with these hurdles conquered, I see these same peers taking on responsibilities to teach, lecture and even publish evidence of their specific expertise. They might volunteer to be a scientific journal reviewer and in doing so, will continue to learn how to become a better practitioner. As you can tell, your peers have much to offer if you are ready to look and listen.

I have been keeping track of editorials, commentaries and papers that have been recently published in the AJO-DO regarding the value of RCTs in scientific evidence. Have you noticed any changes in the quality of manuscripts submitted to the AJO-DO in this respect? Are the researchers in orthodontics trying to meet this need? Flávia Artese

Independent review is an important step in the publication process of many scientific journals, including some dental journals. One of the reviewer's challenges is to identify sources of bias in research. Bias can easily creep into a study in any number of ways. For example, if a study is not properly blinded, the person measuring outcomes can inadvertently introduce bias. Financial conflicts of interest might also play a role. When planning a scientific study, it is of utmost importance that a biostatistician be involved at the very beginning. It is amazing to me how many authors conduct an impressive study and submit a manuscript without every having completed a power determination to calculate the number of subjects required for statistically significant conclusions. This must be determined prior to initiating the study, not after gathering the data from the available subjects. Most journals say they believe in relying on independent review. How thorough they are in carrying that out is the concern.

What were the major changes you witnessed in orthodontics during the years you

were Editor-in-chief of orthodontic journals? Flávia Artese

Under the guidance of Vince Kokich, we have standardized the publication of case reports. With strictly enforced guidelines, case reports submissions have increased in both quality and number.

Vince works with each author to get their best work for the journal. With help from Michael Rennert, we moved the Journal's continuing education program to the AAO and made it available online, allowing for immediate grading and awarding of the appropriate continuing education credits. Thanks to our publisher, Elsevier, we moved to an electronic manuscript submission and review process. This has greatly speeded up the review process, and made the submission and review process available to many orthodontists around the world. Last year we received nearly 1,000 new submissions—compared with about 200 per year a decade ago. Our international prominence has expanded, while our manuscript acceptance rate has fallen to less than 30%. In 2006 we added the AJO-DO Product Resource Guide as a supplemental issue every April, providing a member benefit as well as additional revenues. With 13 issues published each year, we produce more pages of refereed scientific material than any other orthodontic journal. The AAO has successfully limited the increase in cost per/member to only \$3 over the 10-year period. To help deal with the growth in submissions, we expanded the use of associate editors, noted for their specific areas of expertise. Associate editors appoint reviewers, evaluate reviewers comments, make recommendations, and evaluate revised submissions. This expansion is still ongoing. Most recently, we initiated the abridged 2-page format for research studies, aimed at reducing the current publication delay while also giving the Journal a more clinical appearance.

When planning a study, what are your main tips for aspiring authors at the time of

writing a manuscript? Jorge Faber

When planning a scientific study, it is of utmost importance that a biostatistician be involved at the very beginning. It is amazing to me how many authors conduct an impressive study and submit a manuscript without every having completed a power determination to calculate the number of subjects required for statistically significant conclusions. This must be determined prior to initiating the study, not after gathering the data from the available subjects.

To assist in meeting the challenge of conducting a systematic review, be aware that the CONSORT (Consolidated Standards of Reporting Trials) guidelines are developed by a team of dedicated journal editors, epidemiologists, and statisticians. CONSORT (www.consort-statement.org) comprises a checklist and flow diagram to help improve the quality of reports of randomized controlled trials (RCTs). The QUOROM checklist and flow diagram are available (www.consort-statement.org/consort-statement/overview/) for those with an interest in the field of meta-analysis. Moose (Meta-analysis of Observational Studies in Epidemiology) (2000) is also used for conducting meta-analyses of observational studies. SORT (Strength of Recommendation Taxonomy) (2004) is another tool for rating individual studies and bodies of evidence.

When writing the introduction to the topic, be thorough enough to include the major studies published, but strive to keep it relatively short. Accurately report prior findings of the best studies, yet make it clear why another study is needed now. When reporting experiments on human subjects, authors should indicate whether their procedures were in accordance with the ethical standards of the responsible committee on human experimentation and the Helsinki Declaration of 1975, as revised in 2000. When reporting experiments on animals, authors are asked to indicate whether the institutional and national guidelines for the care and use of laboratory animals were followed.

Structured abstracts of 200 words or less are

preferred with every manuscript. A structured abstract contains the following sections: Introduction, describing the problem; Methods, describing how the study was performed; Results, describing the primary results; and Conclusions, reporting what the authors conclude from the findings and any clinical implications.

The manuscript proper should be organized in the following sections: Introduction and literature review, Material and Methods, Results, Discussion, Conclusions, References, and figure captions. Please record measurements in metric units whenever practical. Refer to teeth by their full name or their FDI tooth number. Nearly all journals now require electronic submissions and to only one journal at a time for review.

When an author's work is rejected by an editor, what sort of attitude would you recommend to authors in light of this negative response? Jorge Faber

All of the most highly respected educators and department chairs I know have had at least one manuscript rejected and they have learned from the experience. Manuscripts can be rejected for a variety of reasons, most are not personal and many have little to do with the abilities of the corresponding author. Articles can be rejected by an editor because the journal has already published similar studies, because they are better suited for a different type of journal, or simply because they are too long and not well-written. However, the most common reasons for rejection are a lack of statistical rigor due to small sample sizes and the presence of either real or perceived bias. Yes, bias is always present to some extent, but the good scientist works hard to minimize bias at every turn with a sound study design. It can be done and the effort is rewarded by every editor I've ever worked with.

Your tenure as chief editor of the AJO-DO is nearing its end after so many years of dedication to orthodontics. What are your

future plans? Jorge Faber

With conclusion of the 7th International Orthodontic Congress in Sydney, Australia, I expect to begin a 5-year term as a member of the WFO Executive Committee, joining Tom Ahman and Amanda Maplethorp representing North America. I look forward to working with Roberto Justus (Mexico City) who will succeed Athanasios Athanasiou as president of the WFO and William DeKock (Cedar Rapids) who will continue as secretary-general. I also have 3 grandchildren who live on the East Coast, so expect a few more trips in that direction will be in order. Of course, when called upon I will always be available to help the next editor of the AJO-DO in any way possible.

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Superimposition of 3D cone-beam CT models in orthognathic surgery

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Abstracts

Introduction: Limitations of 2D quantitative and qualitative evaluation of surgical displacements can be overcome by CBCT and three-dimensional imaging tools. **Objectives:** The method described in this study allows the assessment of changes in the condyles, rami, chin, maxilla and dentition by the comparison of CBCT scans before and after orthognathic surgery. **Methods:** 3D models are built and superimposed through a fully automated voxel-wise method using the pre-surgery cranial base as reference. It identifies and compares the grayscale of both three-dimensional structures, avoiding observer landmark identification. The distances between the anatomical surfaces pre and post-surgery are then computed for each pair of models in the same subject. The evaluation of displacement directions is visually done through color maps and semi-transparencies of the superimposed models. **Conclusions:** It can be concluded that this method, which uses free softwares and is mostly automated, shows advantages in the long-term evaluation of orthognathic patients when compared to conventional 2D methods. Accurate measurements can be acquired by images in real size and without anatomical superimpositions, and great 3D information is provided to clinicians and researchers.

Keywords: Cone Beam Computed Tomography. Three-dimensional image. Surgery, computer assisted. Computer simulation. Orthodontics. Surgery, Oral.

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Editor's summary

Novel orthodontic applications of advanced 3D imaging techniques include virtual models' superimposition for the assessment of growth, changes with treatment and stability, 3D soft-tissue analysis and computer simulation of surgical osteotomies. Quantitative and qualitative analysis of skeletal displacement, adaptive response and resorption that could not be attempted with 2D techniques can now be accomplished through 3D CBCT reconstructions and superimpositions.^{1,3,4} The complex movements during surgery for dentofacial deformities clearly need to be assessed in three dimensions to improve outcome, stability and reduce symptoms of temporomandibular joint disorder after surgery.²

To evaluate within-subject changes, images of different phases were superimposed with the software Imagine (<http://www.ia.unc.edu/dev/download/imagine/index.htm>) in a fully automated method using voxel-wise registration to avoid observer-dependent location of points identified from overlap of anatomic landmarks. Since the cranial base is not altered by the surgery, its surfaces were used in the registration procedure, where the software compares the grey level intensity of each voxel between two CT images. In this way, the cranial base of the pre-surgery CT is used as reference for the other time-points (Fig 1). Despite soft-tissue visualization is better performed with magnetic resonance imaging and a better contrast between soft and hard-tissues is observed with spiral computed tomography, 3D models of the soft-tissue of the face can be precisely reconstructed with lower cost and radiation and still provide important information of facial esthetic response to surgical movements.⁴

The presented three-dimensional superimposition method allows the assessment of important structural displacements following surgery, and its short and long-term stability. Despite all training, expertise, technical support, and time required, this methodology seems to have great validity for clinical, scientific and educational orthodontic and surgical application.

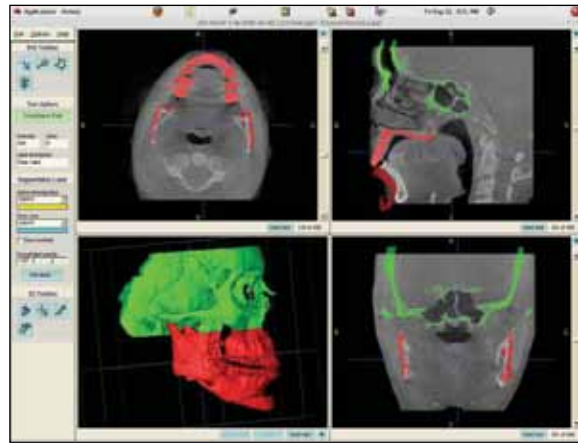


FIGURE 1 - After the registration procedure with the Imagine software, the superimposition between the post-surgery 3D model (color) and gray scale pre-surgery image can be observed, showing matching cranial bases and displaced mandibular structures (mandibular advancement and genioplasty). A correct superimposition between models of the two phases is then confirmed.

Questions

1) Which are the clinical applications of the 3D superimposition method described?

This method has been mostly used in orthosurgery cases, assessing skeletal displacements following different osteotomies and verifying treatment outcomes, short and long-term stability. Complex cases, such as dentofacial deformities and severe asymmetries, for example hemifacial microsomia, can benefit from this method in the treatment planning and during the surgical procedure.

On the other hand, its application has already been tested and proved in growing patients, using a superimposition on the anterior cranial base, which is early established. This possibility opens an extraordinary clinical field for a 3D follow-up of craniofacial growth and development of these patients, providing comprehensive visual and quantitative analysis.

Otherwise, for a routine use by the orthodontic clinician, the method needs to become faster, more simple and user-friendly. Some improvements, like the compilation of various functions performed by different softwares in only one application have already been attained. The authors also believe

that the use of 3D superimposition in case studies at orthodontic graduate programs, allowing a thorough and detailed observation by students and professors, may be an important step on the introduction of this method in the clinical practice of the former residents.

2) Are there advantages on research purposes of the method described over the cephalometric method?

Some advantages of the present method can be cited, such as the automated way of cranial base superimposition, avoiding errors associated to landmark identification or structural contour determination by the operator, representing a significant bias control in a scientific approach. Also, a 3D observation of anatomic structures with real size and form instead of projected superimposed images is a clear differential, allowing the observation of bilateral structures in a more realistic way. Additionally, the comparison of three-dimensional surfaces instead of cephalometric points and lines can result in more reliable and detailed results. Otherwise, it is important to consider factors like simplicity and ease of working with 2D conventional images. When performing a quantitative analysis, the present method generates a great amount of information, leading sometimes to a difficult formulation of straight and concise conclusions of the observed phenomenon. Still, the determination of reliable directional tendencies is difficult because of various movement directions of the structures. This assessment may be improved by the development of vectorial analysis tools, defining in a clear way the displacement directions.

3) Could the method be used on the assessment of dentoalveolar changes following orthodontic treatment?

Yes, one of the possible applications would involve the visualization of dentoalveolar changes following orthopedic or orthodontic mechanics. Studies have tested the effects of dental expansion

mechanics, comparing 3D models before and after aligning and leveling, and showed that the expansion was mostly concentrated on the premolar region. Otherwise, there are some drawbacks, since the segmentation of the teeth requires a good precision, but basic factors like the acquisition in centric occlusion or the presence of braces can represent important image artifacts when building the 3D models. Another limitation lies on the simple fact that the superimposition requires stable reference structures as the cranial base. For example, when assessing lower arch changes, a cranial base superimposition would show both skeletal and dental alterations, but for an accurate dentoalveolar visualization, an isolated superimposition should be done using the mandibular body, rami and other surface contours. This technology, known as shape correspondence, is still being developed.

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Orthodontic treatment of gummy smile by using mini-implants (Part I): Treatment of vertical growth of upper anterior dentoalveolar complex

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Abstract

Orthodontic mini-implants have revolutionized orthodontic anchorage and biomechanics by making anchorage perfectly stable. In this Part I, 'gummy smile' was defined and classified according to the etiologies. Among them, dentoalveolar type, a good indication of mini-implant treatment, was divided into three categories: (1) Cases with vertical growth of upper anterior dentoalveolar complex (Cases 1, 2, and 3), (2) Cases with protrusion of anterior dentoalveolar complex (Cases 4, and 5), and (3) Cases with protrusion of upper anterior dentoalveolar complex and extrusion of upper posterior teeth (Cases 6, and 7). Three cases with excessive vertical growth of the upper anterior dentoalveolar complex were presented. They were characterized with extruded and retroclined upper incisors, deep overbite, and gummy smile. The aim of this paper is to show that mini-implants are useful in the anterior area to intrude incisors and correct the gummy smile. An upper anterior mini-implant (1.6 x 6.0 mm) and a NiTi closed coil spring were used to intrude and procline the retroclined extruded incisors. Mini-implants can be used successfully as orthodontic anchorage to intrude anterior teeth.

Keywords: Mini-implants. Intrusion. Gummy smile. Segmented arch.

Editor's summary

The use of anchorage devices offers undeniable benefits. No wonder it is so widespread among orthodontists. As well as reducing the reciprocal effects of orthodontic forces, mini-implants have opened new therapeutic avenues, such as the implementation of tooth intrusion movements. Posterior

teeth intrusion may be indicated—primarily for prosthetic purposes—for teeth that have been extruded due to absent antagonists. Posterior region intrusion can still be performed to correct anterior open bite in patients with an essentially vertical facial pattern. Moreover, the intrusion of upper anterior teeth entails a rather precise indication.

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It is recommended for the correction of deep overbite in patients with overexposure of the gingiva in the anterior region only, during smiling, and preferably if associated with retroclined upper incisors.

These morphological nuances are featured in three clinical cases illustrated in this article (Figs 1 and 2) and highlights an important clinical application of mini-implants in orthodontics.



FIGURE 1 - Initial and final frontal view of the face; initial and final frontal view of the occlusion.



FIGURE 2 - Initial and final frontal view of the face; initial and final frontal view of the occlusion.

Questions

1) Are there any limitations on the use of mini-implants for upper anterior teeth intrusion?

The limitations are no different than in any other conventional intrusion technique. For example, patients with periodontal disease, root resorption, narrow interradiacular space, etc. If a mini-implant is inserted into a too narrow space, intrusion will cause implant-root contact, which is bound to result in mini-implant failure. Should a mini-implant be inserted too low in order to expose its head it will cause the space left for spring insertion to become too narrow, thereby compromising the mechanics. Although no research has been hitherto conducted on the stability of anterior teeth intrusion, it appears to be clinically better than posterior teeth extrusion.

2) What motivated you to write this article?

Authors qualify anterior teeth intrusion as simple when mini-implants are used as anchorage. Furthermore, patients are not required to comply, since it does not rely on extraoral headgear or any other type of posterior teeth anchorage such as transpalatal arches. If we can intrude anterior teeth without extruding posterior teeth, orthodontic mechanics is rendered more simple and effective. The purpose of this article is to contribute to the simplification of orthodontic treatment by preventing side effects while offering an alternative approach to gummy smile correction.

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A comparative study of manual vs. computerized cephalometric analysis

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Abstract

Objective: To conduct a comparative analysis between manual and computerized tracings using specific software, in order to define inter- and intraobserver results. **Methods:** A sample was used consisting of 50 standardized lateral cephalometric radiographs, of male and female patients of various age groups. The radiographs were analyzed by two observers, who each performed the manual and computerized tracings of all 50 radiographs. Angular and linear measurements were obtained, which were later submitted to the Mann-Whitney test in order to compare the inter- and intraobserver results between the two types of tracings. **Results and Conclusions:** the study concluded that confidence can be increased in tracings obtained from computer-assisted cephalometric analysis, as the discrepancies found between inter- and intraobserver tracings, both manual and computerized, were mostly not statistically significant.

Keywords: Radiography. Cephalometrics. Craniometry.

INTRODUCTION AND LITERATURE REVIEW

The works of Broadbent and Hoffrat in 1931 pioneered the development of cephalometrics² and its application in dentistry, especially orthodontics. It has since become essential in the diagnosis, planning¹⁰ and result evaluation of cases treated with orthodontics.

When performing a cephalometric analysis, it is necessary to define precisely the manner in which the many different cephalometric landmarks will be determined, so that the exams

have universal application—which is, in fact, one of its main qualities. Indeed, it was the wide standardization of analysis methods that made possible the development of cephalometric radiography as a diagnostic tool.¹⁹

Cephalometric analysis has been used as a tool for the evaluation of anthropometric data since the 1930s. It was introduced in the field of orthodontics for the study of human facial growth patterns, to aid in the diagnosis and planning of treatments for dentofacial deformities,

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and in the study of immediate and long-term defects of these treatments. More recently, it has gained increased relevance in the evolution of orthognathic surgery.

Currently, cephalometric radiography can be regarded as a product of the evolution in anthropometric and archeological studies. With regard to the study of bones, the need emerged to standardize the communication between the fields of archeology and anthropometrics, so that descriptions became more precise and made possible objective comparisons of bone morphology. This led to the creation of bone measurement procedures, which became known as osteometry, while the specific measurement of cranial bones was named craniometry. Cephalometrics, meanwhile, consists of measuring the entire head, including the surrounding soft tissue.

Image thickness and resolution, anatomical complexity and superimposition of hard and soft tissue, and the experience of the observers when looking for a particular landmark are important factors that can influence the identification of the landmark.¹⁷

Traditional cephalometric analysis is performed by tracing radiographic landmarks on an acetate sheet and using the landmarks to measure the desired linear and angular values. This traditional method using manual tracing can take time and the linear and angular cephalometric measurements obtained manually using a ruler and protractor can lead to errors.⁵

The objective of using computers was to verify whether there would be a reduction in reproducibility errors of measurements in cephalometric analyses and whether the tracer's experience had a significant influence. It was observed that there was not a satisfactory reproduction of the measurements involving incisors, thus demonstrating that experience is not a factor that can in itself significantly reduce the margin of systematic error in computer-assisted Steiner analysis.¹⁶

A comparative study between the manual and computerized cephalometric measurement methods was performed by Richardson¹⁴ in 1981. He compared 50 lateral cranial radiographs of 12-year-old children, half male and half female. Fourteen landmarks were defined in that study: S, N, anterior nasal spine, subspinal, incisal and zenith of the maxillary incisor, incisal and zenith of the maxillary incisor, supramenton, pogonion, gnathion, molar, pterygomaxillary and articulare. The conclusion was that traditional methods were inferior in comparison to digital procedures, but not alarmingly so, and in some cases traditional methods produced more precise results.

As the use of computers in assisting cephalometric analysis gained popularity, both in research and in clinical applications, Nimkarn and Miles¹² studied the reliability of computer-assisted cephalometrics in 1995. Forty radiographs from the same x-ray machine were used and chosen at random. Each radiograph was traced in acetate paper, and the images of the radiographs and tracings were captured in a video camera, projected onto a monitor, where the landmarks were digitized. The cephalometric measurements were obtained using Quick Ceph 5.1 software (Quick Ceph Systems, USA). The program performed the calculations for all 40 measurements, from 22 marked landmarks. In order to assess methodology errors and identify the source of errors, the study consisted of five parts: 1) Reproducibility of computerized measurement technique; 2) Video imaging, digitalization and software; 3) Digitalization and software; 4) Computer vs. manual measurement; 5) Software calibration and operator digitalization errors. The results showed that the measurements performed in the computer were comparable to manual measurements, with no statistically significant differences.

One study involving two orthodontists, who each twice traced 21 cephalometric landmarks in 100 radiographs obtained through

the traditional method and 100 radiographs obtained from digital imaging, demonstrated a coincidence in intraobserver cephalometric landmarks and little interobserver difference.⁹ The authors also highlighted that the linear and angular measurements were more precise in the digitally obtained radiographs, emphasizing that the quality of digital radiographs facilitates cephalometric measurements.⁹

The objective of the present work was to compare the measurements made using computerized cephalometric tracing software to manual measurements, with the purpose of establishing the level of agreement between them, as well as evaluating intra- and interobserver results.

METHODOLOGY

In order to perform the current study, a sample was used consisting of 50 lateral cephalometric radiographs belonging to patients from the same dental radiology center, selected according to the following criteria: Random selection,

patients from both genders, patients from several age groups.

The radiographs were measured with two different methods, by two observers, named: Observer 1—consisting of 25 lateral cephalometric radiographs, in which linear and angular measurements were made using both the manual method (Fig 1) and computer-assisted method (Fig 2) with Cef-X 2001 software (CDT, Cuiabá, Brazil) under USP analysis; and Observer 2—consisting of 25 lateral cephalometric radiographs, in which linear and angular measurements were made using both the manual method and computer-assisted method with Cef-X 2001 software under USP analysis.

After each observer had measured their 25 radiographs, the x-rays were exchanged between the two observers, so that both inter- and intraobserver results could be obtained, totaling an evaluation of 50 radiographs per observer.

After calibration of observers 1 and 2, in order to reduce errors during the study and standardize the procedures, the tracing and

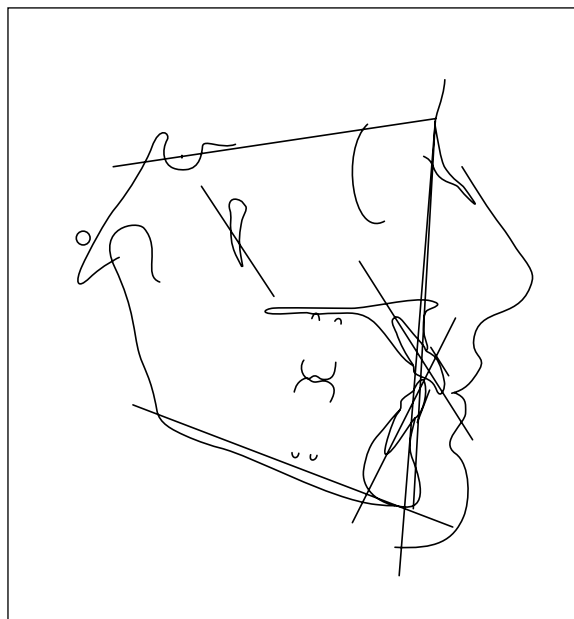


FIGURE 1 - Manual cephalometric tracing.

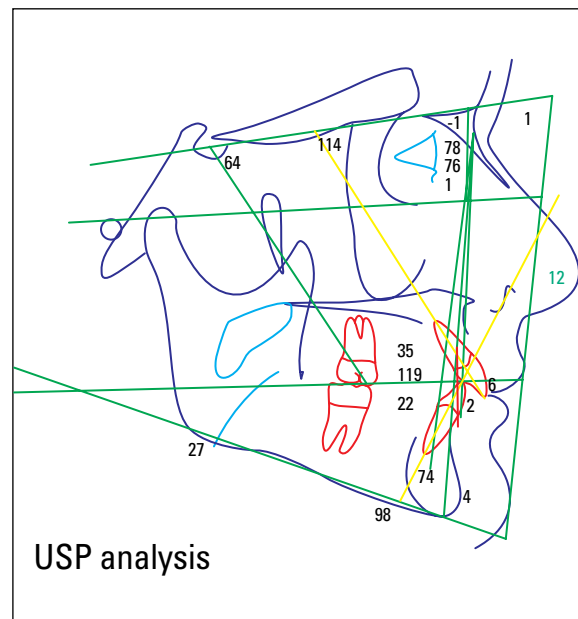


FIGURE 2 - Computerized cephalometric tracing.

cephalometric measurements were obtained in ultraphan paper. The drawings of anatomical structures and cephalometric landmarks, and the USP analysis were made using a light box in a dark room. A maximum of 10 radiographs were evaluated per day by each observer, in order to avoid fatigue leading to casual errors.

Cephalometric measurements were established as follows: angular and linear measurements. In both methods of cephalometric tracing evaluated in this work, the linear measurements defined were 1-NA and 1-NB, and the angular measurements were SNA, SNB, ANB, SNGn and IMPA.

The data were noted on a record sheet and tabulated on a computer for later tests.

The radiographs were later digitized and stored in a computer for computerized cephalometric analysis. After that stage, the radiographs were imported into the Cef-X program, where they were calibrated in order to avoid any distortion of the program with the original radiograph. Next, computer measurements were made using the Cef-X computer program, by marking the landmarks directly on the screen using the mouse cursor. Next, the data provided by the program were calculated and a report sheet model was issued for each radiograph.

STATISTICAL ANALYSIS

The measurements obtained from the manual and computerized cephalometric tracings were organized in tables and later subjected to statistical analysis through the Mann-Whitney test, which is a non-parametric test performed to compare two independent and same-size samples, whose scores have been measured ordinally.¹

RESULTS

For each factor of the USP-standard cephalometric analysis, the arithmetic mean was obtained for the manual and computerized measurements of all tables.

The comparison of measurements between the manual and computerized tracings of Observer 1, after the test was applied, did not show significant differences (Table 1).

The comparison of measurements between the manual and computerized tracings of Observer 2, after the test was applied, showed that the angular measurements did not show significant differences, whereas linear measurements (1-NA and 1-NB) showed statistically significant differences (Table 2).

The comparison of the measurements between the manual tracings of observers 1 and 2, after the

TABLE 1 - Mean of the measurements obtained using the different methods, according to the process of Observer 1, and the result of the Mann-Whitney test.

MEAN (μ) $\pm$ STANDARD DEVIATION (SD)			
Measurements	Manual $\mu_1 \pm SD$	Computerized $\mu_1 \pm SD$	P-value
SNA (degrees)	83.53 $\pm$ 4.46	83.74 $\pm$ 4.45	0.73 n.s.
SNB (degrees)	79.54 $\pm$ 4.48	80.00 $\pm$ 4.45	0.64 n.s.
ANB (degrees)	3.99 $\pm$ 3.01	4.45 $\pm$ 2.61	0.85 n.s.
SNGn (degrees)	67.71 $\pm$ 4.30	67.25 $\pm$ 4.18	0.63 n.s.
IMPA (degrees)	95.79 $\pm$ 7.99	95.38 $\pm$ 8.41	0.90 n.s.
1-NA (mm)	7.20 $\pm$ 2.93	6.60 $\pm$ 3.65	0.21 n.s.
1-NB (mm)	6.80 $\pm$ 2.74	7.10 $\pm$ 3.60	0.77 n.s.

n.s. = non-significant ($p > 0.05$); * = significant ($p < 0.05$).

TABLE 2 - Mean of the measurements obtained using the different methods, according to the process of Observer 2, and the result of the Mann-Whitney test.

MEAN (μ) $\pm$ STANDARD DEVIATION (SD)			
Measurements	Manual $\mu_2 \pm SD$	Computerized $\mu_2 \pm SD$	P-value
SNA (degrees)	83.44 $\pm$ 3.85	84.13 $\pm$ 4.77	0.57 n.s.
SNB (degrees)	79.18 $\pm$ 4.65	79.97 $\pm$ 4.80	0.54 n.s.
ANB (degrees)	4.38 $\pm$ 2.47	5.53 $\pm$ 3.00	0.83 n.s.
SNGn (degrees)	68.70 $\pm$ 4.42	67.30 $\pm$ 4.56	0.33 n.s.
IMPA (degrees)	94.82 $\pm$ 12.06	95.74 $\pm$ 6.49	0.67 n.s.
1-NA (mm)	3.80 $\pm$ 0.53	6.71 $\pm$ 4.12	0.00001 *
1-NB (mm)	2.86 $\pm$ 0.61	7.28 $\pm$ 3.39	0.00001 *

n.s. = non-significant ($p > 0.05$); * = significant ($p < 0.05$).

TABLE 3 - Mean of the measurements obtained using the Manual method, according to the processes of Observers 1 and 2, and the result of the Mann-Whitney test.

MEAN (μ) $\pm$ STANDARD DEVIATION (SD)			
Measurements	Manual $\mu_1 \pm$ SD	Manual $\mu_2 \pm$ SD	P-value
SNA (degrees)	83.53 $\pm$ 4.46	83.44 $\pm$ 3.85	0.94 n.s.
SNB (degrees)	79.54 $\pm$ 4.48	79.18 $\pm$ 4.65	0.99 n.s.
ANB (degrees)	3.99 $\pm$ 3.01	4.38 $\pm$ 2.47	0.85 n.s.
SNGn (degrees)	67.71 $\pm$ 4.30	68.70 $\pm$ 4.42	0.65 n.s.
IMPA (degrees)	95.79 $\pm$ 7.99	94.82 $\pm$ 12.06	0.46 n.s.
1-NA (mm)	7.20 $\pm$ 2.93	3.80 $\pm$ 0.53	0.00001 *
1-NB (mm)	6.80 $\pm$ 2.74	2.86 $\pm$ 0.61	0.00001 *

n.s. = non-significant ($p > 0.05$); * = significant ($p < 0.05$).

TABLE 5 - Mean of the measurements taken using the different methods, according to the processes of Observers 2 and 1, and the result of the Mann-Whitney test.

MEAN (μ) $\pm$ STANDARD DEVIATION (SD)			
Measurements	Manual $\mu_2 \pm$ SD	Computerized $\mu_1 \pm$ SD	P-value
SNA (degrees)	83.44 $\pm$ 3.85	83.74 $\pm$ 4.45	0.45 n.s.
SNB (degrees)	79.18 $\pm$ 4.65	80.00 $\pm$ 4.45	0.49 n.s.
ANB (degrees)	4.38 $\pm$ 2.47	4.45 $\pm$ 2.61	0.65 n.s.
SNGn (degrees)	68.70 $\pm$ 4.42	67.25 $\pm$ 4.18	0.23 n.s.
IMPA (degrees)	94.82 $\pm$ 12.06	95.38 $\pm$ 8.41	0.44 n.s.
1-NA (mm)	3.80 $\pm$ 0.53	6.60 $\pm$ 3.65	0.00001 *
1-NB (mm)	2.86 $\pm$ 0.61	7.10 $\pm$ 3.60	0.00001 *

n.s. = non-significant ($p > 0.05$); * = significant ($p < 0.05$).

test was applied, showed that the angular measurements did not show statistically significant differences, whereas linear measurements (1-NA and 1-NB) showed statistically significant differences (Table 3).

The comparison of measurements between the computerized tracings of observers 1 and 2, after the test was applied, showed that the differences were not significant (Table 4).

The comparison of the measurements between the manual and computerized tracings

TABLE 4 - Mean of the measurements obtained using the Computerized method, according to the processes of Observers 1 e 2, and the result of the Mann-Whitney test.

MEAN (μ) $\pm$ STANDARD DEVIATION (SD)			
Measurements	Computerized $\mu_1 \pm$ SD	Computerized $\mu_2 \pm$ SD	P-value
SNA (degrees)	83.74 $\pm$ 4.45	84.13 $\pm$ 4.77	0.53 n.s.
SNB (degrees)	80.00 $\pm$ 4.45	79.97 $\pm$ 4.80	0.91 n.s.
ANB (degrees)	4.45 $\pm$ 2.61	5.53 $\pm$ 3.00	0.83 n.s.
SNGn (degrees)	67.25 $\pm$ 4.18	67.30 $\pm$ 4.56	0.85 n.s.
IMPA (degrees)	95.38 $\pm$ 8.41	95.74 $\pm$ 6.49	0.62 n.s.
1-NA (mm)	6.60 $\pm$ 3.65	6.71 $\pm$ 4.12	0.21 n.s.
1-NB (mm)	7.10 $\pm$ 3.60	7.28 $\pm$ 3.39	0.76 n.s.

n.s. = non-significant ($p > 0.05$); * = significant ($p < 0.05$).

TABLE 6 - Mean of the measurements taken using the different methods, according to the process of Observers 2 and 1, and the result of the Mann-Whitney test.

MEAN (μ) $\pm$ STANDARD DEVIATION (SD)			
Measurements	Computerized $\mu_2 \pm$ SD	Manual $\mu_1 \pm$ SD	P-value
SNA (degrees)	84.13 $\pm$ 4.77	83.53 $\pm$ 4.46	0.97 n.s.
SNB (degrees)	79.97 $\pm$ 4.80	79.54 $\pm$ 4.48	0.96 n.s.
ANB (degrees)	5.53 $\pm$ 3.00	3.99 $\pm$ 3.01	0.86 n.s.
SNGn (degrees)	67.30 $\pm$ 4.56	67.71 $\pm$ 4.30	0.95 n.s.
IMPA (degrees)	95.74 $\pm$ 6.49	95.79 $\pm$ 7.99	0.94 n.s.
1-NA (mm)	6.71 $\pm$ 4.12	7.20 $\pm$ 2.93	0.89 n.s.
1-NB (mm)	7.28 $\pm$ 3.39	6.80 $\pm$ 2.74	0.88 n.s.

n.s. = non-significant ($p > 0.05$); * = significant ($p < 0.05$).

of observers 2 and 1, respectively, after the test was applied, showed that the angular measurements did not show statistically significant differences, whereas linear measurements (1-NA and 1-NB) showed statistically significant differences (Table 5).

The comparison of measurements between the computerized and manual tracings of observers 2 and 1, respectively, after the test was applied, showed that the differences were not significant (Table 6).

DISCUSSION

The studies related to the same theme and with a similar purpose as this research, reviewed in literature, show a lack of criteria with regard to the choice of cephalometric landmarks and the ideal linear/angular measurements to be used in studies of this nature.^{3,4,6,7,12,16}

Justifications can be made with regard to the selection of landmarks and cephalometric measurements in this type of work, as exemplified in the ease of locating the landmarks, providing higher reliability and precision, which can directly influence the measurement,^{13,17,18} as the reproducibility of the measurement is part of different types of cephalometric analysis proposed by several authors.^{2,5,7,8,11,16}

The manual method required higher time expenditure, but it is the most common method for tracing, identifying landmarks, measuring distances and angles between the locations of the landmarks,¹⁵ in addition to having a high possibility of error. The authors recommended the replication of tracings as a good measure to diminish the possibility of error with this method.¹⁶

With the advent of the computer-assisted method, a decrease in the differences of cephalometric measurements began to be observed, as the precision of the measurements became significantly more accurate due to the intrinsic characteristics of measuring computer pixels.⁷

The computer reduced, although discretely, the possibility of differences, as it is more secure than the manual method. When locating landmarks defined as being more inferior or deep in a given bone contour—for instance, points A, B and N—the computerized method proved to be more reliable than the manual method.¹³

However, in order to obtain a computer-assisted cephalometric tracing, it is important to have anatomical/radiographic knowledge of the cephalometric structures required for marking the landmarks, even though it becomes easier and faster to identify anatomical structures and

mark the landmarks, as different features of the software can be used—such as zoom, contract and brightness.

With respect to marking the cephalometric landmarks related to the location of N, B and A vertically, we verified that the difficulty in adequately reproducing them is similar in the manual and computerized methods.^{14,16}

With regard to angular measurement SNGn, although it is a measurement that involves the landmark N, which is difficult to locate in both methods, it is not statistically different in both methods of cephalometric tracing.^{8,18}

The angular measurement IMPA is easily measurable, as it does not involve hard-to-find landmarks described in this study. It also did not show statistically significant changes in both methods.⁸

Linear measurements I-NA and I-NB, which require the location of points A and B (which in turn are equally difficult to reproduce both in the manual and computer-assisted methods), did not show statistically significant differences in this study when comparing the measurements of the manual and computerized tracings of Observer 1, when comparing interobserver computerized tracings, and when comparing the computerized tracing measurements of Observer 2 with the manual tracing measurements of Observer 1.⁸

However, for linear measurements I-NA and I-NB, when comparing the manual and computerized tracings of Observer 2, there were statistically significant differences in this study.¹⁶ When comparing interobserver manual tracings and when comparing the manual tracing of Observer 2 with the computerized tracing of Observer 1, there were also statistically significant differences in this study.⁴

The interobserver variations found in some studies may be caused by variations in training and experience or by the nature of landmark identification. Moreover, intraobserver variations may be the results of lighting and image position.¹⁵

CONCLUSION

According to the results obtained through the methodology used in this research, it is concluded that:

1) The confidence can be increased in the results of cephalometric tracings obtained from computers, as the discrepancies found between the measurements of manual and computerized tracings were, in their majority, statistically non-significant.

2) Intraobserver linear measurements showed statistically significant differences between manual

and computerized tracings for one of the observers.

3) Interobserver linear measurements showed statistically significant differences both in manual tracing and between manual and computerized tracings. However, there was no statistical difference in the results of computer-assisted tracings.

4) The time spent to perform manual tracing was greater than for computerized tracing.

5) The use of features of the computerized cephalometric tracing software, such as zoom, changes in brightness, density and contrast, were useful to determine cephalometric landmarks.

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Change in the gingival fluid volume during maxillary canine retraction

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Abstract

Introduction: In the analysis of the pressure-tension theory of tooth movement, the application of an orthodontic force causes gradual displacement of fluids of the periodontal ligament, followed by distortion of the cells and extracellular matrix. **Objectives:** This study evaluated the gingival fluid volume on the mesial and distal aspects of the maxillary canines of 14 patients (3 males and 11 females) submitted to orthodontic movement. **Methods:** The fluid was collected using standard absorbent paper strips (Periopaper™) and the fluid volume was determined using the instrument Periotron™ at seven different periods (day -7, day 0, 1 hour, 24 hours, 14 days, 21 days, 80 days). The Friedman test was applied to compare the data achieved ($p < 0.01$ and $p < 0.05$). **Results:** The results revealed a significant change in the gingival fluid volume with time on both the pressure side ($p < 0.001$) and the tension side ($p < 0.01$). On the pressure side, the gingival fluid volume was significantly lower at the periods 0 ($p < 0.01$) and 24hs ($p < 0.001$) compared to the period 80 days.

Keywords: Gingival sulcus. Orthodontic movement. Inflammation.

INTRODUCTION

The initial stage of orthodontic tooth movement involves an acute inflammatory response in the periodontium, characterized by vasodilation and leukocyte migration outside the capillaries. These migrating cells produce several cytokines, the local biochemical molecular signals, which interact directly or indirectly with the parodontal cells.⁵ The cytokines trigger the synthesis and secretion of several substances by the target cells, including prostaglandins, growth factors and other

cytokines. Ultimately, these cells form functional units that promote remodeling of the parodontal tissues and facilitate the tooth movement.⁷

The acute inflammatory process that characterizes the initial stage of orthodontic tooth movement is predominantly exudative, in which plasma and leukocytes migrate outside the capillaries in areas of parodontal stress. After one or two days, the acute stage of inflammation is decreased and replaced by a chronic process involving fibroblasts, endothelial cells and osteoblasts.

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During this period, the leukocytes continue to migrate in the stressed paradental tissues and modulate a remodeling process. The chronic inflammation prevails until the following session, when the orthodontist activates the force-inducing component and triggers another period of acute inflammatory process, which is superimposed to the chronic inflammation.⁸

For the patient, the periods of acute inflammation are associated with pain and impaired function (mastication). The reflex of this phenomenon may be observed in the gingival fluid of teeth submitted to orthodontic movement, which presents temporary significant increases in the concentrations of inflammation mediators such as cytokines and prostaglandins.⁸

The observation that orthodontic tooth movement involves several reactions with inflammatory characteristics was important because it allowed a better understanding that the factors involved in inflammation may be part of the reactions of tooth supporting tissues to orthodontic forces. However, the orthodontist should not feel embarrassed to induce focal areas of inflammation of the periodontal ligament during tooth movement for therapeutic purposes.¹⁵ The occurrence of inflammatory events in the tissues does not necessarily imply clinically noticeable local changes or symptoms, because the inflammation may be subclinical.³

The expression of these biologically active substances concerning the changes in the gingival fluid during orthodontic tooth movement has been analyzed by non-invasive investigations in humans. These substances are produced by the periodontal ligament cells in sufficient quantity to be present and diffuse in the gingival fluid.⁴

PURPOSE

Based on these considerations, this study quantified the gingival fluid volume on the mesial and distal aspects, respectively areas of tension and pressure, of maxillary canines submitted to orthodontic movement.

MATERIAL AND METHODS

Patient selection

This study was conducted on 14 patients attending the clinic of the Specialization Course in Orthodontics at the Dental School of the State University of Rio de Janeiro. The selection of patients did not follow criteria related to gender, ethnicity or malocclusion, except for the fact that all patients were indicated for extraction of maxillary first molars as part of the orthodontic treatment planning. The patients were informed on the characteristics and objectives of the study and signed an informed consent form. The group of patients was composed of 3 males and 11 females (18.8 ± 4.8 years; range 12 to 28 years).

The exclusion criteria comprised the presence of autoimmune diseases, pregnancy, breastfeeding, prolonged use of drugs during the six months before study onset (antibiotics, anti-histaminic drugs, cortisone, hormones), and others that might interfere with the inflammatory process or cause any direct adverse effect on the periodontium.

Orthodontic device

Brackets with 0.022 x 0.028-in slots (Morelli, Sorocaba, SP, Brazil) were bonded on the canines and second premolars and bands were fitted and cemented on the first molars with 0.055 x 0.022 x 0.028-in triple tubes (Morelli) welded on the buccal aspect and 2 x 0.036-in tubes (Morelli) welded on the palatal aspect. The premolars had been extracted at least 20 days earlier, before onset of canine retraction. The canines were retracted using a 0.017 x 0.025-in segmented archwire fabricated with TMA (Morelli) with a vertical loop activated by a NiTi coil (Morelli), which delivered a 150 g force measured with a strain gauge (Dentaureum, Ispringen, Germany). A passive auxiliary archwire was tied to the tube on the first molars and brackets on the maxillary second premolars^{6,7} (Figs 1 and 2). Auxiliary anchorage was achieved with a transpalatal bar connecting the maxillary first molars, fabricated with 0.032-in wire (Morelli).

Clinical follow-up

The clinical examinations comprised analysis of: (1) Plaque index (PI) and (2) Gingival index (GI). Periodontal examination was conducted by a single calibrated examiner. The PI and GI measurements were determined with the aid of a Goldman-Fox/Williams periodontal probe (Hu-Friedy, Chicago - IL, USA). The absence/presence of plaque/bleeding was evaluated on all teeth on the buccal, lingual, mesial and distal aspects. Seven days before the initial application of orthodontic force the patients received oral hygiene instructions and were asked to brush their teeth using an orthodontic toothbrush (Oral-B, São Paulo-SP, Brazil), using the dentifrice Colgate Total 12 (Colgate/Palmolive, São Bernardo do Campo-SP, Brazil) and perform mouthrinsing with 0.12% chlorhexidine gluconate² (Noplak, Lab. Daudt, Rio de Janeiro-RJ, Brazil) twice a day until completion of the study.

Collection of gingival fluid (GF) samples

The samples were collected from the mesial and distal aspects of the maxillary canines of each patient at six different periods. The first collection was performed 7 days before onset of application of orthodontic force, called period -7d. The second collection was obtained on the first day of force application, called period 0. The third was collected one hour after force application, called period 1h. The fourth was obtained 24 hours after force application, called period 24hs. The fifth was collected two weeks after force application, called period 14d. The sixth was achieved three weeks after force application, called period 21d. Finally, the seventh collection was performed 80 days after the initial force application, called period 80d.

The collection sites were isolated using cotton rolls and air-dried. A standard absorbent paper strip (Periopaper, IDE Interstate, Amityville-NY, USA) was placed in the gingival sulcus until



FIGURE 1 - Orthodontic device employed for maxillary canine retraction in period 0.



FIGURE 2 - Aspect 80 days after onset of maxillary canine retraction.



FIGURE 3 - Absorbent paper strip used for collection of gingival fluid.

resistance was felt and left in this position for 30 seconds (Fig 3). The GF volume was immediately determined using a calibrated GF measurement instrument (Periotron 8000, IDE Interstate, Amityville, NY, USA). The electrode tweezers were cleaned and dried and the digital monitor was zeroed after each measurement.

RESULTS

The device employed for canine distalization was effective, achieving considerable magnitude of movement in a period of 80 days.

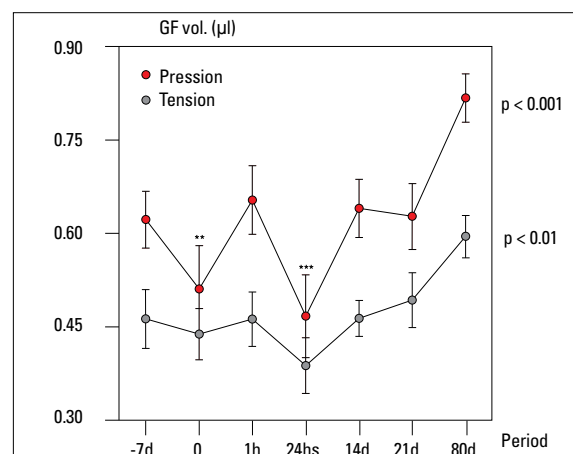
Graph 1 presents the mean gingival fluid volumes (GF) in μL on the Pressure side ($n = 14$) and Tension side ($n = 14$) with time. The non-parametric Friedman test was applied to analyze the significance of difference with time. The results revealed significant change in the GF volume with time on both the pressure side ($p < 0.001$) and the tension side ($p < 0.01$). On the pressure side, the GF volume was significantly lower in periods 0 ($p < 0.01$) and 24hs ($p < 0.001$) compared to the period 80d, according to the Dunn's multiple comparisons test.

DISCUSSION

Even though the force application was carefully controlled, achieving optimal values, there was a tendency of crown tipping instead of a translation movement.^{7,8,15} This inclination may be corrected in the subsequent stages of orthodontic treatment and was observed in most cases in this study.

During canine retraction, the pressure-tension theory of tooth movement and accompanying phenomena were expected. Application of an orthodontic force on a tooth causes gradual displacement of fluids of the periodontal ligament, followed by distortion of the cells and extracellular matrix.⁵

In this study, the change in the gingival fluid volume demonstrated variations in the different periods. In the period -7d, when the patients presented their own oral hygiene habits, the readings



GRAPH 1 - Graph of mean changes in the GF volume on the pressure and tension areas with time (** $p < 0.01$ and *** $p < 0.001$).

of the PeriotronTM revealed values indicating presence of mild inflammation in the gingival tissue, with higher values on the pressure site, probably due to the greater difficulty to perform oral hygiene on the distal aspect of canines. These values were similar to those observed in a previous study that analyzed the gingival fluid volume in patients with gingivitis.⁴ In period 0, when the patients had received oral hygiene instructions and had initiated daily mouthrinsing with chlorhexidine gluconate, the gingival fluid volume was reduced and the readings of the PeriotronTM exhibited lower values, without differences between the pressure and tension sides. One hour after orthodontic force application the values were increased, especially on the pressure side, despite the effective dental plaque control. In the period 24hs there was a reduction in the gingival fluid volume on both sides. This agrees with the report of Tuncer et al¹⁸ on the tension side, who considered that this finding represented an initial stage of inflammatory response to a mechanical trauma.

In the period 14d the values were similar to the period -7d, indicating that, with the induction of a mechanical stimulus, the gingival fluid volume was changed as observed in the presence of a bacterial stimulus. In the period 21d to 80d,

the use of chlorhexidine was interrupted and the patients did not receive any specific toothbrushing instructions. A considerable increase in the gingival fluid volume was then observed, especially on the pressure side; in this period, probably there was a combination of mechanical stimulus due to canine retraction and the presence of dental plaque.

Previous studies demonstrated that the gingival fluid flow reflects the changes in deeper regions of the periodontal tissues, such as the alveolar bone and periodontal ligament, in teeth submitted to orthodontic treatment.^{4,6,8,9,12} The increase in the gingival fluid flow may be observed in teeth submitted to orthodontic movement, being reduced in the retention period, when tooth movement is interrupted.¹³ This variation in the gingival fluid volume in teeth under mechanical stress might be associated to the onset of a subsequent inflammatory process, which is involved in the cascade of events necessary for orthodontic tooth movement.^{3,6,8,9,12} The direction of gingival fluid flow in teeth under mechanical stress would be from the pressure side to the tension side, both apically and coronally toward the gingival sulcus. Compression of the periodontal ligament would be asso-

ciated to the appearance of biochemical markers released by the cells, which would be detected in the gingival sulcus. Moreover, the effect of orthodontic forces on the periodontal ligament is fast, with changes occurring in minutes after their application.¹⁶

It should be considered that the utilization of orthodontic braces may contribute to the increase in dental plaque and gingival inflammation, which might be related to the increased enzymatic activity of in all sites.¹³ The hygiene of teeth with orthodontic appliances is difficult and toothbrushing may be complemented by chemical dental plaque control in special situations, such as in patients submitted to orthognathic surgery. Chlorhexidine is the best product for gingivitis control in orthodontic patients. The 0.12% chlorhexidine gluconate is an important therapeutic agent for the control of inflammation, gingival bleeding and plaque accumulation in orthodontic patients.^{1,2}

Therefore, it may be concluded that there is a significant change in the gingival fluid volume with time in maxillary canines submitted to retraction, both on the pressure and tension sides. On the pressure side, the gingival fluid volume was significantly lower in the periods 0 and 24hs compared to the period 80d.

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Relationship between mandibular growth and skeletal maturation in young melanodermic Brazilian women*

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Abstract

Objective: To assess the degree of correlation between mandibular growth and skeletal maturation in young melanodermic Brazilian women. **Methods:** The authors examined 140 lateral cephalometric radiographs and an additional 140 radiographs of hands and wrists of young female Brazilian melanodermic subjects aged 8 to 14 years with normal occlusion or Angle Class I malocclusion, who had not been subjected to previous orthodontic treatment. Using the hand and wrist radiographs, the authors evaluated the development of ossification centers in the proximal phalanx of the 3rd finger and the distal epiphysis of the radius bone, by tracing according to the method described by Eklöf and Ringertz. The lateral cephalometric radiographs enabled an analysis of frontal sinus pneumatization according to the method described by Ruf and Pancherz, and of the cephalometric measurements representative of mandibular growth, namely, Co-Go, Co-Gn, Go-Gn, Fg-Pg. The data were statistically analyzed using Pearson's Correlation to determine the degree of relationship between variables. **Results and Conclusions:** A highly significant correlation was found between ossification centers observed on the hand and wrist radiographs and cephalometric measurements representative of the mandibular growth ($r = 0.777$). Although statistically significant, there was a low correlation between frontal sinus pneumatization and the progression of skeletal maturity ($r = 0.306$), as well as a relationship between frontal sinus pneumatization and the cephalometric measurements representative of mandibular growth ($r = 0.218$).

Keywords: Skeletal maturation. Melanodermic subjects. Hand and wrist radiographs. Mandibular growth. Frontal sinus.

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INTRODUCTION AND LITERATURE REVIEW

Knowledge of events related to craniofacial growth and development has been of paramount importance in orthodontics because the selection of a therapeutic goal that ensures maxillomandibular growth must be based on an assessment of each patient's skeletal maturation.^{16,25} This information is crucial for orthodontists as an aid in the prevention, diagnosis, planning and early treatment of anomalies since the success or failure of orthodontic treatment is inextricably entwined with craniofacial growth and development.^{19,25}

The methods often used to identify skeletal maturation include chronological age, dental age, height, weight,¹¹ manifestations of secondary sexual characteristics,^{22,25} and an assessment of ossification center development.^{3,5,6,8,20,21,22,25,27} However, the first four methods are ineffective while the assessment of bone age using primarily hand and wrist radiographs provides the most accurate information about skeletal age. The close relationship between the age at which the body growth rate is at its peak and the period of mineralization of ossification centers in the hand and wrists has been firmly established in the literature.^{2-11,13,20,25,27}

Due to concern about the radiographic exposure that patients undergo to produce the necessary orthodontic documentation and also deterred by the costs involved, some practitioners tend to reduce the number of radiographs. Due to this concern, research has been undertaken to enable the use of the structures typically present in radiographs that are part of routine orthodontic documentation, such as lateral radiographs, to assess skeletal maturity.^{9,10,18,25} Some have used the analysis of cervical vertebrae¹⁸ while others have studied evaluations of frontal sinus development.^{20-24,29}

Anteroposterior mandibular growth during pubertal growth spurt (PGS) is a determining factor in the correction of some sagittal skeletal

disharmonies, thereby contributing to a more balanced facial pattern. However, although increased mandibular dimensions appear more conspicuously during PGS, there is great individual variability in terms of quantity, speed and onset. Professionals must then use diagnostic resources to assist them in predicting how this growth is likely to unfold.^{16-20,26,28}

The importance of establishing skeletal maturity during orthodontic diagnosis should not be based solely on the evaluation of the existing structure and function but also on the observation of pubertal growth. If one is to take full advantage of growth, orthodontic treatment needs to start prior to the PGS phase.^{9,10,13}

Researchers have investigated the occurrence of PGS in facial dimensions, which would be similar to body height PGS, and have agreed that the processes of skeletal growth and development are influenced by a wide range of mechanisms, especially genetic, endocrine, functional and environmental.^{11,16,17}

Some investigations have confirmed the existence of facial growth spurt and have found that it coincides chronologically with the phase of height growth spurt.^{11,18} Other studies endorsed this correlation, but an evaluation in boys showed that height growth spurt occurred slightly before facial growth spurt,¹⁷ whereas height growth spurt in girls occurred earlier than maximum mandibular growth.²⁸ The findings revealed that increases and decreases in the rate of skeletal maturation are accompanied by similar fluctuations in some aspects of facial growth, particularly in the mandible.

Most authors agree that the evaluation of hand and wrist radiographs is the most widely used method for the observation of bone age and skeletal maturation.^{2,9,10,13,25} Other studies, however, used the degree of frontal sinus pneumatization as a skeletal assessment method, noting that this anatomical structure correlated with skeletal maturity assessed by means of

hand and wrist radiographs.²⁰⁻²³

In light of the above, the need was felt to evaluate the possible association of mandibular growth with these maturational changes in young melanodermic women. Our intent is to contribute additional information to the knowledge base on this subject.

PROPOSITION

Based on the obtained information and since this is a cross-sectional study, we evaluated:

1. Changes in mandibular growth in young melanodermic subjects aged 8 to 14 years.
2. Changes in frontal sinus height, width and pneumatization between 8 to 14 years of age.
3. Changes in hand and wrist ossification centers, specifically the development of the proximal epiphysis of the 3rd finger and of the radius bone from 8 to 14 years of age.
4. The degree of correlation between ossification centers as viewed on hand and wrist radiographs and cephalometric measurements representative of the mandibular growth; between frontal sinus pneumatization and the development of ossification centers observed on hand and wrist radiographs; and between frontal sinus pneumatization and cephalometric measurements representative of mandibular growth.

MATERIAL AND METHODS

Material

This study was conducted after submitting the project to the Committee of Research Ethics at the Pontifical Catholic University of Minas Gerais and securing their approval No. 00890213-05.

The sample consisted of 140 lateral cephalometric radiographs and 140 hand and wrist radiographs of 140 young female melanodermic subjects with normal occlusion or Angle Class I malocclusion. All featured facial balance. None had been subjected to previous orthodontic

treatment and their ages ranged from 8 years and 0 month to 14 years and 11 months. Sample distribution followed the age brackets, thus: 20 subjects at the age of 8 years, 20 at 9, 20 at 10, 20 at 11, 20 at 12, 20 at 13 and finally 20 were 14 years old.

Methods

Sample selection and acquisition

Subjects were classified as melanodermic based on some of the anthropological features mentioned by Bastos de Ávila¹ such as skin color (presence of melanin pigmentation in the skin), spiral hair (curly), a unique morphology of the nose (broad nose base) and mouth (thick and centered lips) and parents and grandparents (ancestry).

Exclusion factors encompassed inadequate general health and oral hygiene, the presence of deep cross and/or open bite, missing teeth and/or respiratory disorders.

To perform the lateral cephalometric radiographs, heads were positioned in a cephalostat with the Frankfurt plane parallel to the ground. We used a Mind Tome Ceph model X x-ray machine, manufactured by Orion Corporation Soredex calibrated at 70 kVp and 10 mA, with exposure time ranging from 0.32 to 0.64 seconds. We used Kodak film, size 18 x 24 cm, equipped with a Lanex intensifier screen. For film development an automatic film developing machine was employed with transport motor compatible with Multi X 36 film spools, keeping chemical solutions at a temperature of 36°C and dry-to-dry development time at 3 minutes and 26 seconds.

The same equipment described above was used to obtain the left hand and wrist radiographs with hands outstretched and centered on the film. The x-ray machine was calibrated to operate at 60 kVp and 10 mA and 0.32 tenths of seconds exposure time using Kodak film, size 18 x 24 cm.

All cephalometric and hand and wrist ra-

diographs were obtained at the same location by a single operator. Only radiographs featuring sufficient clarity and contrast were used as to allow good visualization and identification of bone structures and with less than 6% distortion.

A digital gauge (Starret™) with 0.01 mm precision was used to perform all measurements.

Evaluation of mandibular dimensions

After identifying the relevant dentoskeletal and tegumental structures landmark definition was based on findings by McNamara Jr.¹⁵ and Wylie³⁰ (Fig 1):

- Me (Mentum),
- Go (Gonion),
- Pg (Pogonion),
- Gn (Gnathion),
- Co (Condyle),
- Fg (Located in the posterior-most region of the mandibular condyle).

According to the precepts by McNamara Jr.¹⁵ and Wylie³⁰ the following linear distances were measured (Fig 1):

1. Co-Gn: Effective mandible length (obtained by joining Co to Gn).
2. Co-Go: Mandibular ramus height (obtained by joining Co to Go).
3. Go-Gn: Mandibular body length (obtained by joining Go to Gn).
4. Fg-Pg: Total mandibular length (obtained through the orthogonal projection of both the pogonion and the posterior-most point of the mandibular condyle onto the Go-Me mandibular plane).

Evaluation of frontal sinus pneumatization

Based on R f and Pancherz,^{21,22,23} the following landmarks were selected (Fig 2):

1. Sh - Upper frontal sinus, located in the uppermost region of the frontal sinus.
2. Si - Lower frontal sinus, located in the lowermost region of the frontal sinus.

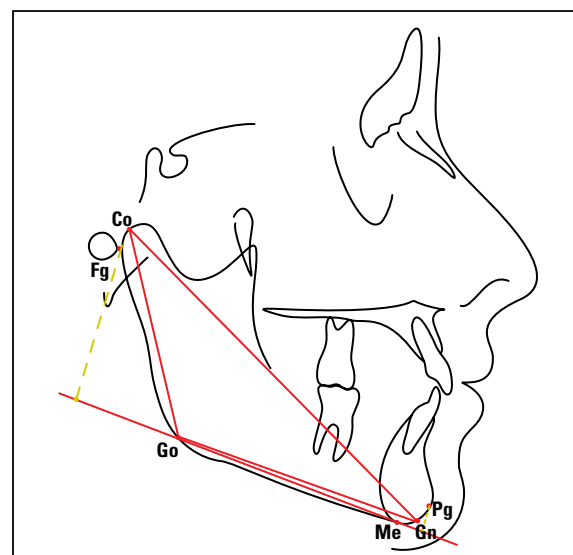


FIGURE 1 - Demarcation of anatomical landmarks and linear measurements.

After landmark identification the following lines were drawn (Fig 2):

1. Sh-Si line - Determined by the junction of Sh and Si.
2. Frontal sinus width - Determined by a line perpendicular to Sh-Si.

Linear distances used for evaluation of the frontal sinus pneumatization (Fig 2):

1. Sh-Si - Distance between Sh and Si representing frontal sinus height.
2. Perpendicular to Sh-Si - Distance at the greatest frontal sinus width, representing the width of the frontal sinus.

Evaluation of hand and wrist radiographs

With the purpose of determining skeletal age hand and wrist radiographs were evaluated using the method described by Ekl f and Ringertz⁵ due to their widespread application in clinical practice, ease of use and interpretation.^{5,25,29} Subsequently the proximal phalanx of the 3rd finger and the distal epiphysis of the radius bone were identified (Fig 3).

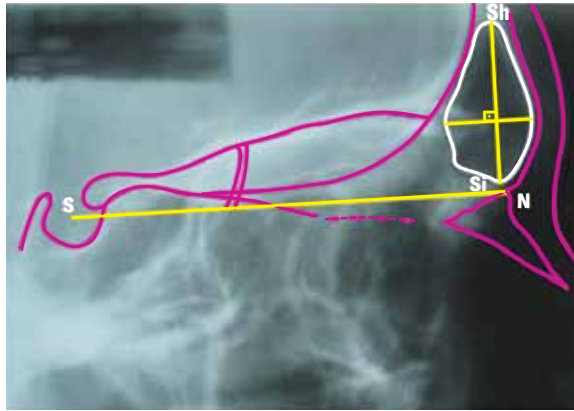


FIGURE 2 - Identification and demarcation of cephalometric landmarks, lines and frontal sinus magnitudes.

After tracing, the length of the proximal epiphysis of the 3rd finger and the width of the epiphysis of the radius were measured, using a digital gauge (Fig 3).

Measurements and tracings were performed twice by the same researcher in 20% of the sample, randomly selected and at intervals of about 30 days, resulting in two measurements of all magnitudes in order to minimize method error. Student's *t* test was applied, which allowed us to ascertain that there were no statistically significant differences between the first and second measures of all variables (Table 1).

Statistical methodology

Statistical analysis was performed on data pertaining to skeletal maturation observed in ossification centers present in the hand and wrist and frontal sinus radiographs as well as mandibular data observed in the lateral cephalometric radiographs. At first, our purpose was to establish a descriptive analysis of the data, obtain the mean, median, standard deviation and minimum and maximum values for each variable and each of the age groups.

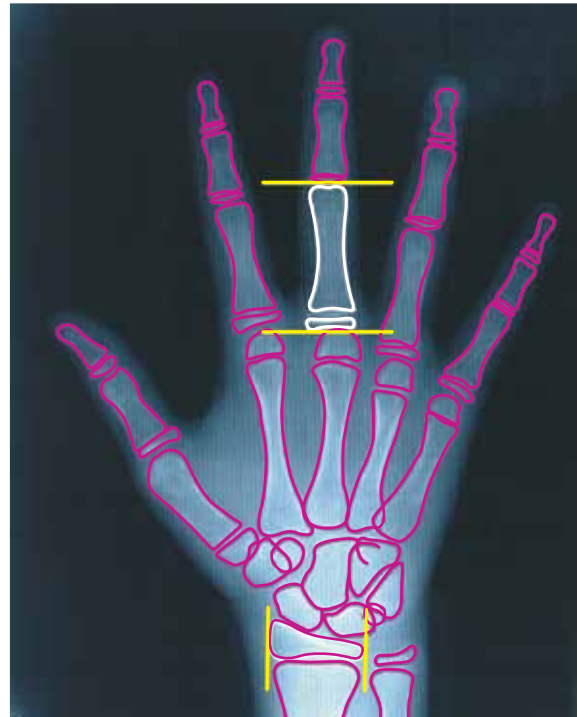


FIGURE 3 - Schematic drawing of the hand and wrist, highlighting the height of the proximal phalanx of the 3rd finger and the width of the epiphysis of the radius.

The data were compared to detect the presence or absence of correlations between frontal sinus variables, mandibular growth variables and those of the hands and wrists. Pearson's Correlation to check for a linear relationship was applied between these variables.

Factor Analysis was applied to find linear combinations between frontal sinus, mandibular measurements and hand and wrist measurements, i.e., frontal sinus height was the first variable, mandibular growth measurements the second variable, and the width of the distal epiphysis of the radius bone in conjunction with the height of the proximal phalanx of the 3rd finger represented the third variable. These three variables were also correlated with one another by using Pearson's Correlation.

All results were considered significant at a 5% significance level ($p < 0.05$).

TABLE 1 - Student's t test to assess method error.

	MEASUREMENTS	MEAN	P-VALUE
Mandibular Length	Co-Gn (1)	102.90	0.142
	Co-Gn (2)	102.94	
	Co-Go (1)	46.47	0.241
	Co-Go (2)	46.44	
	Go-Gn (1)	68.87	0.334
	Go-Gn (2)	68.90	
	Fg-Pg (1)	96.86	0.328
	Fg-Pg (2)	97.11	
Frontal Sinus	Frontal Sinus Height (1)	21.44	0.293
	Frontal Sinus Height (2)	21.40	
	Frontal Sinus Width (1)	7.46	0.060
	Frontal Sinus Width (2)	7.51	
Phalanx of 3rd finger Radius Bone	Height of proximal phalanx of 3rd finger (1)	35.86	0.070
	Height of proximal phalanx of 3rd finger (2)	35.95	
	Width of distal epiphysis of Radius (1)	21.88	0.164
	Width of distal epiphysis of Radius (2)	21.95	

RESULTS

The results achieved after statistical analysis are shown in Figures 4 to 10 and in Table 2.

Frontal sinus height and width at age 8 were 21.01 mm and 6.75 mm; at 9 years, 21.86 mm and 8.18 mm; at 10, 25.03 mm and 8.93 mm; at 11, 22.41 mm and 8.35 mm; at 12, 26.37 mm and 8.71 mm; at 13, 28.35 mm and 9.45 mm; at 14, 26.15 mm and 8.25 mm, respectively.

At 8 years of age, the subjects' mean height of the proximal phalanx of the 3rd finger was 34.82 mm and the width of the epiphysis of the radius measured 21.30 mm; at age 9, 36.89 mm and 22.46 mm; at 10, 40.01 mm and 25.85 mm; at 11, 40.97 mm and 27.38 mm; at 12, 42.54 mm and 27.67 mm; at age 13, 42.12 mm and 27.30 mm; at 14, 43.11 mm and 29.39 mm, respectively.

At 8 years of age, the following subject mea-

surements were found: Co-Gn = 100.76 mm, Co-Go = 45.68 mm, Go-Gn = 67.50 mm and Pg-Fg = 94.43 mm; at 9, 105.04 mm, 47.26 mm, 70.25 mm and 99.29 mm; at 10, 108.46 mm, 48.58 mm, 73.31 mm and 102.55 mm; at 11 years, 111.72 mm, 51.35 mm, 73.24 mm and 105.68 mm; at 12, 114.25 mm, 52.09 mm, 76.61 mm and 107.88 mm; at 13, 115.31 mm, 54.65 mm, 77.83 mm and 107.84 mm; at 14, 118.03 mm, 55.79 mm, 79.43 mm and 110.29 mm, respectively.

DISCUSSION

In the present study, we sought to correlate changes in the proximal phalanx of the 3rd finger and in the epiphysis of the distal radius (as assessed with the aid of hand and wrist radiographs), with frontal sinus pneumatization (as evaluated with the aid of lateral cephalometric

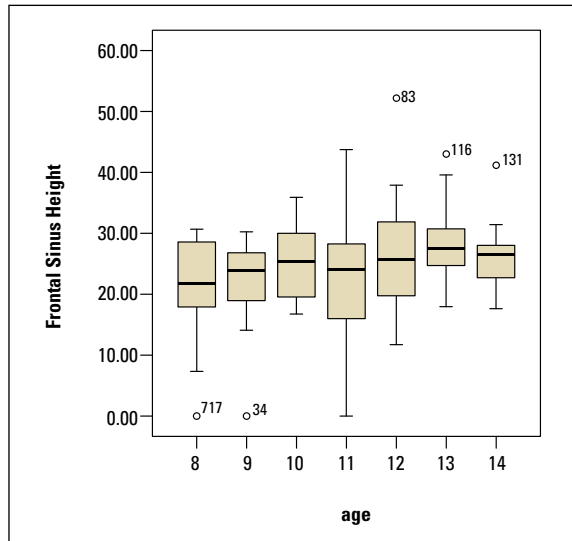


FIGURE 4 - Distribution of frontal sinus height and width by age groups.

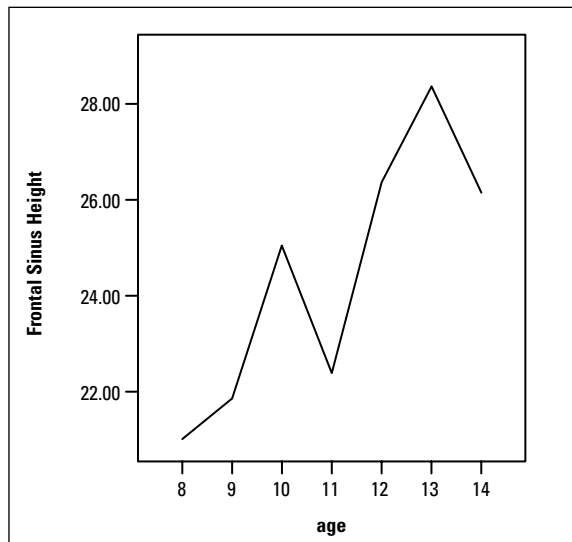
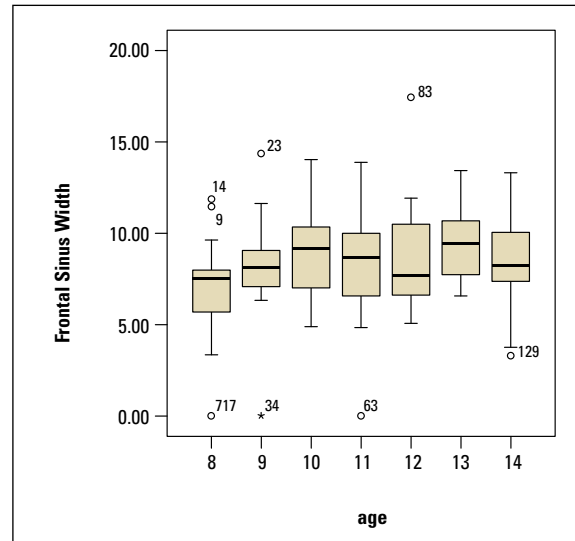
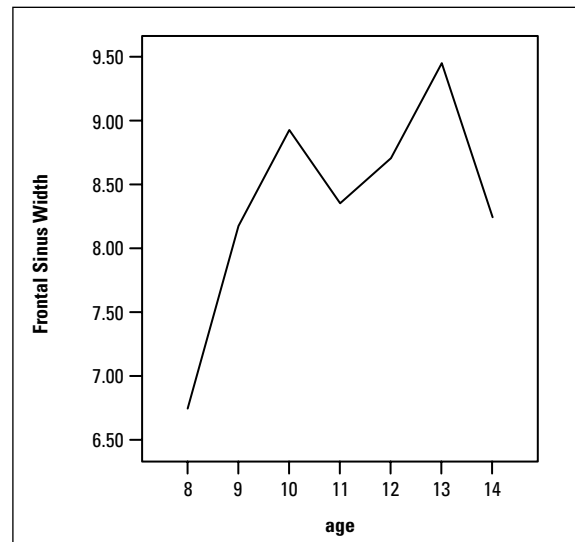


FIGURE 5 - Graph showing frontal sinus height and width means.



radiographs) and with anteroposterior mandibular growth.

To evaluate pubertal growth, hand and wrist radiographs were used given the accuracy afforded by this area. The methodology developed by Eklöf and Ringertz⁵ was selected because it is

suitable for the evaluation of Brazilian patients. It is also reliable and easily reproducible by different examiners using well defined parameters.

This study revealed that pubertal growth spurt began between 9 and 10 years of age and peaked at age 12. Figures 6 and 7 suggest

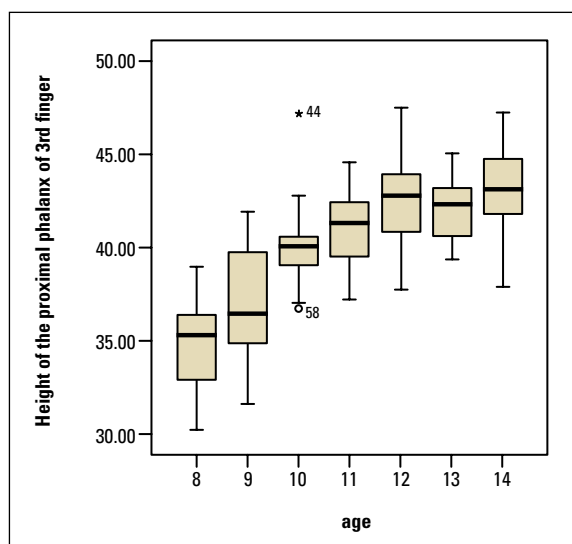


FIGURE 6 - Distribution of hand and wrist measurements by age groups.

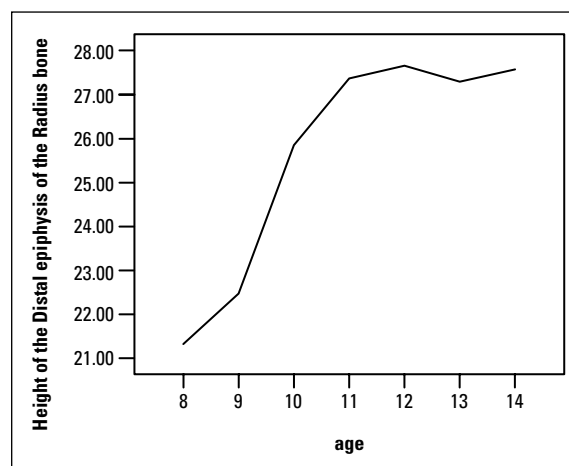
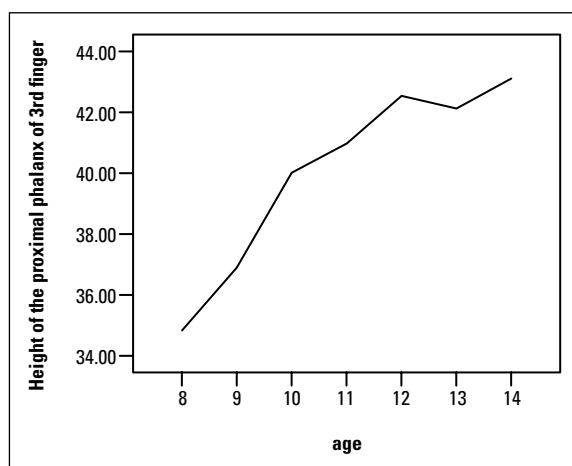
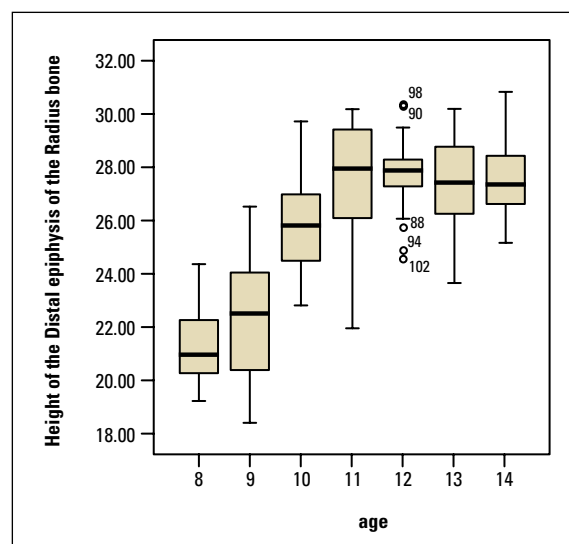


FIGURE 7 - Graph showing hand and wrist measurement means by age groups.

that young melanodermic women tend to experience premature skeletal maturation, which agrees with previous findings in the literature.^{4,29} A research conducted to evaluate young leucodermic women showed that the onset of pubertal growth spurt occurred at a mean age of 10.5 years and pubertal growth speed peaked on average 2 years after spurt onset^{2,9,10} or later,

between ages 13 and 14.²⁷

Frontal sinus pneumatization was also assessed as an indicator of bone age since the frontal sinus is significantly correlated with skeletal maturation—as assessed by hand and wrist radiographs^{7,20-23,29} and the time of maximum pneumatization nearly coincides with puberty in both genders.^{14,24}

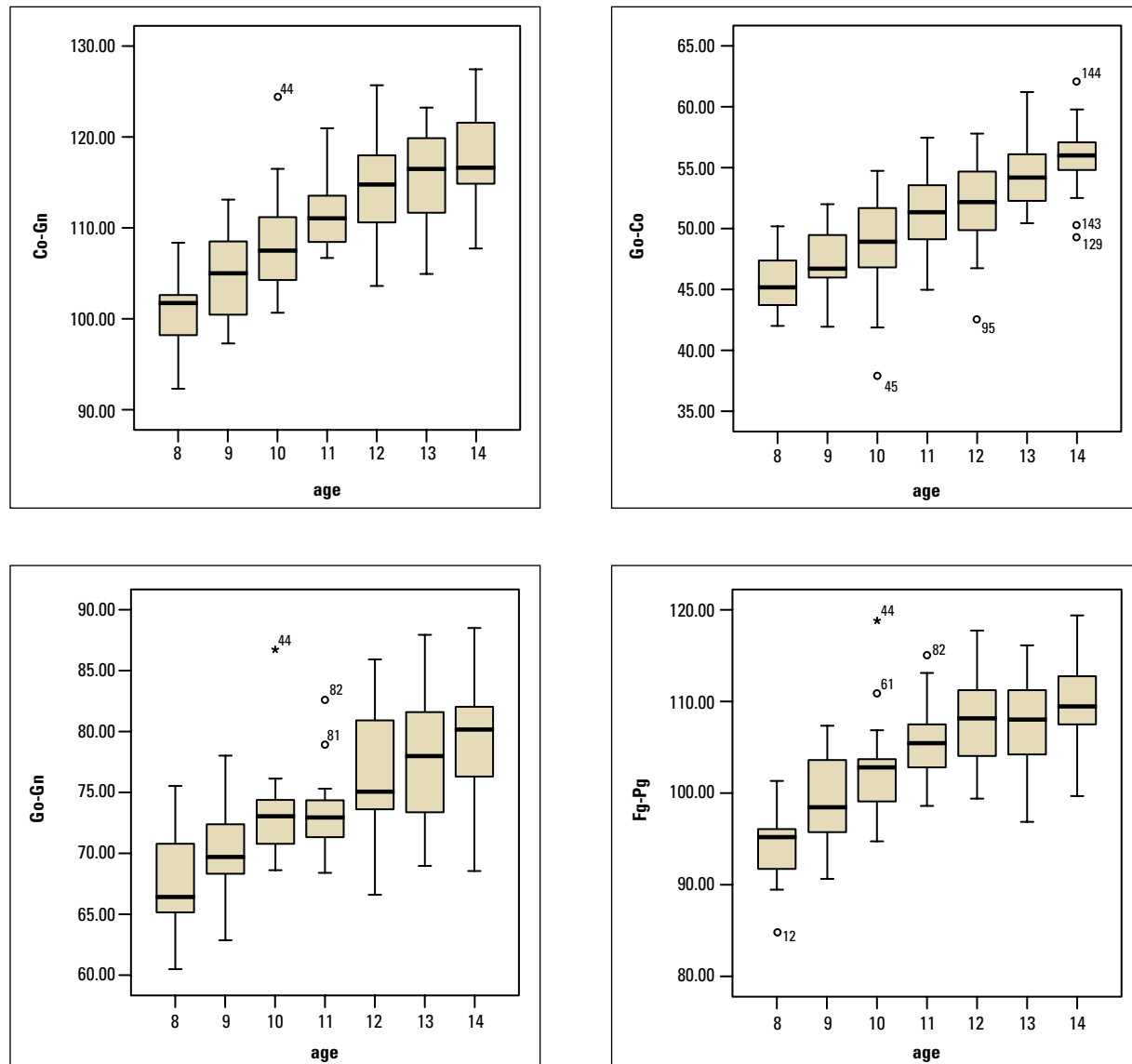


FIGURE 8 - Distribution of mandibular variables by age.

The maximum dimensions of frontal sinus height and width occurred at the age of 13 years confirming findings from previous studies.^{14,24,29}

Figures 4 and 5 illustrate the variations in frontal sinus height and width by age groups. It was noted that frontal sinus height and width experienced the highest increase at age 13, whereas the major increases in both variables

occurred between ages 9 and 10 and between 12 and 13. This study found a statistical correlation of 0.306 ($p < 0.001$) between frontal sinus height and width and the measurements obtained from hand and wrist radiographs, as seen in Table 2, which corroborates previous studies.²⁹

Figures 6 and 7 show the data pertaining to

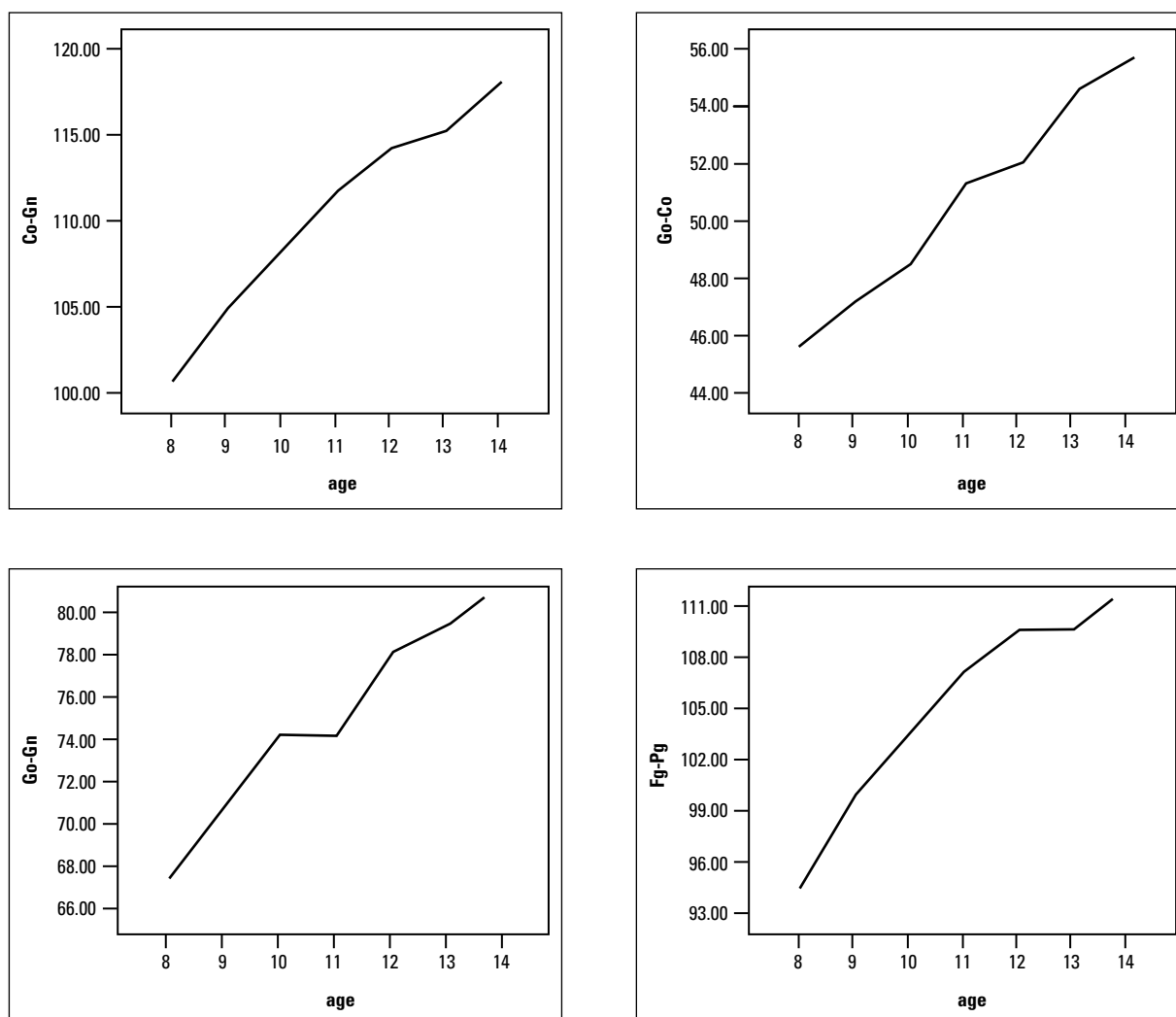


FIGURE 9 - Graph showing means for mandibular variables.

the width of the distal epiphysis of the radius bone and the height of the proximal phalanx of the 3rd finger. It was found that the width of the distal epiphysis of the radius and the height of the proximal phalanx of the 3rd finger increased with age. The only decrease was found in the mean of ages 12-13 whereas meaningful increases were found between ages 9 and 10. This information attests to the progression of phenomena related to skeletal maturation, as determined by changes in hand and wrist ossification

centers.^{2,3,6,9,10,13,27}

Figures 8 and 9 show an increase with age of all mandibular variables evaluated in this study, i.e., Co-Go, Co-Gn, Go-Gn and Pg-Fg. A progressive growth trend was found to exist in all variables. The variable Go-Gn demonstrated greater variability between age groups showing very similar means at ages 10 and 11 while variable Pg-Fg showed similar means at ages 12 and 13. This study corroborates previous investigations^{11,18,19,28} in terms of mandibular growth.

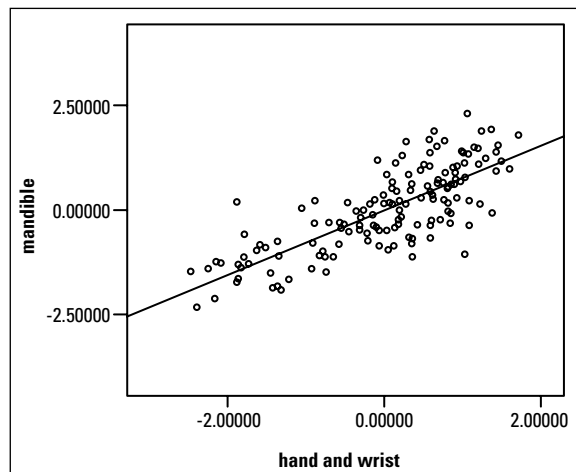
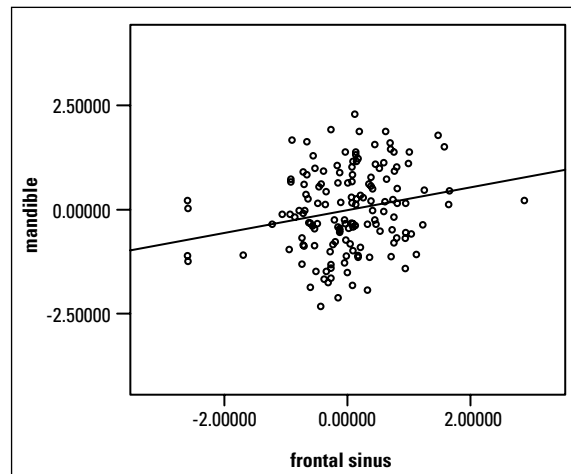
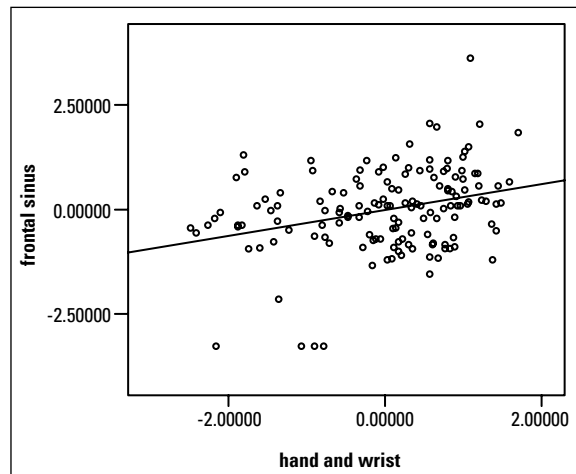


FIGURE 10 - Graphs showing dispersion of mandible, frontal sinus and hand and wrist indices.

CORRELATION BETWEEN FRONTAL SINUS, HAND AND WRIST AND MANDIBULAR MEASUREMENTS

In this study, we used a sample of young women who were still in their growth phase. Correlation was found not only between frontal sinus pneumatization and mandibular dimensions but also between frontal sinus pneumatization and skeletal maturity. Information obtained from previous studies pointed to a significant correlation between frontal sinus pneumatization, mandible size and skeletal maturity, respectively.^{12,14,20-23} Correlations were also found between height and mandibular growth.^{18,26} Other studies found no significant correlation between bone age and mandibular growth.^{16,19}

As can be observed in Table 2 and in the scatterplots of Figure 10, there was a significant and positive linear correlation between frontal sinus height and width, the height of the proximal phalanx of the 3rd finger and the width of the epiphysis of the radius bone, as well as with the mandibular length measurements, i.e., Co-Go, Go-Gn and Fg-Pg.

Also in Table 2, we found a correlation between mandibular growth features and pubertal growth features. Such correlation was found through an analysis of skeletal maturity based

TABLE 2 - Pearson's Correlation matrix for mandible, frontal sinus and hand and wrist dimensions.

		MANDIBLE	FRONTAL SINUS	HAND AND WRIST
Mandible	Correlation	1.000	0.218*	0.777*
	p-value		0.008	0.000
Frontal Sinus	Correlation		1.000	0.306*
	p-value			< 0.001
Hand and Wrist	Correlation			1.000
	p-value			

*p < 0.05.

on the evaluation of hand and wrist radiographs and frontal sinus pneumatization.

Table 2 shows that Pearson's correlation was found between mandibular, frontal sinus and hand and wrist indices. A significant correlation was found between the three indices ($p > 0.05$). In other words, as the hand and wrist indices increased so did frontal sinus indices. Hand and wrist indices increased side by side with mandibular indices. Finally, frontal sinus indices increased as mandibular indices also increased.

The correlations found between frontal sinus height and width, height of the proximal phalanx of the 3rd finger, width of the epiphysis of the radius and mandibular measurements were positive and significant at 5% probability.

CONCLUSIONS

In light of sample characteristics, methodology and the results and information obtained in this study, it is safe to conclude that:

A highly significant correlation was found between ossification centers observed on the hand and wrist radiographs and cephalometric measurements representative of the mandibular growth ($r = 0.777$). Although statistically significant, there was a low correlation between frontal sinus pneumatization and the progression of skeletal maturity ($r = 0.306$), as well as a relationship between the frontal sinus pneumatization and the cephalometric measurements representative of mandibular growth ($r = 0.218$).

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Breastfeeding, deleterious oral habits and malocclusion in 5-year-old children in São Pedro, SP, Brazil

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Abstract

Objective: To estimate the frequency of malocclusion and their associations with the type and period of breastfeeding, deleterious oral habits, and information received by mothers during the pre-natal period, in 5-year-old children attending municipal daycare centers. **Methods:** The sample consisted of 162 children resident in the municipality of São Pedro, SP, Brazil. In an interview with each of the mothers, information was collected about the time and form of breastfeeding, presence of deleterious habits, and information the mother received during the pre-natal period. The epidemiological exam was performed at the daycare center facilities by a single, previously calibrated examiner, under direct lighting. The following variables were evaluated: presence and severity of malocclusion [slight overcrowding and spacing (OS)], open occlusal relationship (open bite) (OPB), vertical overlap (over bite) (OVB), uni- or bilateral crossbite (CB), positive overjet (OV) and the primary second molar terminal plane relationship (TPR)]. Data analysis consisted of univariate analysis (chi-square test) and multiple logistic regressions. **Results:** The prevalence of malocclusions was 95.7% (OS = 22.8%; OPB = 24.7%; OVB = 20.4%; CB = 14.8%; and OV = 13.0%). In TPR the straight terminal plane was predominant (85.0%). Among the deleterious oral habits, the use of a pacifier was the only risk indicator (OR = 5.25; $p = 0.001$) for open occlusal relationship (open bite) in children that used it for over three years, detected in the logistic regressions. **Conclusion:** The prevalence of malocclusions and deleterious oral habits in the studied sample was high. Children that used a pacifier for over three years showed greater probability of presenting with open occlusal relationship (open bite).

Keywords: Breastfeeding. Malocclusion. Children.

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INTRODUCTION

Breastfeeding is far more than mere nutrition; it is a decisive and primordial factor in the correct maturation and growth of the stomatognathic system structures, maintaining them apt for exercising the development of the orofacial musculature, which in turn will guide and stimulate the development of physiological functions, guaranteeing survival and quality of life.⁴ The stomatognathic system performs many functions, comprising suction, swallowing, chewing, speech/articulation, which involve the neuromuscular activities of the face, affecting and producing continual changes in the forces that act on bones and teeth.²¹ Therefore, breastfeeding is the best orthopedic appliance one can offer an adult's face in terms of harmonious development.²⁵

The World Health Organization (WHO) recommends that the nutritional and immunological conditions of mother's milk cannot be replaced by any other natural or synthesized product, however, it has still not recognized the severe lesions that are produced in the stomatognathic system by the lack of functional stimuli coming from nursing at the mother's breast, which is imperative for the good development of the system in the most important period of the new being's life.

In fact, natural breastfeeding is performed through enormous muscular effort. The newborn is forced to bite, advance and retract the mandible, which makes the entire muscular system, particularly the masseter, temporal and pterygoid muscles develop and acquire the muscular tonus required for use when the time for chewing arrives. On the other hand, the early introduction of the feeding bottle, although it satisfies the baby's nutritional needs, annuls an enormous quantity of excitation that begins in the mouth, particularly of the temporomandibular joints, and does not provide the development responses necessary for facial

growth and development.

Thus, deviations in the development of the stomatognathic system may become established right from the time of babyhood. Many malocclusions result from the combination of small deviations from normality, which are still far too slight to be classified as abnormal, but their combination and persistence help to produce a clinical problem that must be solved. Frequently they originate from noxious orofacial muscular habits, attributed to alternated functions such as prolong non-nutritional sucking, inadequate dietary habits, pasty diet, nasopharyngeal diseases, respiratory function disturbances, abnormal tongue posture and caries disease. In this context, the majority of malocclusions can be prevented.¹⁷

Therefore, the study of malocclusions and their relationship with deleterious oral habits and functional imbalance of primary occlusion is of extreme relevance, both in the Public Sector and in private clinics, in order to obtain parameters of action for functional orthopedic programs targeting the community, which in general presents a low frequency of natural breastfeeding, with high prevalence of early weaning.

In this context, the aim of this study was to estimate the frequency of malocclusions and their associations to the type and period of breastfeeding, deleterious oral habits and information with reference to the pre-natal period, in 5-year-old children who frequented the municipal daycare centers in the municipality of São Pedro, SP, Brazil.

MATERIAL AND METHODS

Ethical aspects

This study was approved by the Research Ethics Committee of the Piracicaba School of Dentistry, University of Campinas, in accordance with National Health Council resolution 196/96 of 10/10/1996 of the Ministry of Health, Process Number 108/2004.

Study location

This research was developed in the municipality of São Pedro that has an estimated population of 23,352 inhabitants in a territorial area of 618 km², with 80% of people residing in the urban area. The economic profile of the city is characterized by the mean nominal income of R\$ 644.55 for persons aged 10 years or older, and with 1,437 persons without schooling or less than one year of schooling. In the municipality, there are 11 health establishments, with seven providing service to the National Health Service (SUS), 80 hospital beds of which 38 provide services to SUS.⁸ Around 22.63% of the pregnant mothers in the municipality received over six consultations in the prenatal period. The population from zero to six years of age consists of 2,912 children, 100% have received the complete vaccination schedule and 6.67% are enrolled in daycare centers. Around 50.65% of the fathers and 20.43% of the mothers of these children have a precarious educational level (less than four years of schooling). In the Brazilian Childhood Status map (2001), the municipality of São Pedro was ranked 960th in the Federal and 318th in the State classification, with a Childhood Development Index of 0.609 still considered unsatisfactory.²⁸

Study design

This cross-sectional study was developed in three stages. The first stage was based on collecting retrospective information about the period and type of breastfeeding and sucking habits, by means of interviews with the parents. The second stage was composed of a cross-sectional epidemiologic survey about malocclusion.

Study universe

The target population was all the 5-year-old children regularly enrolled in the Municipal Daycare Centers of the city of São Pedro-SP in 2005, totaling 186 children. The sample was distributed among three Municipal Infant

Educational Centers (CEMEIs) (CEMEI Dra. Halina Buba Baldon, CEMEI Maria Amélia Pimentel e CEMEI Maria Angelina Leão Ferreira dos Santos). The Municipal Secretary of Education uses socioeconomic criteria for children entering the Municipal Daycare Centers, which made the sample homogeneous from this aspect. The studied population represented individuals from categories SES C, D and E of the population. The children excluded from the study were those whose parents or legal representatives did not return the signed Term of Free and Informed Consent (TFIC) and/or completed questionnaire. Thus the final sample consisted of 162 children.

First stage interview with parents

During pre-scheduled meetings, the mothers received and signed the TFIC, authorizing the child's participation in the research. After this, a personal interview was held with each mother, following a pre-tested questionnaire to collect information about the time and form of breastfeeding and the presence of deleterious habits.

Second stage: Epidemiological survey of malocclusion

The survey was conducted at the Daycare Center facilities, by a single, calibrated examiner, using a school chair, under direct lighting, in accordance with the biosafety rules in force in the country, at intervals of approximately five minutes for each exam.

Examiner calibration consisted of previous training, in order to reduce the disagreements of interpretation relative to the researched conditions at the time of applying the criteria proposed by the World Health Organization.²⁹ To evaluate the effectiveness of calibration, 18 children previously selected at one of the Daycare Centers were evaluated by the examiner with regard to all the survey items. The Kappa values for intra-examiner agreement ranged from 0.85 to 0.91, agreement being considered excellent.¹¹

Codes and criteria used in the exam

Classification of malocclusion

For the age of 5 years, the same index was adopted as that recommended by the SB Brazil Project – Survey on Brazilian Population Oral Health Conditions.³ The codes and criteria used were those recommended by the WHO, 1987 version, since it presents the conditions relative to each category of malocclusion defined with greater precision, offering more elements for considering the problem. Thus, the following criteria were adopted for classifying the occlusal condition at 5 years of age:

- Normal: absence of occlusal alterations.
- Slight: When there are one or more teeth with disturbance of position (rotation); or slight crowding; or spacing harming regular alignment.
- Moderate/Severe: When there was an unacceptable effect on facial appearance; or a significant reduction in masticatory function; or phonetic problems observed due to the presence of one or more of the following conditions in the four anterior incisors: 1) maxillary horizontal overlap estimated at 9 mm or more, positive overjet; 2) mandibular horizontal overlap, anterior reverse articulation (cross-bite) equal to or greater than the size of one tooth, negative overjet; 3) open occlusal relationship (open bite); 4) midline deviation estimated at 4 mm or more and; 5) crowding or spacing of 4 mm or more.

It is worth pointing out that the occlusal alterations that were not explicit in the above criteria, such as posterior reverse articulation (uni or bilateral posterior crossbite), overbite or vertical overlap of over 2 mm were included in the slight category.

Molar relationship

The distal relationship of the maxillary and mandibular primary second molars was classified according to Baume:²

- Straight: Forming a plane.
- Distal step: Forming a distal step to the mandible.
- Mesial step: Forming a mesial step to the mandible.

Statistical analysis

To verify the association of the most frequent malocclusions in the sample with the forms of breastfeeding, deleterious oral habits, and information received by the mothers during the prenatal period, the chi-square test for contingency tables (univariate analysis) was used. Variables that presented $p \leq 0.15$ in the test of association were selected to enter in the multiple logistic regression analysis. The Odds Ratio (OR) and respective confidence intervals of 95% were estimated for the indicators that remained in the multiple regression model at the level of 5%. All the analyses were performed using the statistical program SAS.²²

RESULTS

The response rate for the study was 87%, since the children that had no authorization, or whose parents did not appear at meetings to answer the questionnaire were excluded.

The results collected in the questionnaire showed that the majority (55.5%) of the children were breastfed up to the age of six months, and that 11.1% ($n = 18$) of the children were never breastfed. Regarding exclusive breastfeeding (EBF), only 12.3% did not receive exclusive breastfeeding. About 68% of the mothers did not have access to information about natural breastfeeding, exclusive breastfeeding, use of feeding bottle, pacifier and finger sucking, during the prenatal period. The predominant educational level of the mothers (61.1%) was from 1 to 4 years of formal schooling. As regards the deleterious oral habits, 93.2% of the children made use of a feeding bottle (Table 1).

In the epidemiological exam it was verified that 4.3% ($n = 7$) of the children presented normal occlusion, 58.6% ($n = 95$) slight and 37.1% ($n = 60$) moderate/severe malocclusion. Figure 1 displays graphs that show the distribution of malocclusions and the molar relationship in the studied sample. It was verified that over half the

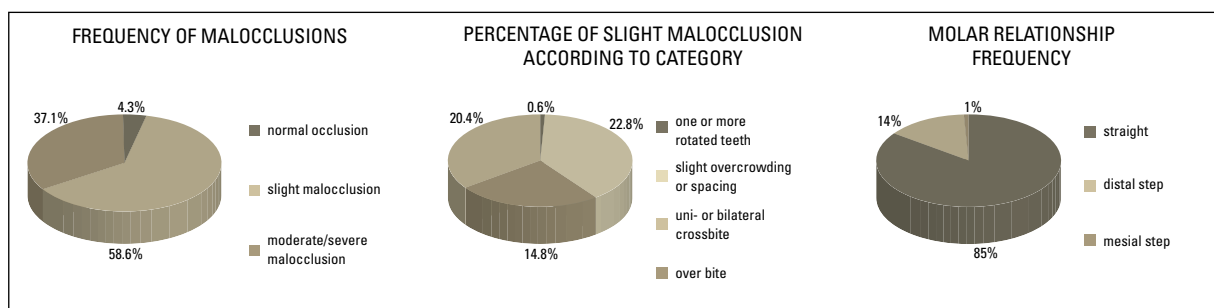


FIGURE 1 - Graphical illustration showing distribution of malocclusions and of molar relationship.

TABLE 1 - Sample distribution according to the variables collected in the interview (n = 162).

VARIABLE	CATEGORY	N	%
Time of breastfeeding	Not breastfed	18	11.1
	Up to 6 months	90	55.5
	Longer than 6 months	54	33.3
Time of exclusive breast-feeding (EBF)	Not breastfed	20	12.3
	Up to 3 months	69	42.6
	Longer than 3 months	73	45.1
Mothers who received information in the prenatal period	Yes	52	32.1
	No	110	67.9
Mothers educational level	1st to 4th grade	99	61.1
	5th to 8th grade (high school)	38	23.5
	Middle School	2	1.2
	Higher education	2	1.2
Deleterious oral habits	Use of feeding bottle	151	93.2
	Use of pacifier	103	63.5
	Finger sucking	14	8.6

children (58.6%) presented slight malocclusion. Within each category (light malocclusion and moderate/severe malocclusion) the pertinent classifications were also evaluated, with the aim of evaluating the problem more precisely. With

regard to the slight malocclusion, slight crowding or spacing harming the regular alignment was found in 22.8%, uni- or bilateral posterior reverse articulation (crossbite) in 14.8% and vertical overlap (overbite) of more than 2 mm in 20.4% (n = 32). Among the moderate/severe malocclusion, positive overjet was observed in 13.0% (n = 21) and open occlusal relationship (open bite) in 24.7% (n = 36) of the sample. In the majority of the children, the molar relationship was the straight terminal plane (85.0%).

In the univariate analysis, using the presence of deleterious oral habits as a dependent variable, it was verified that the time of exclusive breastfeeding presented statistically significant association ($p = 0.0035$), in contrast with the time of breastfeeding and the information received in the prenatal period, which were not associated with the dependent variable (Table 2). Nevertheless, in the multivariate analysis no statistical significance was verified between deleterious oral habits and time of exclusive breastfeeding (the only variable that entered the model).

Tables 3, 4 and 5 show the results of the univariate analysis between the independent and dependent variables (malocclusion).

In Table 3, the variable "time of pacifier use" ($p = 0.0302$) was associated to "Slight Presence of Crowding or Spacing" whereas the variable "time of breastfeeding" ($p = 0.0476$) was associated to the "Presence of Positive Overjet", both at

TABLE 2 - Univariate Analysis (Chi-square test) between independent variables and deleterious oral habits.

Independent Variables		Deleterious oral habits		p-Value
		Presence n/N (%)	Absence n/N (%)	
Time of breastfeeding	0 to 6 months	108/108 (100.0%)	0/108 (0.0%)	1.000
	Longer than 6 months	47/54 (87.04%)	7/54 (12.96%)	
Time of EBF	0 to 3 months	88/88 (100.0%)	0/88 (0.0%)	0.0035
	Longer than 3 months	67/74 (90.54%)	7/74 (9.46%)	
Information in prenatal period about breastfeeding and habits	Yes	50/52 (96.15%)	2/52 (3.85%)	1.0000
	No	105/110 (95.45%)	5/110 (4.55%)	

TABLE 3 - Univariate Analysis (Chi-square test) between independent variables and dependent variables: Presence of slight crowding or spacing; Presence of positive overjet.

Independent Variables		Dependent Variables			
		Presence of slight crowding or spacing		Presence of positive overjet	
		n/N (%)	p-Value	n/N (%)	p-Value
Time of breastfeeding	0 to 6 months	25/108 (23.15%)	0.8819	16/108 (14.81%)	0.0476
	Longer than 6 months	13/53 (24.53%)		5/53 (9.43%)	
Time of EBF	0 to 3 months	24/88 (27.27%)	0.4188	10/88 (11.36%)	0.6135
	Longer than 3 months	14/72 (19.44%)		11/74 (14.8%)	
Time of feeding bottle use	0 to 3 years	22/75 (29.33%)	0.1365	6/75 (8.00%)	0.1019
	Longer than 3 years	16/87 (18.39%)		15/87 (17.24%)	
Time of pacifier use	0 to 3 years	31/107 (28.97%)	0.0302	14/107 (13.08%)	1.000
	Longer than 3 years	7/55 (12.73%)		7/55 (12.73%)	
Finger sucking	Sucked fingers	5/14 (35.71%)	0.3203	4/14 (28.57%)	0.0878
	Did not suck fingers	33/148 (22.30%)		17/148 (11.49%)	

a level of significance of 5%. The results of Table 4 showed evidence that no malocclusion was associated to the presence of posterior reverse occlusal relationship (posterior crossbite); nevertheless the variables time of breastfeeding ($p = 0.0152$) and time of exclusive breastfeeding ($p = 0.0233$) were associated to the presence of vertical overlap (overbite). Multiple logistic regression analyses were performed for each dependent variable

described above, including the independent variables that obtained a level of significance of up to 15%. Nevertheless, no independent variable remained in the logistic regression model.

Table 5 shows the univariate analysis and multiple logistic regression analysis for the malocclusion "presence of open occlusal relationship (open bite). The time of feeding bottle use ($p = 0.0898$) and time of pacifier use ($p = 0.001$) were

TABLE 4 - Univariate Analysis (Chi-square test) between independent variables and dependent variables: Presence of posterior crossbite; Presence of overbite.

Independent Variables		Dependent Variables			
		Presence of posterior crossbite		Presence of overbite	
		n/N (%)	p-Value	n/N (%)	p-Value
Time of breastfeeding	0 to 6 months	18/108 (16.67%)	0.5589	15/108 (13.89%)	0.0152
	Longer than 6 months	6/53 (11.32%)		17/54 (33.08%)	
Time of EBF	0 to 3 months	14/88 (15.91%)	0.2735	11/88 (12.50%)	0.0233
	Longer than 3 months	9/72 (87.50%)		21/74 (28.37%)	
Time of feeding bottle use	0 to 3 years	9/75 (12%)	0.3831	17/75 (22.67%)	0.4321
	Longer than 3 years	15/87 (17.24%)		15/87 (17.24%)	
Time of pacifier use	0 to 3 years	15/107 (14.02%)	0.8157	24/107 (22.43%)	0.2988
	Longer than 3 years	9/55 (16.36%)		8/55 (14.55%)	
Finger sucking	Sucked fingers	0/14 (0.00%)	0.2278	3/14 (21.43%)	1.000
	Did not suck fingers	24/148 (16.22%)		29/148 (19.59%)	

TABLE 5 - Univariate Analysis (Chi-square test) and multiple logistic regression analysis between the presence of open bite and independent variables.

Independent Variables		UNIVARIATE ANALYSIS		MULTIPLE LOGISTIC REGRESSION ANALYSIS	
		Presence of open bite		Presence of open bite	
		n/N (%)	p-Value	OR (IC95%)*	p-Value
Time of breastfeeding	0 to 6 months	27/108 (25.00%)	0.4679		
	Longer than 6 months	9/53 (16.98%)			
Time of EBF	0 to 3 months	23/88 (26.14%)	0.4005		
	Longer than 3 months	13/72 (18.06%)			
Time of feeding bottle use	0 to 3 years	12/75 (16.00%)	0.0898		
	Longer than 3 years	24/87 (27.59%)			
Time of pacifier use	0 to 3 years	13/107 (12.15%)	0.001	1.00	0.001
	Longer than 3 years	23/55 (41.82%)		5.25 (2.208-11.494)	
Finger sucking	Sucked fingers	2/14 (14.29%)	0.7371		
	Did not suck fingers	34/148 (22.97%)			

* OR: Odds Ratio; IC: Interval of confidence 95%.

associated to the presence of open occlusal relationship (open bite). In the regression analysis only the variable time of pacifier use remained in the model. The children that used a pacifier for longer than 3 years had 5.25 greater probability of presenting open occlusal relationship (open bite) than the others ($p = 0.001$).

DISCUSSION

Over the course of years, several authors have been concerned about studying the association between the form of feeding babies and the establishment of deleterious habits, and from these, the development of malocclusion in children.^{1,4,5,9,15,17,19,20,23}

The present research consisted of a survey of malocclusions in 5-year-old children who frequented municipal daycare centers, children of parents with a precarious educational level, the majority belonging to the social class C, D and E. Low frequency was found of mothers that breastfed their children naturally for periods that favored the non establishment of deleterious habits and muscular maturation for functional mastication.

In the studied sample, only 4.3% of the children did not present any type of malocclusion; that is, without any anomaly with regard to the bony structures and dental positions. At first sight this result is alarming, considering that 95.7% presented some type of malocclusion, and is in disagreement with the results of other researches, such as Tomita's²⁶ in pre-schoolchildren from 3 to 5 years old, who found alterations in 50%; Legovic and Ostric¹² who found 46.9%. The lack of a specific index for recording and measuring occlusal problems in this age bracket could be the explanation for these percentage differences between the children of the present study and other researches.

Using the World Health Organization index, it was observed that 58.6% of the children presented slight, and 37.1% moderate/severe malocclusion, totaling 95.7%. Frazão⁶ observed that at

5 years of age, 22.9% of children presented slight malocclusion, 26.1% moderate/severe malocclusion, totaling 64.5% of malocclusion and 35.5% of normal occlusion. The project "SB Brasil"³ found slight malocclusion in 22%, moderate/severe malocclusion in 14.5%, totaling 36.5% of malocclusion and 63.5% of normal occlusion. It was observed that when one added the frequencies of normal occlusion and slight malocclusion in the various surveys, they were close to one another. Probably, the index used for mixed and permanent dentition, and not a specific index for the stage of development of primary dentition is the cause of the differences in the results.

In an endeavor to arrive at a more detailed occlusion status of the sample, the category of the World Health Organization index was analyzed.¹⁶ The data of this research with reference to the survey of malocclusion, relates that as regards the most frequent categories, slight crowding and spacing were found in the sample in 22.8% of the children, open occlusal relationship (open bite) in 24.7%, vertical overlap (overbite) of more than 2 mm in 20.4%, uni or bilateral reverse articulation (crossbite) in 14.8% and positive overjet in 13.0%.

When the terminal classification of molars was used, around 85.0% of the children were classified as having normal molar relationship, showing that in the primary dentition such factors are of little epidemiological relevance, since this anomaly receives a strong genetic influence.¹³ Hereditariness or genetics, understood as multiple inheritance of genes, seems to exert a strong influence on the skeletal characteristic of certain cranial-facial dimensions. The influence of genetic aspects is particularly strong for mandibular prognathism,¹³ whereas variations in occlusal characteristics appear to be environmentally determined.⁷

When the most frequent malocclusions in the sample were associated to the possible environmental causes of occlusal problems, such as forms of feeding babies and deleterious oral habits, it

was verified that the time of pacifier use was associated with the slight crowding and spacing and open occlusal relationship (open bite) in the univariate analysis. In the logistic regression the time of pacifier use was an indicator of risk for open occlusal relationship (open bite) as the children that used the pacifier for longer than 3 years have 5.25 more chance of presenting open occlusal relationship (open bite) in comparison to the other, results in agreement with those of Serra Negra et al²³ and Tomita.²⁶ The etiological significance of the predominance of pacifier use in the sample could also be attributed to sociocultural aspects on natural breastfeeding.

The results of the present study showed that 85.0% of the children presented occlusion in a straight molar relationship and the most frequent malocclusions were slight crowding and spacing, open occlusal relationship (open bite), vertical overlap (overbite) of more than 2 mm, uni- or bilateral reverse articulation (crossbite), and positive overjet. Probably, the etiology is environmental in the studied population, showing that these occlusal alterations appear in great frequency such as those found in the researches of Kabue et al¹⁰ and Tschill et al.²⁷ It is important to point out that when detected, they should receive early interventions, as related by McNamara and Brudon,¹⁴ Planas¹⁸ and Simões.²⁴

To sum up, the results of the present research showed that the prevalence of malocclusion in 5-year-old children (60 months) who attend the municipal Daycare Centers in the city of São Pedro, São Paulo, was of an epidemiologically high value (95.7%) in comparison with values in the studied literature. The most frequent malocclusions, in a decreasing order of frequency were as follows: slight crowding or spacing, open occlusal relationship (open bite), vertical overlap (overbite), uni or bilateral reverse articulation (crossbite) and positive overjet. For the molar relationship, the straight terminal plane presents a high epidemiological value, showing a probable

environmental etiology of these malocclusions. There was association between the malocclusions and deleterious oral habits, and pacifier use was shown to influence the development of open occlusal relationship (open bite). Natural breastfeeding for over 6 months (33.3%) and exclusive natural breastfeeding for over 3 months (45.1%) presented low epidemiological values; whereas the presence of deleterious oral habits showed high frequency (95.6%) in the studied population. The time of exclusive breastfeeding was shown to influence the absence of deleterious oral habits.

The results of this and other surveys suggest that the etiology of the majority of malocclusions in adults is environmental, already presenting deviations from normality at the breastfeeding; however, as regards the action on the determinant environmental causes, a specific index is required for measuring the problem. Therefore, the public Health Services could perform actions in the prevention of malocclusion in an organized manner, so that they become economically sustainable and socially accessible, differing from the current situation of offering orthodontic treatments, in the face of the populations needs. Moreover, during the survey of the occlusal status of the sample, it was necessary to use indexes established in other surveys, however, a need was observed for an index that reflects the problem in the initial stages, demonstrating initial deviations from normality both of static and dynamic occlusion for each stage of the child's development. Generally, the indexes used in surveys of occlusion in primary dentition do not consider small deviations from normality, and one has to wait for the problem to develop in order to measure them. One observes that the offer of diagnostic instruments and treatments predominates for acting in the period of mixed or permanent dentition, and that problems in the initial stages of primary dentition are not considered or treated by the oral health team.

Furthermore, studies are suggested for the creation of an index for even younger ages than the

one studied, reaching up to the baby's mode of feeding, which measure deviations from normality that precede the establishment of the malocclusion. It could also be suggested that health system managers and professionals in private clinics include planned and continuous educational actions as regards natural breastfeeding and its implications in the planning and organization of Preventive Orthodontic Programs; as well as interventions at the stage of primary dentition, based on etiologic, morphologic and functional diagnosis to reduce the percentage of malocclusion in the population to more economically bearable and socially acceptable levels, in the mid and long term.

CONCLUSION

The prevalence of malocclusion in 5-year-old children who attend the municipal Daycare Centers in the city of São Pedro, São Paulo, was of an epidemiologically high value (95.7%) in comparison to values in the studied literature. Moreover, the presence of deleterious oral habits also showed high frequency (95.6%) in the population. Significant associations could be observed between some deleterious oral habits and some malocclusions, with emphasis on the time of pacifier use, which was shown to have significant influence and was an indicator of the presence of open occlusal relationship (open bite).

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Frictional forces in stainless steel and plastic brackets using four types of wire ligation*

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Abstract

Objective: This in vitro study evaluated and compared the frictional resistance of stainless steel and polycarbonate (PC) composite brackets tied with metal wire and elastomeric ligation.

Methods: Four stainless steel and four polycarbonate composite brackets for premolars were placed in a universal testing machine for the traction of a piece of 0.019 x 0.025-in wire at 0.5 mm/min and total displacement of 8 mm. Ligations were performed according to the following alternatives: metal ligation with Steiner tying pliers; metal ligation using Mathieu tying pliers; Morelli™ elastomeric ligation; and TP Orthodontics™ elastomeric ligation.

Results and Conclusions: Elastomeric modules generated more friction than the metal ligations, and the ligation with the Mathieu tying pliers caused less friction than all the other conditions under study. PC brackets generated less friction than metal brackets, but the choice of material to be used in clinical conditions should take into consideration other variables, such as resistance to shearing and to fractures, as well as color stability and microorganism adherence.

Keywords: Friction. Orthodontic ligation. Metal bracket. Plastic bracket.

INTRODUCTION

Orthodontics is based on the movements of teeth within the alveolar bone bed due to the forces applied. This process may be facilitated or complicated by the subsequent response of tissues and the appropriate and rational use of the mechanical resources available.⁸ Frictional forces pose clinical challenges: they should be understood and controlled because their increase may be an advantage when used for an-

chorage, but harmful because of their effects in sliding mechanics.¹²

The nature of friction in orthodontics depends on several factors and is determined by mechanical and biological factors:^{1,3,9}

Physical/mechanical factors

- Properties of the orthodontic wire: material, cross section, thickness, surface texture and hardness.

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- Type of ligation between wire and bracket: material and ligation, and type of instrument used.

- Properties of the bracket: material, surface treatment, manufacturing process, slot dimensions, number of wings.

- Orthodontic apparatus: interbrackets distance, difference in height between brackets and force applied for retraction.

Biological and environmental factors

- Saliva, bacterial plaque, acquired film.
- Corrosion.

In summary, the force generated depends primarily on the materials used in the system, their physical properties, their interactions with the environment and their application, including their ligation.

Esthetic brackets have been focused by the orthodontic material industry. Several materials have been tested: zirconium, porcelain and polycarbonate. They are currently produced with small changes in their structures, depending on the manufacturer. Although clear brackets are more esthetic than metal brackets, they have a series of disadvantages, such as the high

incidence of fracture and damage to the enamel during debonding in the case of porcelain, and lack of stability of color, little resistance to wear and failure in incorporating the torque forces in the case of plastic brackets.

However, esthetic brackets are part of our current practice, and their future in orthodontics seems clear. Therefore, this study evaluated their mechanical properties, particularly frictional forces, in association with the following variables: type of bracket material (metal or polycarbonate composite), type of ligation (metal or elastomeric) and instrument used (Mathieu or Steiner tying pliers).

MATERIAL AND METHODS

Eight twin brackets for premolars were used; four were made of stainless steel (Fig 1) and four, of polycarbonate composite (PC) reinforced with 30% glass fiber (Fig 2), whose slots measured 0.022 x 0.030-in. The brackets were bonded with epoxy resin to a metal support and the set was placed in a universal testing machine for traction of the stainless steel wire segment with a rectangular section of 0.019 x 0.025-in, at 0.5 mm/min at a total of 8.0 mm displacement in dry medium (Fig 3).



FIGURE 1 - Metal bracket used in the study.



FIGURE 2 - Polycarbonate composite (plastic) bracket used in the study.

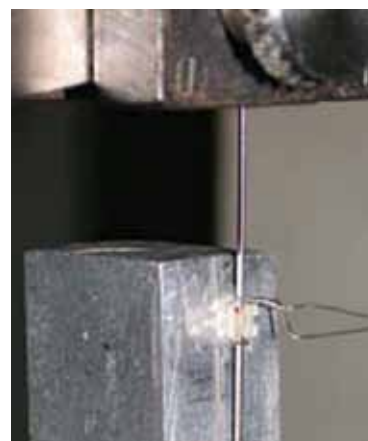


FIGURE 3 - Detail of the metal wire tied to the plastic bracket bonded to the metal support and placed in the universal testing machine.

According to information provided by manufacturers, the polycarbonate composite brackets are injected parts with a density of 1.4 g/cm³ and typical hardness of 74 in the Shore scale; and conventional or unsintered metal brackets had a density of 7.4 to 7.9 g/cm³.

The instruments for ligation were the Steiner or the Mathieu tying pliers, which were used, for each experimental situation, by the same operator using a 0.010-in-thick stainless steel wire (10 loops). Elastic tying was simple, around the bracket wings, and performed with two types of elastomeric ligations: TP Orthodontics™ and Morelli™. The ligation was positioned using an adaptor for elastomeric ligations.

Fifteen repetitions were performed for each

of the 8 conditions or groups (Table 1).

Results were described as mean, standard deviation, minimum and maximum values. Analysis of variance (ANOVA) was used to assess the significance of statistical differences between groups, and the Tukey test was used for multiple comparisons between pairs at a 95% confidence interval ($p < 0.05$). The pairs studied were: PL Steiner x PL Mathieu; PL Morelli x PL Steiner; Met Steiner x Met Mathieu; Met Morelli x Met TP; PL Steiner x Met Steiner; PL Mathieu x Met Mathieu; PL Morelli x Met Morelli; PL TP x Met TP.

RESULTS

Table 2 describes mean frictional forces (gf) generated during the mechanical trial in the 8 conditions studied, as well as their standard deviations and minimum and maximum values.

The analysis of variance (ANOVA) revealed statistically significant differences between means in the 8 groups ($p < 0.05$). Similarly, when the variable bracket type was kept constant and the type of tying was changed, a statistically significant difference was also found, both for the metal and the plastic brackets ($p < 0.05$).

The Tukey test revealed that all the pairs under evaluation had statistically significant differences ($p < 0.05$) in frictional forces generated, except the PL Mathieu x Met Mathieu pair, whose results were statistically similar.

TABLE 1 - Characteristics of the 8 sample groups.

GROUP	Bracket	Tying
PL Steiner	plastic	metal with Steiner pliers
PL Mathieu	plastic	metal with Mathieu pliers
PL Morelli	plastic	Morelli elastomeric ligation
PL TP	plastic	TP elastomeric ligation
Met Steiner	metal	metal with Steiner pliers
Met Mathieu	metal	metal with Mathieu pliers
Met Morelli	metal	Morelli elastomeric ligation
Met TP	metal	TP elastomeric ligation

TABLE 2 - Descriptive statistics: means, standard deviations (SD), minimum and maximum values of friction generated in gram-force in the various conditions analyzed (n = 15).

GROUP	Mean	SD	Minimum value	Maximum value
PL Steiner	93.93	10.94	75.00	107.15
PL Mathieu	41.43	4.28	33.93	46.43
PL Morelli	95.72	11.84	82.15	108.93
PL TP	72.56	7.68	60.18	80.05
Met Steiner	125.34	22.49	104.80	167.28
Met Mathieu	46.85	4.30	39.81	52.29
Met Morelli	177.52	17.18	149.77	199.98
Met TP	254.63	24.51	215.19	283.77

DISCUSSION

There was great variation in the generation of frictional forces (41.43 gf to 254.63 gf), and the greatest variation was found when the metal bracket and wire were tied using the TP Orthodontics elastomeric ligation, and the lowest, for the plastic bracket, metal wire and Mathieu pliers.

In general, frictional forces generated in the groups of metal brackets were greater than the ones for the plastic brackets and metal ligation. The groups in which Mathieu pliers were used had the lowest friction, with either a plastic or a metal bracket.

The sequence of groups in growing order of friction generated was: PL Mathieu, Met Mathieu, PL TP, PL Steiner, PL Morelli, Met Steiner, Met Morelli, Met TP.

Graph 1 shows that metal brackets generated greater friction than plastic brackets in this study. Previous studies showed that surface irregularity of polycarbonate brackets is significantly lower than that of other esthetic materials, such as porcelain.¹⁴ However, when compared with metal (stainless steel) brackets, findings in the literature have shown that

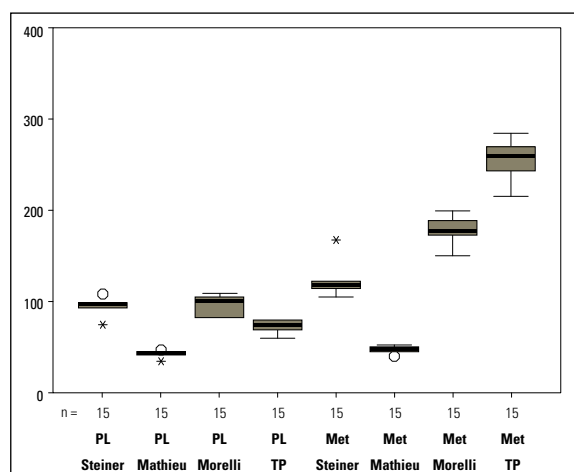
plastic brackets generate greater friction during sliding, probably due to their deformation when tied.^{11,13} It may be inferred that, in our tests, there was not enough deformation of plastic brackets to increase friction between brackets and the metal wire.

Although plastic brackets generated less friction than the metal brackets, the choice of material to be used in clinical settings should take into consideration other variables, such as the resistance to shearing, fracture, and deformation, as well as color stability and microorganism adherence.

Ligations may range from 50 to 300 gf and the elastomeric modules generate about 225 gf with gradual decrease due to relaxation.⁹ In this study, elastic ligation tended to generate more friction than the metal ligation, in agreement with findings by Berdnar, Gruendeman and Sandrik,² in 1991. However, Omana, Moore and Bagby,¹⁰ in 1992, opportunely added that, although theses procedure generated less resistance, it is difficult to standardize the force employed.¹⁰ It is important to keep in mind that lubricated elastomeric ligations generate less friction than the ones that are not lubricated, as used in this study.^{4,7}

The Mathieu pliers, as a tying instrument, produced less friction than the Steiner pliers when used with metal or plastic brackets, which was already expected, because light metal tying produces less friction than when adjusted.^{7,9}

Classically, the standard surface of sliding mechanics is metal, particularly stainless steel. However, other orthodontic materials have satisfactory results, or better than in previous trials, particularly when using plastic brackets, which, in this study, had a better frictional result than metal brackets. However, as materials are modified or replaced, the constant investigation of friction generated by new and update materials is fundamentally important.^{5,6}



GRAPH 1 - Box graph of friction force (gf) in the eight situations under analysis.

CONCLUSIONS

1. Frictional forces varied considerably between the eight conditions under study; such variation is positive because it provides several options in orthodontic mechanics and more or less friction according to the needs for each case.

2. Plastic brackets generated less friction than metal brackets.

3. Elastomeric materials generated more friction than metal ligations, and the ligation with the Mathieu tying pliers caused less friction than all the other conditions under study.

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Influence of mandibular sagittal position on facial esthetics

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Abstract

Objectives: To analyze the influence of mandibular sagittal position in the determination of facial attractiveness. **Methods:** Facial profile photographs were taken of an Afro-descendant man and a Caucasian man, as well as an Afro-descendant woman and a Caucasian woman. These photos were manipulated on the computer using Adobe Photoshop™ CS2 to produce—from each original face—a straight profile, three simulating retrusion and three protrusion mandibular discrepancies. In all, 28 photographs were evaluated by orthodontists (n = 20), oral maxillofacial surgeons (n = 20), plastic artists (n = 20) and laypersons (n = 20). The descriptive analysis was performed by calculating the mean and standard deviation for each group. **Results:** The straight facial profile was met with greater acceptance by Afro-descendant male faces and female faces. Caucasian males found a lightly concave facial profile with a more prominent mandible to be the most pleasant. After an analysis of skeletal discrepancies simulations, Caucasian males also showed a preference for mandibular protrusion versus retrusion. Females, however, preferred convex over concave profiles. **Conclusion:** The results showed agreement between groups of evaluators in selecting the most attractive profiles. Regarding male faces, a straight profile with a slightly concave face seemed more attractive and a straight facial profile was also greatly valued.

Keywords: Facial profile. Orthodontics. Orthognathic surgery.

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INTRODUCTION

Physical appearance influences an individual's integration and self-esteem and may become critical to their psychological well-being.^{8,10} Therefore, many patients seek orthodontic treatment motivated by the desire to improve their facial appearance^{15,23} and minimize aesthetic-related psychosocial problems.¹⁷

Perception of beauty depends upon individual preference but is influenced by ethnic and cultural experiences as well as by family beliefs.¹ By showing famous faces as beautiful mass media can also exert a powerful influence. These different aspects underlie certain claims that the perception of beauty changes with time and place.⁷

With a view to accomplishing their aesthetic goals, orthodontists must prepare a treatment plan substantiated by a thorough patient evaluation.¹⁷ Using the clinical examination of the frontal and profile views of the face, one can evaluate the harmony of the structures that compose it. A patient's profile evaluation is so important that many researchers have conducted studies to better define their normal conditions, harmony and balance. Legan and Burstone¹¹ recommend an angular measurement to evaluate the profile of the patient's soft tissue. The facial convexity angle or facial contour angle—formed by a line joining the glabella to the subnasale and another that connects the subnasale to the pogonion—is considered normal at 12°. As the values of this angle decrease the facial profile begins to suggest a Class III skeletal relationship. As the angular measurements increase the profile becomes more convex, suggesting a Class II skeletal relationship.

In order to study the patterns established in the literature and adapt them to the faces of various human races, Brito² evaluated the preference given by the Brazilian population in terms of facial esthetics of Caucasian adults who have undergone orthodontic treatment. The results showed considerable consistency

in the preference for a straight facial profile, conforming to Steiner's S line²¹, for both male and female individuals.

On the other hand, Sushner²² used references from some reviews to evaluate the faces of the Afro-descendant population and found that their men and women are more protrusive than Caucasians. Thus, the values established by analyses using samples of the Caucasian population are not applicable to the faces of Afro-descendant individuals.²² Other researchers⁶ also conducted a study to examine facial attractiveness in Afro-descendants. Faces with straight profiles were considered the most beautiful. These faces, however, showed a slight lip protrusion when evaluated using the Steiner²¹ and Ricketts¹⁸ analyses.

Many of these studies help clinicians to perform the facial analysis of different races and genders. However, although research uses established standards as the prototype of beauty, it is essential that practitioners be aware of patient perception. Professional opinion regarding the assessment of facial aesthetics may not match the beliefs and expectations of patients. To test this difference, some studies have been conducted comparing the sensitivity of professionals and laypersons to horizontal and vertical changes in human faces, as well as determining which, in their opinion, is the most pleasant facial composition.^{12,19}

For all these reasons, professionals should be aware of aspects of facial appearance that patients consider attractive or not.³ Thus, the most important problems will be identified and treatment will be based not only on clinical aesthetics, function and stability but also on what is most important and beneficial for the patient.²³

Thus, since orthodontists and oral maxillofacial surgeons share a compelling need to obtain data to help them evaluate the components of facial harmony, this study aims to examine the influence of the mandibular sagittal position in determining profile attractiveness

and compare the views of dentists, maxillofacial surgeons, artists and laypersons on the aesthetics of the faces examined.

MATERIAL AND METHODS

This study used 28 photographs depicting the facial profile of four adults, two Caucasians and two Afro-descendants of both genders, defined according to the classification of the Brazilian Institute of Geography and Statistics (IBGE) (State of São Paulo / USP / FSP, 2000). These four individuals were selected because their faces featured what is considered the standard patterns of facial harmony both in the vertical plane, based on quotes by Medeiros and Medeiros¹³ and Proffit¹⁷, and in the horizontal plane, according to the precepts advanced by Legan and Burstone¹¹.

The photographs were obtained with the subjects in a sitting position, with both the Frankfort plane and the pupillary plane parallel to the ground by using the ear positioners of a cephalostat. An EOS Rebel-D (Canon™) digital photography equipment was used with an EF 100 mm macro lens (Canon™) and MR14EX circular flash (Canon™). The distance between individual and photo sensor was kept at 1.47 m and a speed of 1/125.

The four photographs of the original, balanced profiles were manipulated on the computer using Adobe Photoshop™ CS2 (Adobe Systems Incorporated - San Jose, CA) in order to eliminate any details that might distort rater perception, such as spots on the skin and excess fat in the cervicomandibular angle region. Landmarks were also defined in all the original images in order to standardize photograph changes and allow a more accurate analysis.

The landmarks were as follows: Glabella (G), most prominent point on the forehead; subnasale (Sn), cut-off point between the nasal septum and the skin of the upper lip; pogonion (Pg), the anterior-most point of the chin's soft tissue;

mentum (Me), lower-most point of the chin's soft tissue;^{11,13,17} upper lip (Ls) and lower lip (Li), the most external points of the upper and lower lips, respectively.

The vertical proportions of the subjects' faces, which were analyzed in each photograph, were standardized so that the middle and lower thirds were close to 1:1 ratio. The middle third was measured in a line perpendicular to the Frankfort plane—from G to Sn—and the lower third, from Sn to Me.^{13,17} The profiles were analyzed and changed in the horizontal direction according to the facial convexity angle.¹¹ This angle, formed by a line connecting G to Sn and another that connects Sn to Pg, should be 12° in adults with 4° standard deviation.¹¹ Therefore, 12° was the yardstick applied to measure the convexity angles of the four ideal profiles.

The degree of lip protrusion considered ideal was different for Caucasians and Afro-descendants. For Caucasians, the protrusion was rated and changed in order to reflect normality, according to Steiner.²¹ This author advocates that the upper and lower lips should touch the line connecting the middle of the nose base to the pogonion. Afro-descendants' profile photographs had their lip protrusion altered in order to represent the harmony referenced by Farrow et al.⁶ To this end, a line was drawn perpendicular to the Frankfort plane cutting through point G. The upper and lower lips were manipulated to be between 3 mm and 6 mm ahead of this line. These measurements were defined in each profile in order to produce harmonious changes with the upper lip always positioned ahead of the lower lip.

For every profile considered ideal, the Pg was moved ahead by decreasing the G-Sn-Pg angle by 4°, sequentially, down to 0°. Similarly, the Pg was also repositioned by increasing the G-Sn-Pg by 4°, down to 24°. During this Pg movement, there was need to assess the vertical dimension through point Me so that it remained un-



FIGURE 1 - Photographs of facial profiles of Caucasian woman with convexity angles of 0° (A), 4° (B), 8° (C), 12° (D), 16° (E), 20° (F), 24° (G).

changed. Seven profiles were thus obtained of each photographic model, i.e., one ideal, three derived from mandibular advancement and three simulating mandibular setback. The mentum, lower lip and mentum/labial sulcus were advanced or retruded in an order of magnitude similar to the Pg movement but the profile was outlined so as to make manipulations imperceptible. One example of the seven photographs, showing the ideal profile and the protrusion and retrusion mandibular discrepancies—in this case representing a Caucasian woman—can be seen in Figure 1.

The photo album was organized with seven

images of each individual laid out on the same page. The layout order for each photograph on the pages was randomly selected as was the sequence of photographs of each individual in the album.

To assess the 28 profiles for facial attractiveness, 80 raters, 20 orthodontists, members of the Bahia Orthodontics Association (SOBA), 20 oral maxillofacial surgeons, members of the Brazilian College of Surgery and Oral Maxillofacial Traumatology and/or professionals who had attended specialization courses, 20 artists with academic training in this area, and 20 laypersons, graduates from or attending university, excluding those who had attended or were attending a dentistry or fine arts course and who were employed by dental clinics or orthodontic patients. The subdivision of each group according to rater gender was not justified since there were only two women in the group of oral maxillofacial surgeons while the other eighteen were male.

Along with the albums, each rater received a form comprising eight rulers (visual analog scale), one for each page, and were then instructed to mark with a dot and identify the letter corresponding to the image and then rate each image according to its attractiveness. Rater could mark the dot anywhere on the image and place two or more letters on each dot, if necessary. The visual analog scale^{12,14,23} was 10 cm long and had “VERY BAD” written on the left end and

“VERY GOOD” at the other end. In the center of the ruler, as well as on the differential semantic scale,¹⁶ the following word was written: “REGULAR”. The distance (in mm) between the mark made by the photograph rater and the extreme left of the ruler defined the attractiveness of each face being rated.²⁰

The data from each questionnaire were compiled in a spreadsheet and then treated statistically. A descriptive analysis was performed by calculating the mean and standard deviation in each group. Subsequently, the Kolmogorov-Smirnov test was used to analyze normal distribution. Once data normality had been identified, a one-way ANOVA and Tukey's Test were applied to identify differences between the groups. A 5% alpha test ($p < 0.05$) was used for all tests.

RESULTS

Descriptive statistics was used to compare the total marks of the 80 raters for each face and thus evaluate the influence of the anteroposterior mandibular position—in a side view—in determining facial attractiveness.

Table 1 allows an analysis of the mean and confidence interval (at 95% attractiveness) that the different profiles exert on all raters, according to facial convexity angle—regardless of the rater group—on the Afro-descendant and Caucasian men and Afro-descendant and Caucasian women.

TABLE 1 - Mean and standard deviation of the degree of attractiveness for Afro-descendant and Caucasian men and Afro-descendant and Caucasian women, according to facial convexity angle.

G-Sn-Pg	AFRO-DESCENDANT MAN		CAUCASIAN MAN		AFRO-DESCENDANT WOMAN		CAUCASIAN WOMAN	
	X	SD	X	SD	X	SD	X	SD
0°	1.10	1.19	2.07	1.74	0.74	1.07	0.74	0.98
4°	3.43	2.08	4.77	2.36	2.15	1.60	3.00	2.01
8°	6.96	2.12	8.97	1.18	6.40	2.12	6.75	2.53
12°	8.48	1.69	8.31	1.46	8.64	1.45	8.81	1.40
16°	6.09	2.01	5.62	1.98	7.14	2.02	6.89	2.03
20°	3.24	1.91	2.36	1.45	3.74	2.11	3.86	1.80
24°	1.04	1.18	0.87	1.11	1.52	1.56	1.48	1.46

Tables 2, 3, 4 and 5 show the degree of attractiveness that each facial profile of Afro-descendant men, Caucasian men, Afro-descendant women and Caucasian women, respectively, exert on the different rater groups. The results showed that for Afro-descendant men facial profiles with a Class I skeletal

pattern were the preferred choice whereas for Caucasian men, a more prominent mandible held the strongest aesthetic appeal. Regarding female faces, rater preference was given to the straight profile, while the discrepancies that simulated a skeletal Class III were the most widely rejected.

TABLE 2 - Mean and standard deviation of the degree of attractiveness for the faces of the Afro-descendant man, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	SD	X	SD	X	SD	X	SD
0°	0.95	1.11	1.43	1.08	0.60	0.74	1.40	1.57
4°	3.17	1.90	3.08	1.63	3.70	2.48	3.77	2.26
8°	6.86	2.31	6.69	1.98	7.40	2.06	6.89	2.21
12°	8.39	1.19	7.86	1.85	9.30	1.19	8.36	2.11
16°	5.61	1.74	4.99*/ **	1.82	6.97**	2.38	6.77*	1.43
20°	2.47*	1.59	2.46**	1.37	3.88	2.23	4.13*/ **	1.82
24°	0.33*	0.51	1.12	0.97	1.11	1.11	1.59*	1.57

*, ** p < 0.05 - difference between rater groups.

TABLE 3 - Mean and standard deviation of the degree of attractiveness for the faces of the Caucasian man, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	SD	X	SD	X	SD	X	SD
0°	1.44	1.22	1.95	1.60	2.79	2.27	2.08	1.58
4°	4.44	2.08	4.45	2.51	5.36	2.48	4.82	2.41
8°	9.20	0.95	8.53	1.44	9.27	1.14	8.86	1.08
12°	8.10	1.12	7.90	1.43	8.94	1.30	8.30	1.79
16°	5.31	1.93	5.02	1.98	6.33	1.99	5.80	1.90
20°	1.85*	1.20	2.00	1.04	2.49	1.61	3.08*	1.64
24°	0.41	0.80	0.78	0.86	1.00	1.32	1.26	1.26

* p < 0.05 - difference between rater groups.

TABLE 4 - Mean and standard deviation of the degree of attractiveness for the faces of the Afro-descendant woman, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	SD	X	SD	x	SD	X	SD
0°	0.40	0.43	0.76	0.95	0.77	1.48	1.00	1.14
4°	1.52	0.91	1.93	1.76	2.43	1.80	2.69	1.62
8°	5.93	2.13	6.16	1.99	6.66	2.34	6.82	2.03
12°	8.71	1.08	7.87*	1.40	9.33*	1.11	8.64	1.80
16°	7.14	1.79	6.00*	2.40	8.05*	1.95	7.37	1.35
20°	3.47*	2.00	2.31**	1.84	5.30*/ **	1.83	3.85	1.75
24°	0.67*/**	0.74	1.30	0.99	1.98**	1.88	2.11*	1.92

*, ** p < 0.05 - difference between rater groups.

TABLE 5 - Mean and standard deviation of the degree of attractiveness for the faces of the Caucasian woman, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	DP	X	DP	X	DP	X	DP
0°	0.51*	0.70	0.60	0.58	0.56	0.87	1.26*	1.41
4°	2.16*	1.54	2.25**	1.43	4.05*/**	2.07	3.52	2.29
8°	6.24	2.65	5.98	2.32	7.86	2.19	6.91	2.68
12°	8.98	1.14	8.32	1.48	9.23	1.17	8.70	1.66
16°	6.96	1.79	6.44	2.01	7.67	2.21	6.46	1.97
20°	3.23	1.54	3.66	1.78	4.61	2.08	3.94	1.58
24°	0.78	0.96	1.64	1.13	1.76	1.82	1.72	1.63

*, ** p < 0.05 - difference between rater groups.

DISCUSSION

Since facial aesthetics is an important component of diagnosis and treatment planning in orthodontics, many studies have been conducted in order to assess whether there are differences in the perception of facial attractiveness among professionals and laypersons.^{3,9,10,12} In this study, color profile photographs were used for this analysis given the fact that images impart more realism to the representation of facial aesthetics than do silhouettes and profile drawings.¹² However, the use of photographs involves many factors that influence facial attractiveness, such as color and style, nose size, eye color and age of the photographic model.³ These variables were eliminated in this research by using the profile reproduction method, which makes use of digital images and Adobe Photoshop™ CS2. Therefore, the key features of each photographic model were retained and only the mandible position of each facial profile was changed.

To evaluate the esthetic perception of the manipulated images a visual analog scale was utilized which allowed swift, straightforward measurements to be obtained while streamlining and clarifying the process for the raters. Furthermore, according to Maple et al¹² when results are recorded as a continuous variable—in millimeters—researchers are afforded more leeway and sensitivity in analyzing the data, thereby averting

biases towards any preferred values, as is the case with numeric interval scales. Additionally, Orsini et al¹⁶ support the use of a scale with words of contrasting meanings at each end asserting that it is ideal for evaluating people's reactions to specific stimuli.

After reviewing the results of this study it becomes clear that any variation in the mandibular sagittal position exerts an impact on the raters' aesthetic opinion. This impact was affected by the gender and race of the photographic models since their profiles were rated as more or less attractive—given their different convexity angles—depending on the face being rated. On the other hand, unlike the present study, Knight and Keith¹⁰ found that, although attractive faces tend towards a relationship that represents skeletal Class I, the values for the sagittal changes had little influence on facial attractiveness. This difference, however, seems to lie in the fact that Knight and Keith¹⁰ studied the facial attractiveness in male and female faces of different individuals. Thus, other variables must have had a bearing on the results.

The results found for Afro-descendant faces showed a preference for the skeletal Class I profile, i.e., with a 12° convexity angle. This face, chosen as the most attractive, features slightly protruded lips.⁶ No preference was noted regarding photographs representing skeletal Class

II or III discrepancies. Profiles with an 8° to 16° convexity angle were chosen as the second most attractive, followed by 4° to 20° convexity angle profiles. Profiles between 0° and 24° were considered the least attractive.

Concerning Caucasian males, preference was given to faces reflecting a skeletal Class III to the detriment of Class II profiles. The raters regarded faces with an 8° convexity angle as the most attractive, thereby denoting a preference for male faces with a more prominent mandible. This result corroborates a study by Czarnecki et al,⁴ who concluded that straight profiles with a prominent chin are preferred for Caucasian men but not so much for Caucasian women.

Similarly to the present study, other researchers¹⁹ used the convexity angle¹¹ to make changes in mandibular position. These authors¹⁹ manipulated female and male faces simulating horizontal and vertical changes in both maxillas. Aesthetic preference was more clearly determined for differences in horizontal mandibular position, which showed an unequivocal tendency towards profiles with 9° facial convexity angle in both genders. These findings corroborate the results found in this investigation, especially in the assessment of Caucasian male profiles. However, this tendency to choose a profile with convexity angle lower than 12° did not apply to Afro-descendant faces. These faces are considered attractive when they featured a slight lip protrusion compared with Caucasians.^{6,22} This may account for the fact that faces with a 12° convexity angle are most acceptable for Afro-descendant and 8° for Caucasians, since the latter is closer to a concave face.

Moreover, for Caucasian males, the face regarded as the least pleasant had a 24° convexity angle and represented the most severe Class II skeletal discrepancy. This result endorses that of other researchers,³ who perceived greater rejection of Class II than Class III skeletal discrepancies.

As for Afro-descendant women, raters displayed preference for a 12° convexity angle¹¹ and slight lip protrusion.⁶ For Caucasian women the straight profile was also the most widely accepted by the raters, in agreement with other investigators.³ Caucasian females were preferred who had a 12° convexity angle¹¹ and lips touching the S line.²¹ The profiles that simulated 18° to 16° convexity angles occupied the second place. Next, profiles with 20°, 4°, 24° and 0° were ranked in order of attractiveness and statistically significant differences were found between these angles. This shows that Class III skeletal discrepancies are more aggressive and therefore considered less attractive for women. Moreover, according to Cochrane et al,³ Class II faces are the least attractive, irrespective of gender.

The influence of mandibular position upon facial esthetics in Caucasian women was studied as early as 1980,⁵ with changes being made to photographic models using bite plates that simulated the sagittal and vertical movements of the mandible. According to the results for women, Class I faces are the most attractive while Class III faces the most unpleasant. In another study,⁹ facial attractiveness was assessed by silhouettes representing profiles with different mandibular anteroposterior positions. Thus, the profiles were examined, irrespective of gender or race, which is confirmed by the preference given to profile skeletal Class I profiles.

As for the results, there was agreement between the views of four rater groups in choosing the most attractive profile for both Afro-descendants and Caucasians, which is consistent with the literature.^{10,12,19} This observation bolsters the role of the aesthetic variable in orthodontic planning since the ideal standard is identical for professionals and laypersons alike. Inconsistency was found, however, in the groups' assessment of some of the faces. In general, clinicians were more demanding in terms of facial esthetics than non-clinicians, which coincide with the

study by Cochrane et al,³ which concluded that the general public are less biased towards what it considers attractive.

Agreement in rater opinion was higher for Caucasian than for Afro-descendant faces. Regarding gender, there was greater consistency in the analysis of male faces than of women, which corroborates the findings in the literature.¹⁰ A comparison between artists' and laypersons' opinions showed no statistically significant difference. The same concordance was found when comparing the opinions of orthodontists and oral maxillofacial surgeons, which agrees with Cochrane et al.³ On the other hand, Arpino et al¹ asserted that orthodontists are more tolerant of changes in facial profiles than surgeons.

A comparison between the perception of clinicians and nonclinicians regarding changes in facial profiles shows that all have similar sensitivity to changes, i.e., laypersons and artists in general perceived the facial changes but were less demanding than clinicians concerning some of the faces. This observation coincides with a statement by Romani et al¹⁹ that laypersons and orthodontists have the same degree of perception of mandibular sagittal changes. This assertion, however, disagrees

with other studies,^{12,16} suggesting that clinicians have greater ability to perceive changes than laypersons. This difference was attributed to the professional training that clinicians undergo to determine facial aesthetics,¹⁶ or to differences in the socioeconomic or educational backgrounds of rater groups¹².

CONCLUSION

The results showed agreement between orthodontists, oral maxillofacial surgeons, artists and laypersons in the choice of the most attractive profiles for both Afro-descendants and Caucasians, regardless of gender. For Afro-descendant faces, the Class I profile gained greatest acceptance. Comparing the faces where some sort of skeletal discrepancy was simulated, there was no preference for either Class II or Class III. For Caucasian men, the most attractive face featured a straight profile with a more prominent mandible, but still within the normal range. An analysis of skeletal discrepancies discloses a preference for Class III than Class II profiles. Raters showed preference for a straight profile on the faces of both Afro-descendant and Caucasian women. For these women, the discrepancies that simulated skeletal Class III were the most rejected.

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The relationship between bruxism, occlusal factors and oral habits

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Abstract

Objective: Evaluating the relationship between bruxism, occlusal factors and oral habits in children and adolescent subjects, students from public schools in Brasília-Federal District city.

Methods: A group of 680 students, of both genders, average age 4 - 16 years, were randomly selected. Data was collected by clinical evaluation and questionnaires replied by the responsible for the students. The occlusion morphological aspects were evaluated according to Angle classification and following a criteria created for the deciduous dentition, according to Foster and Hamilton (1969). Uni or bilateral posterior and anterior crossbites were evaluated. The chi-square test, the Odds Ratio and the SPSS software were used for the statistic analysis.

Results and Conclusion: 592 questionnaires were fulfilled completely. Bruxism had a prevalence of 43%, whilst 57% presented malocclusion. Oral habits were observed in 53%. The prevalence of a malocclusion increased from 42.6% in the deciduous dentition to 74.4% in the permanent dentition. The evaluation of the results showed that there was no statistically significant relationship between bruxism and the studied occlusal factors ($p > 0.05$). Differences were not found between genders in both variables. Onicofagy was the most frequent habit (35%), mainly in the female subjects. There was a statistically significant relationship between bruxism and oral habits. Evaluating the specific types of habits, just pacifier sucking showed to be related to the bruxism. Additional studies will be necessary for a better understanding of the local origin of bruxism.

Keywords: Bruxism. Sleep. Malocclusion. Oral habits.

INTRODUCTION

Bruxism can be defined as a parafunctional activity of the masticatory system which includes tightening and teeth grinding (centric and

eccentric bruxism respectively). During sleep, it is presented in rhythmic muscular contractions with force higher than the natural, creating friction and heavy noise when the teeth grind.

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This can not be reproduced during awareness periods. According to the International Classification of Sleep Disorders (ICSD-2),¹ bruxism belongs to the group of movement disorders, being frequently associated to sleeping stimulation.^{1,20} Bruxism, without a real cause, is called primary bruxism, while the secondary bruxism is the one that occurs in association to the use of psychoactive drugs, drugs and medical disorders.¹

Studies on the etiology of bruxism are not concluded yet. Researchers have suggested that local factors, such as malocclusion, are losing importance, whereas behavioral cognitive factors such as stress, anxiety and personality traits are gaining more space.^{14,18} The current focus is directed to the fact that bruxism is part of a waking reaction. This parafunctional activity seems to be modulated by several neurotransmitters in the central nervous system, however, it can not be affirmed that it has just a central control.¹⁹

In 2001, Sari and Sonmez²⁵ reported a statistically significant relationship between bruxism and some occlusal factors, whereas, in other research studies, this association can not be proved.^{5,6,20}

Bruxism can be associated to craniomandibular disorders including headache, temporomandibular disorder (TMD), muscular pain, early tooth loss due to excessive attrition and mobility and sleep interruption from both the subject and the person with whom he shares the room.^{9,12,22,24} Studies have shown the close relationship between bruxism and some pathologies such as breathing disorders and the Obstructive Sleep Apnea Syndrome (OSAS).^{22,30}

Oral habits such as thumb sucking, onicofagia, object biting etc can be usual and happen temporarily. However, when they surpass a physical tolerance, the system may collapse and harm the person's health. According to Cheifetz et al,³ the fact that children without any oral habits present a higher prevalence of bruxism suggests that this parafunction can also be an alternative method to relieve stress.

The lack of homogeneity and standardization of criteria to evaluate bruxism has resulted in a large variation of its prevalence: 6 to 88% in children and 5 to 15% in adults,^{2,3,17,27} making it difficult to establish comparative parameters.

Frequently, clinicians who treat children and adolescents are questioned about the etiology, the prevalence and the effect of bruxism. It is important that clinicians are well informed on recent studies and on the variables related to this parafunctional activity.

This current study aimed at evaluating the relationship among bruxism, occlusal factors and oral habits by clinical examination and questionnaires fulfilled by the person responsible for the subject.

MATERIAL AND METHODS

A transversal study was carried out in public schools, in Brasília-Federal District city, Brazil. The sample was statistically calculated by clumps, randomly. The study comprised 680 students, from both genders, with mean age of 4 to 16 years.

The study was approved by the Health Science Ethics Committee – University of Brasília. After the agreement letters were returned and signed by the parents or the responsible ones, the students were seen by the clinician. The excluding criteria was: (1) Mental disorders or other pathologies that could cause dento-osseous malformation and masticatory disorders, (2) Current or past orthopedic/orthodontic treatment and (3) Non-authorization by the parents or guardians.

Eccentric bruxism was the only one to be investigated as it is easier to be detected by patients and parents. This makes data analysis more reliable. The selection of students presenting and not presenting bruxism was based on the positive and the negative replies, respectively, to the questionnaire. The dentition stage of each child was also observed.

The occlusion was evaluated by only one examiner under direct view and good lighting, with the help of a disposable wooden spatula (Theoto S/A Ind. e Com. Jundiaí, SP, Brazil). The occlusion was considered to be a normal occlusion when the following criteria were observed: (1) No crowding; (2) No crossbite; (3) No anterior deep or open bite, and (4) No overjet. Angle classification was applied when evaluating the morphological aspects of the occlusion in both the mixed and permanent dentitions. In the deciduous dentition, the criteria followed were based on canine relationship, according to Foster and Hamilton.⁷

Questionnaires were based on the literature review and the clinical experience of the authors, seeking for information about eccentric bruxism and oral habits presented by the students.

Statistic analysis

The maximum variance, the 95% reliability and the error below 5% were used to establish the sampling plan. Drawings, as well as the whole

analysis, were done using the SPSS Software, 14.0 version. The chi-square test and the calculation of the Odds Ratio were used when comparing the variables. The significance level was considered when $p < 0.05$.

The intraexaminer agreement ratio was verified using the Kappa index between the text and the re-test after one-month interval. Results for each one of the evaluations were 0.80 and 0.86.

RESULTS

After applying the excluding criteria, a sample of 592 students was divided in two groups. The first group (G1) comprised 255 subjects with bruxism (127 male and 128 female subjects), whereas the second group (G2) comprised the 337 remaining subjects (153 male and 184 female subjects). The prevalence of bruxism, in the total sample, was 43%. Forty-five (45%) per cent of male students and 41% of female students presented bruxism. This difference was not statistically significant (Table 1).

TABLE 1 - Distribution of bruxism in relation to gender.

GENDER	BRUXISM G1 (n = 255)	NO BRUXISM G2 (n = 337)	TOTAL (n = 592)	P VALUE
	n (%)	n (%)	n	χ^2
Male	127 (45)	153 (55)	280	ns
Female	128 (41)	184 (59)	312	ns

ns = non-significant ($p > 0.05$).

TABLE 2 - Distribution of normal occlusion and malocclusion in relation to the type of dentition.

DENTITION	NORMAL OCCLUSION	MALOCCLUSION	TOTAL (n = 592)	P VALUE
	n (%)	n (%)	n	χ^2
Deciduous	105 (57.4%)	78 (42.6%)	183	0.000*
Mixed	118 (41.5%)	166 (58.5%)	284	0.000*
Permanent	32 (25.6%)	93 (74.4%)	125	0.000*
TOTAL	255 (43%)	337 (57%)	592	0.000*

*Statistically significant $p < 0.05$.

TABLE 3 - Prevalence of normal occlusion and malocclusion compared to bruxism.

OCCLUSAL FACTORS	BRUXISM G1 (N = 255)	NON-BRUXISM G2 (N = 337)	TOTAL (N = 592)	P VALUE
	n (%)	n (%)	n	χ^2
Normal occlusion	118 (46.3)	137 (53.7)	255	ns
Class I malocclusion	49 (36.6)	85 (63.4)	134	
Class II malocclusion	81 (43.5)	105 (56.5)	186	
Class III malocclusion	7 (41.2)	10 (58.8)	17	

ns = non-significant ($p > 0.05$).

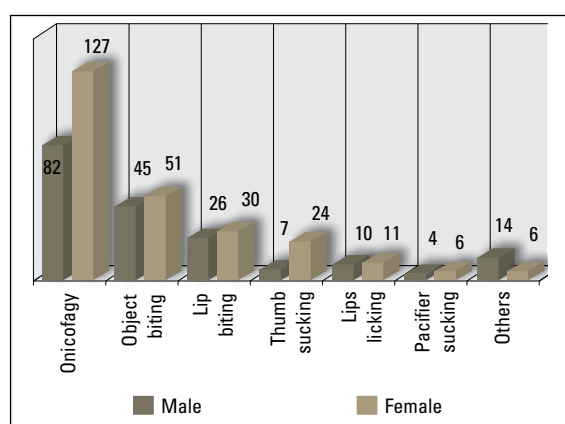
TABLE 4 - Prevalence of crossbite in relation to bruxism.

OCCLUSAL FACTORS	BRUXISM G1 (N = 255)	NON-BRUXISM G2 (N = 337)	TOTAL (N = 592)	P VALUE
	n (%)	n (%)	n	χ^2
Without crossbite	221 (44.0)	281 (56.0)	502	ns
Anterior open bite	13 (48.0)	14 (52.0)	27	
Unilateral posterior crossbite	17 (34.7)	32 (65.3)	49	
Bilateral posterior crossbite	3 (30.0)	7 (70.0)	10	
Anterior and posterior crossbite	1 (25.0)	3 (75.0)	4	

ns = non-significant ($p > 0.05$).

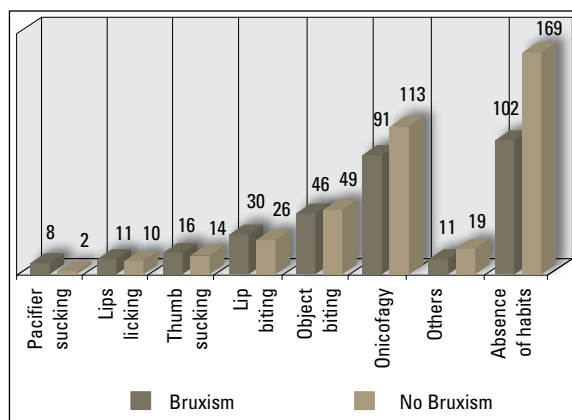
In the general sample, the prevalence of malocclusion was 57%, without statistically significant differences between genders. Table 2 shows the distribution of normal occlusion and malocclusion in relation to the type of dentition ($p < 0.05$). Among the students with bruxism, 46.3% presented a normal occlusion and 53.7% presented malocclusion. The statistic analysis showed that there was no relation between the occlusal factors studied and the bruxism ($p > 0.05$). The distribution of the different occlusal factors in relation to bruxism is presented on tables 3 and 4.

Fifty three percent (53%) of the sample presented one or more oral habit. Onicofagy was the most prevalent habit (35%), mainly in the female subjects. Table 1 shows the distribution of habits that presented differences between genders. There was a relationship between bruxism and oral habits ($p < 0.05$). Evaluating the specific



GRAPH 1 - Distribution of oral habits in relation to the gender.

types of habits, just pacifier sucking presented a statistically significant relationship with bruxism ($p < 0.05$ / OR = 5.4). Only 10 students showed



GRAPH 2 - Distribution of oral habits in relation to bruxism.

this habit and eight presented bruxism (Table 2). Considering the diversity of habits, there was no difference among the students who presented one or more habits and the presence of bruxism.

DISCUSSION

Bruxism and malocclusion

There are two theories that may explain the cause of bruxism. The first one is based on the idea that this parafunction has a central¹⁸ root, and the second one is based on the fact that there is not enough evidence to deny its peripheral root as, for instance, the occlusal factors.^{19,25} Studies on bruxism carried out in young people are a challenge to researchers, as its prevalence may be underestimated. Generally, data collection is obtained interviewing children and by questionnaires filled in by the parents, as well as by an evaluation of tooth wear caused by bruxism. When children are interviewed, some divergences may occur, as they can be shy or, simply, not be aware of their problem. Tooth wear sign during clinical evaluation can indicate a previous presence of bruxism that is not occurring at the time of the examination. But, on the other hand, the

recent development of the habit may not show a tooth wear yet. Thus, interviews with children's parents, although subjective, can be considered a reliable source to verify the prevalence of bruxism, as it reflects the occurrence of tooth noise produced by the children and that are effectively noted by the parents. Even though this prevalence can be underestimated, the occurrence of false-positive is virtually eliminated.²⁷

In this research study, as in others,^{3,4,10,20,23,25} parents have replied to the questionnaire considering the presence of bruxism in young subjects and the prevalence was very similar in all of them (around 38.4% and 43%). However, Demir et al⁶ and Gavish et al¹¹ verified the prevalence of 12% and 13% respectively. In both studies, the methodology applied was interviews with children. In this study and in further ones,^{3,23,27} just the eccentric bruxism was evaluated, whereas other authors^{6,10,20} did not make any difference between tightening and teeth grinding. The methodological differences applied in each study makes results to show huge discrepancies, being a limitation to this type of study.

Among the students with bruxism, there were not statistically significant differences between the genders. This is in accordance with Cheifetz et al³ and other authors^{4,6,22,27} findings, which differs from the findings of Manfredini et al,²⁰ who have found a higher prevalence of bruxism in women subjects (57.8%).

The prevalence of a malocclusion was 57%. Results similar to this current study were reported by Tomita, Bijella and Franco,²⁸ who evaluated the occlusion of 2,139 children, from 3 to 5 years of age, verifying changes in 51.3% male subjects and in 56.9% female subjects. According to Frazão et al,⁸ the prevalence of malocclusion increased from 49% in the deciduous dentition to 71.3% in the permanent dentition. These findings were similar to the ones of current study, in which the malocclusion increased from 42.6% in the deciduous dentition to 74.4% in the permanent dentition.

Sari and Sonmez²⁵ found a relationship between bruxism and some occlusal factors: Angle Class I malocclusion in the mixed dentition, anterior crossbite and posterior crossbite, etc. Henrikson et al¹³ showed that tightening and teeth grinding was higher in the group with Angle Class II malocclusion than in the group with normal occlusion, which suggested a relationship between bruxism and malocclusion. Nilner,²¹ studying this same relationship, in 7 – 14 year-old subjects, found a relationship between bruxism and Angle Class II and Class III malocclusions. In this current study, however, there was no statistically significant relationship between bruxism and any other occlusal factors studied ($p > 0.05$). These findings were in accordance with the studies of Demir et al⁶ and other authors.^{5,20,27}

Regarding the type of malocclusion, the results of this current study show a prevalence of Angle Class II malocclusion in 55%, followed by Class I (45%) and Class III (5%). Even in the deciduous dentition, in which the criteria used was based on cuspid relation,⁷ the prevalence of malocclusion was 42.6% and the higher number of cases was Class II malocclusions (25.7%). A similar percentage of children with Class II malocclusion (26%) was reported by Tschill et al.²⁹

Analyzing transverse relationship of the dental arches of the students, the prevalence of a posterior crossbite was seen in 10% of the students, without significant differences in relation to genders. These findings corroborate with Kerosuo¹⁵ studies, who found a frequency of 13%, analyzing the occlusion in both the deciduous and the early mixed dentitions in Finnish children. However, Santos et al²⁴ verified a higher prevalence of posterior crossbite (38.7%). In this study, the chi-square showed that there was no relation between bruxism and crossbites.

Bruxism and oral habits

The prevalence of oral habits, found in here (53%), was higher than in the Kharbanda et al¹⁶ studies (25.5%) and Shetty and Munshi²⁶

(29.7%), and smaller than the 82.8% found out by Fujita et al.⁹ This great variance in the prevalence of oral habits may occur due to the different methods applies as, for instance, the difference in habits included in each study. Santos et al,²⁴ studying the prevalence of parafunctional habits in 5 – 12 year-old children, reported that 47.5% presented onicofagy, being the most prevalent habit, as observed in this study (35%). However, other authors^{3,11,27} found a smaller number, but, yet, with significant prevalence of onicofagy, which was around 25%. In Shetty and Munshi²⁶ study, as well as in this one, the onicofagy was found more prevalent in the female subjects. There was no relation between bruxism and oral habits in the Shinkai et al²⁷ studies. In this current study, there was a relationship between bruxism and oral habits, confirming the results reported by other authors.^{3,24} Evaluating the specific types of habits, just the pacifier sucking presented a statistically significant relationship. Differing from the findings of this study, Cheifetz et al³ reported that children with thumb sucking habits had a smaller chance of showing bruxism ($p = 0.06$). Porto et al,²³ studying the variables associated to bruxism in children, found a relationship between bruxism and some oral habits. When the authors used a significance level of $p < 0.05$, just lip biting showed a relationship with bruxism.

This descriptive observational study aimed at contributing to the writing of new research studies on the etiology and the physiopathology of bruxism in the future. Additional studies may report significant results to assist with doubts that clinicians face when treating this kind of problem and, that, many times feel disappointed with the information available at the moment.

CONCLUSION

Based on the methodology applied and the results achieved, the following can be concluded:

- There was no statistically significant relationship between bruxism and the occlusal

factors studied.

- There was a statistically significant relationship between bruxism and oral habits. Evaluating the specific types of habits, just pacifier sucking

showed a relationship with bruxism.

- Additional studies will be necessary for a better understanding of the local causal factors of bruxism.

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The profile of orthodontists in relation to the legal aspects of dental records

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Abstract

Objective: The purpose of this study was to acquire knowledge about the key legal aspects of orthodontic practice, which may be used as important defense tools in the event of ethical and/or legal actions. **Methods:** A cross-sectional study was conducted with dentists in Belo Horizonte, Minas Gerais State, Brazil, by means of a specific instrument (questionnaire) addressing the ethical and legal disputes that involve the orthodontic specialty. Participants were asked to fill out the following questionnaire fields: personal identification, academic background, orthodontic accessories, oral hygiene, treatment plan, service provision, orthodontic documentation, drug prescription and forms of communication with patients, among others. **Results:** A total of 237 orthodontists, all members of the Regional Council of Dentistry, Minas Gerais State (CRO-MG) and living in Belo Horizonte, were given the data collection instrument. Out of this total, 69 (29.11%) answered and returned the questionnaires. Of the 69 respondents, 57.97% were male and 42.03% female. It was found that 52.17% of these professionals graduated from Higher Education Institutions (ISEs). It was observed that 34.78% of these orthodontists completed specialization between 5 and 10 years after graduation. Most professionals (94.2%) enter into their medical records information about any damage caused to the orthodontic accessories used by their patients and 53.62% of the orthodontists keep their patients' orthodontic documentation on file throughout their active professional life. **Conclusions:** This study revealed that some analysis parameters were very satisfactory, such as: the availability of service provision contract models, communication with patients and/or their lawful guardians in case of abandonment of treatment, orthodontic documentation files and the entering into the dental records of information concerning the breakage of and damage to orthodontic accessories. However, some practices have yet to be adopted, such as: patient signature should be collected in the event of damage to orthodontic accessories and copies of drug prescriptions and certificates should be kept on file.

Keywords: Civil liability. Orthodontics. Forensic dentistry.

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INTRODUCTION

With the new Brazilian Constitution of 1988 and new laws that have arisen or have been reformulated after this constitution, such as the Consumer Protection Code in 1990 and the Brazilian Civil Code in 2002, society has come to exercise effective citizenship grounded in the spirit of democratization contained in these laws with a greater awareness of individual and collective rights.⁴ Thus, civil relations, contractual or otherwise, have been modified as a result of this new context.⁴ The relationship between dentist and patient is no exception to this rule¹¹.

A key indicator of change in doctor-patient relationship is the growing number of ethical and civil lawsuits filed against dentists in recent years, which contrasts with the small and/or negligible number of these cases in the early 1980s.⁸ Dental professionals, even if apparently timid, have been increasingly concerned with the growing likelihood of being sued and the inevitable havoc that these actions can inflict in their professional and financial status. The current context has contributed to the creation of a new concept and a new approach to the dentist-patient relationship. “Defensive Dentistry”, a term that bears resemblance to other existing classifications, such as “defensive driving”, is defined as any activity designed to produce early evidence of good dental practices.⁸ The use of “Defensive Dentistry” has been growing steadily while undergoing improvements carried out by the various dental specialties, which seek to conform to their new reality. Orthodontics is a case in point, probably because it is one of the most often targeted dental specialties when it comes to ethical and civil litigations.⁸

Vanrell¹⁷ maintains that one manner in which to produce early evidence of good professional practices is by gathering legal dental documents, i.e., statements, oral or written, signed by the dentist during the course of his profession activity, and grouping such evidence in the form

of medical records. In addition to serving the traditional clinical purposes it may be used as evidence in case of legal actions. Dental records are the major documents and the dental professional's key defense weapon.

Proffit¹⁰ believes that diagnosis in orthodontics, as in other areas of dentistry and medicine, requires a proper collection of basic patient data. Based on these data one can analyze and record clearly and objectively the problems and changes that take place during patient evaluation. Treatment planning is the synthesis of possible solutions to the problems identified by the dentist. However, it is necessary to pursue a specific strategy for the treatment by taking into account the best possible therapy for the particular case of the patient under evaluation. The adoption of these procedures, provided they are in line with changes in the law, leads to the application of “defensive orthodontics” instruments, which are of paramount importance for compliance with and fulfillment of civil liability obligations. Among these routine instruments, orthodontists should mandatorily produce anticipated evidence such as accurate and updated clinical records. The present study aims to determine whether the specialists in orthodontics in Belo Horizonte, Minas Gerais State, Brazil, are knowledgeable of the legal dental issues pertaining to dental records, which can prove relevant for “defensive orthodontics”.

MATERIAL AND METHODS

This is a cross-sectional and descriptive study. Data were collected from the self-explanatory questionnaire developed specifically for this survey. The questions comprised in the questionnaire were designed to enable the collection of data concerning legal-dental issues, i.e., the production of evidence early in the course of “defensive orthodontics”. The population for this study consisted of dentists—specialists in orthodontics—residing in the city of Belo Horizonte, Minas Gerais, Brazil. The questionnaire

contained the following fields: personal identification, academic background, orthodontic accessories, oral hygiene, treatment plan, service provision, orthodontic documentation, drug prescription and means of communication with the patient, among others.

The orthodontists were identified from the records provided by the Regional Council of Dentistry, Minas Gerais (CRO-MG). The list of experts only comprised orthodontists who were registered in the State of Minas Gerais as of the month of April 2005, whose home and workplace addresses were located in the city of Belo Horizonte.

From the list of experts provided by CRO-MG, which contained the names and addresses of the orthodontists, the authors selected those ($n = 237$) who were to receive, between May and June 2005, the questionnaire and a term of free and informed consent that would enable them to contribute to this scientific investigation. It should be underscored that the criteria for exclusion from the study included deceased professionals and those who no longer worked in dentistry. After the questionnaires had been filled out and returned, data were collected for statistical analysis of the joint distribution of frequency and to determine the significance of effects by means of Fischer's test, when necessary. A confidence level of 95% was therefore established. It should be noted that this study was approved by the Ethics Committee of Universidade Federal de Minas Gerais, UFMG.

RESULTS

The population of this study consisted of 237 dentists, registered in the CRO-MG and domiciled in Belo Horizonte (MG). Of the 237 questionnaires that were sent out, 69 (29.11%) were returned. The demographic profile of the orthodontists is illustrated in Table 1. As can be observed, the time period required to complete the specialization course is consistent across the

board, as is the nature of the institution where they completed their graduate course.

Tables 2 and 3 refer to the variables: (1) orthodontic accessories and (2) oral hygiene effectiveness. As can be observed, the vast majority of orthodontists recommend at least one oral hygiene method. Table 2 also shows that the minority of patients (23.19%) are required to sign a document when orthodontic accessories are damaged.

Table 4 shows the treatment plan and service provision contract. As can be noted, most professionals require patients or their lawful guardians to sign the proposed treatment plan and most also use their own service provision contract model.

Table 5 shows that most professionals (53.62%) keep their patients' orthodontic documentation on file throughout their active professional life. A similar behavior was observed regarding the archiving of prescriptions and certificates.

Table 6 shows heterogeneity with regard to the orthodontist's request for periapical radiographs for use in orthodontic treatment control. The most common request was for periapical radiographs once a year (37.31%), followed by twice a year and other intervals (23.88%) different from those included in the data collection instrument. According to Table 6, the most common form of documentation at the completion of the orthodontic treatment was a combination of photographs, radiographs and dental cast models (50.7%).

Table 7 shows that in the event of abandonment of orthodontic treatment, 92.75% of the professionals communicated with their patients. It was found that only 21.74% of professionals require their patients to sign documents at the end of the orthodontic therapy. As can also be seen in Table 7, 53 orthodontists requested an occlusal analysis to be performed after orthodontic treatment.

TABLE 1 - Demographic features of orthodontic specialists in Belo Horizonte, Minas Gerais, Brazil.

FEATURES	NUMBER (N)	PERCENTAGE (%)
Gender		
Male	40	57.97
Female	29	42.03
Total	69	100
Institution of Graduation		
Public	33	47.83
Private	36	52.17
Total	69	100
Completion of Specialist Course (in years)		
0 - 5	23	33.33
5 - 10	24	34.78
> 10	22	31.88
Total	69	100

TABLE 2 - Analysis of the explanatory variables selected with regard to orthodontic accessories.

VARIABLE	NUMBER (N)	PERCENTAGE (%)
I enter information about damage to orthodontic accessories into the dental records		
Yes	65	94.20
No	4	5.80
I have patient sign a document when orthodontic accessories are damaged		
Yes	16	23.19
No	53	76.81

TABLE 3 - Analysis of the explanatory variables selected with regard to oral hygiene.

VARIABLE	NUMBER (N)	PERCENTAGE (%)
I enter information about poor oral hygiene into the dental records*		
Yes	35	51.47
No	33	48.53
I recommend the following method(s) to improve patient oral hygiene*		
Verbal warning	22	32.35
Recommendation in writing (I do not keep a copy for my records)	20	29.41
Recommendation in writing (I keep a copy for my records)	15	22.05
A combination of methods	11	16.17
Other methods	0	0

*One professional did not respond.

TABLE 4 - Analysis of explanatory variables selected as regards treatment plan and service provision contract.

VARIABLE	NUMBER (N)	PERCENTAGE (%)
I require a signature authorizing implementation of treatment plan		
Yes	60	86.96
No	9	13.04
I have my own service provision contract model*		
Yes	60	88.24
No	8	11.76

*One professional did not respond.

TABLE 5 - Analysis of explanatory variables selected as regards orthodontic documentation file, drug prescription and certificate.

VARIABLE	NUMBER (N)	PERCENTAGE (%)
I keep my orthodontic documentation on file after treatment		
No, I do not keep orthodontic documentation on file	4	5.80
For up to 5 years	8	11.59
For 5 to 10 years	20	28.99
Throughout my active professional life	37	53.62
I keep a copy of drug prescriptions and certificates*		
Yes	42	61.76
No	26	38.24

*One professional did not respond.

TABLE 6 - Analysis of explanatory variables selected as regards the request for periapical radiographs, initial documentation and final documentation.

VARIABLE	NUMBER (N)	PERCENTAGE (%)
Frequency with which I request periapical radiographs for treatment control*		
Once a year	25	37.31
Twice a year	16	23.88
Only at the beginning of treatment	4	5.97
Only at the end of treatment	6	8.95
Other	16	23.88
Form(s) of documentation at the end of the orthodontic treatment		
Photographs	2	2.89
Dental cast models	2	2.89
Radiographs	4	5.79
Dental cast model photographs	3	4.34
Radiographs and photographs	14	20.28
Radiographs and Dental cast models	5	7.24
Photographs, Radiographs and Dental cast models	35	50.7
No documentation	4	5.79

*Two professionals did not respond.

TABLE 7 - Analysis of the explanatory variables selected as regards abandonment of treatment, patient discharge and end of orthodontic treatment.

VARIABLE	NUMBER (N)	PERCENTAGE (%)
In the event of abandonment of treatment I send a communication to my patient		
Yes	64	92.75
No	5	7.25
At the end of orthodontic treatment my patient is "discharged" in writing and I sign the document		
Yes	15	21.74
No	54	78.26
Occlusal analysis is performed after the end of orthodontic treatment		
Yes	53	76.81
No	10	14.49
Other method(s)	6	8.69

DISCUSSION

Liability is the obligation to account for one's own actions or those of others. It encompasses both moral and legal aspects. The former denotes good behavior, good conduct, conformity with the rules of society. The latter refers to the duty to account, both criminally and civilly, for violation of a specific right established by law. Therefore, liability is the result of action by which individuals express their behavior in light of such duty or obligation.¹⁵ In Brazilian law, criminal liability and civil liability are independent from each other¹.

Civil liability depends on the existence of a causal link between two conditions: a) a person's conduct, which is regarded as inappropriate and b) damage resulting from such conduct. Civil liability is founded in these two circumstances of cause and effect. The conduct referred to above may be omissive or commissive.⁷ In general, liability within the civil scope is manifested in the application of the value of compensation, in the act of prevention or indemnification for damages.⁹ Thus, legal science has a direct bearing on dental activity, and orthodontists have both the duty and the right to learn about the basic provisions governing their professional activities so as to comply with them and thus avoid legal problems.⁸ This study sought to highlight and clarify the legal and civil liabilities associated with orthodontic practice.

The scientific literature points to the importance of documentation in the course of clinical practice.³ Initially, one of the key concerns of this investigation focused on receiving the return letters with the completed questionnaires. Of the 237 dentists who were targeted, only 69 (29.11%) answered the questionnaire, providing the data presented in Tables 1 to 7. It should be noted that similar statistics was also observed in other scientific studies².

Regarding the demographics of the population under study, there was a predominance

of males (57.97%), compared with females (42.03%). When analyzing the nature of the institution where the respondents completed their graduation course, certain percentage similarities between public and private can be identified. This is likewise true of their specialization course, which varied in intervals of fewer than 5 years, 5 to 10 years and above 10 years after graduation.

Machen⁶ asserts that the most glaring weakness displayed by orthodontists is their inefficiency to keep records of the following facts: oral hygiene, damage to orthodontic accessories, tooth decay, damaged restorations and cancellation of or missed appointments. Constantly warning about problems by establishing an open and honest communication channel could go a long way towards influencing the decision of whether or not to file a lawsuit. It was found that most professionals enter into their dental records information about events involving damage to the orthodontic accessories (94.20%), but only a minority requires their patients to sign a document attesting to their awareness of this fact (23.19%) (Table 2). Regarding oral hygiene, there was a prevalence of verbal instruction and a combination of methods encompassing verbal warnings and instruction models. Twenty orthodontists replied that they provide professional orientation on oral hygiene in writing, or through texts, but do not keep a copy of the document. Fifteen orthodontists gave their assurance that they behave identically, but always file a copy of the document signed by the patient or lawful guardian (Table 3).

Riedel¹³ asserts that the orthodontic treatment comprises three phases: before, during and after treatment. After treatment begins the maintenance phase, whereby the ideal functional and aesthetic position of the teeth is achieved. Professionals agree that orthodontists are not responsible only for treating the patient's malocclusion *per se* but also for preserving the results. Table 4 shows the importance ascribed

by professionals to the contract, both regarding treatment implementation and the existence of a service provision contract.

Orthodontists, like any other health care professionals, should always be well documented and ready for any legal disputes. Any sign of dissatisfaction by the patient should immediately be detected and discussed.¹⁶ Some patients pursue legal actions against dentists long after completion of treatment, many of whom believe they are under the care of these professionals for ever and that these specialists are responsible for any problems that may arise in future.⁵ According to the variable regarding the orthodontic documentation, shown in Table 5, most professionals keep their documentation on file for time periods of either 5 to 10 years (28.99%) or throughout their career (53.62%). The same concern, however, does not apply to certificates and drug prescriptions since only 61.76% of orthodontists archive these documents.

Preappointed evidence consists of all dental documentation developed throughout clinical practice. Therefore, documentation of all phases of professional activity is of utmost importance.¹⁴ Professionals agree that there is a need to record all events that occur daily in the care of their patients.¹² When it comes to recording the end of treatment, most orthodontists ($n = 35$) use photographs, radiographs and dental casts for documentation (Table 6). Table 6 shows that the majority of orthodontists ($n = 25$) request periapical radiographs once a year for orthodontic

treatment control. Also according to Table 7, 53 professionals replied that they request an occlusal analysis by the end of treatment.

Terra et al¹⁶ recommended that professionals develop a high level of communication with the patient. This means not only speaking clearly and objectively but also listening, being attentive and showing interest and consideration. Concerning this issue, Table 7 shows, in particular, that most orthodontists (92.75%) try to contact patients and/or their lawful guardians in the event of abandonment of treatment. Nevertheless, a minority of professionals (21.74%) require their patients and/or lawful guardians to sign a document at the end of the orthodontic treatment (Table 7).

CONCLUSIONS

Dentistry has reached a new stage in terms of professional liability. This study revealed that some analysis parameters were very satisfactory, such as: the availability of service provision contract models, communication with patients and/or those responsible for them in case of abandonment of treatment, orthodontic documentation files and the entering into the dental records of information concerning the breakage of and damage to orthodontic accessories. However, it is still necessary to reflect and act on some other issues, such as: patient signature should be collected in the event of damage to orthodontic accessories and copies of drug prescriptions and certificates should be kept on file.

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Analysis of mandibular dimensions growth at different fetal ages

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Abstract

Objective: To investigate growth asymmetry between the left and right hemimandibles (HMs) during the 2nd and early 3rd trimester of pregnancy. **Methods:** Sixty eight hemimandibles (34 mandibles) of fetuses were used—20 female and 14 male—preserved in 10% formalin solution, and the following measurements were performed: Condyle-Coronoid Process (Co-CP), Gonion-Coronoid Process (Go-CP), Gonion-Gnathion (Go-Gn), Condyle-Gnathion (Co-Gn), Symphyseal Height (SH), Mandibular Angle (MA). The data were collected, tabulated and analyzed with the aid of SPSS software, version 11.0, 2005. One-way ANOVA test was performed to compare the mean values of anatomical measurements of the right and left HMs. Gestational ages were divided into second trimester (Period 1: 13-18 weeks and Period 2: 18-24 weeks), and early third trimester (Period 3: 24-30 weeks) of pregnancy. **Results:** We noted a slight growth rate asymmetry in Go-Gn, Co-CP, Co-Gn, Go-CP and SH, comparing the left and right mandibular halves, between the 2nd and early 3rd trimester of pregnancy, although not statistically significant ($p > 0.05$). It was also found that the mandibular angle decreased and showed a slight—though statistically significant ($p < 0.05$)—asymmetry in the same prenatal period. **Conclusion:** The authors concluded that there was a slight asymmetry in the growth rate of measurements Go-Gn, Co-CP, Co-Gn, Go-CP and SH, comparing the left with the right hemimandible between the 2nd and early 3rd trimester of gestation.

Keywords: Growth. Mandible. Fetus.

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INTRODUCTION

The mandible appears in adults as a single bone. However, various portions or subunits are found during its development process: the body of the mandible, to which the alveolar portion is attached, the condylar and coronoid processes, mandibular angles and mentum.³

The facial development process begins from the first and second pharyngeal arches during the fourth week of gestation.⁹ Proffit¹⁰ asserted that the first pharyngeal arch, also called mandibular arch, gives rise to tissues that will develop in the masticatory muscles and mandible. The mandibular arch houses Meckel's cartilage, which is responsible for its support. The mandibular body originates in the anterior portion of Meckel's cartilage from the intramembranous ossification of the ventral portion of the first branchial arch. The mandibular condyle, in turn, starts its development from a secondary cartilage, which is covered with a fibrous capsule.¹⁰ According to Moyers,⁹ mandibular dimensions show different growth patterns during the prenatal period and after birth.

It was long believed that the condyle was the center of mandibular growth.³ With the advent of Functional Matrix Theory, however, a number of theories emerged addressing bone structure growth and development.⁸ The condyle undoubtedly plays a major role in mandibular growth but it is not alone since mandibular growth is a complex process that cannot be explained away in simplistic terms.³

Research on fetal mandibular growth basically correlates the development of mandibular structures with fetus age.^{1,4,5,16}

In his study, Mandarim et al⁶ provided a straightforward and accurate method for classifying fetal age. Once the values of certain parameters are known—such as growth of cephalic module, greater foot length, crown-rump length, and weight—it is possible to determine fetal age. They used a table initially proposed by

Streeter,¹⁷ which was perfected by the authors and helps determine such an age in weeks post conception with reasonable approximation.⁶

The work of Mandarim et al⁶ was rectified and showed a correlation between foot length and the growth in crown-rump length.¹⁴

Studying the mandible during the prenatal period is critical for the evaluation and diagnosis of congenital anomalies of the face, whereas mandibular abnormalities may be associated with several syndromes.^{1,4,5,7,12} Thus, data from this study may contribute to a better understanding of the process of formation and development of the facial skeleton.¹³

The purpose of this study is to provide a comparison between different anatomical dimensions of the right and left hemimandibles (HMs) during the second and early third trimester of pregnancy.

Ultrasound methods, when used to assess mandibular growth structures and for the diagnosis of fetal malformations such as micrognathia and macrognathia, establish evaluation criteria for the diagnosis of mandibular anomalies *in utero*, which allows early diagnosis and the choice of a suitable therapy.¹² Research has emphasized that any structural changes in mandibular cartilage during the prenatal period are more intimately related to local mechanical factors and articulation than to bone growth *per se*.¹²

The functions exerted by the masseter and temporal muscles induce mandibular growth during the 11th week.¹

MATERIAL AND METHODS

Were used 68 HMs (34 mandibles) of fetuses—20 female and 14 male—preserved in 10% formalin solution. The fetuses, supplied by the Department of Morphology, Juiz de Fora Federal University, were Brazilian and presented with no malformation whatsoever. The study was preapproved by the Ethics Committee of the Juiz de Fora Federal University.

Gestational age ranged from 13 to 30 weeks post-conception (WPC) and was estimated on the basis of greatest foot length and weight, according to protocol^{5,6,16} (Table 1).

After the fetal age had been estimated, the mandibles were dissected, disjointed and immersed in a plastic 50 x 50 x 80 cm wash tub containing water. The technique of natural running water maceration was utilized.¹² It took a period of 6 weeks for the complete removal of

the soft tissues, including the periosteum, for better visualization of the anatomical landmarks chosen for analysis. After this process, the following measurements⁵ were performed (Fig 1):

1. Condyle-Coronoid Process (Co-CP): Distance between the posterior-most point on the condylar process and the anterior-most point on the coronoid process.

2. Gonion-Coronoid Process (Go-CP): Distance between the gonion and the upper-most

TABLE 1 - Gestational age according to the criteria of greatest foot length and weight.

AGE (WPC)	GENDER	WEIGHT (g)	GREATER FOOT LENGTH (mm)	Co-CP (cm)	Go-CP (cm)	SH (cm)	Go-Gn (cm)	Co-Gn (cm)	MA	HM
13.4	F	68.2	18	0.555	0.755	0.425	1.115	1.765	148°	R
				0.565	0.775	0.400	1.100	1.725	153°	L
13.7	M	61.5	19	0.575	0.710	0.365	1.055	1.685	157°	R
				0.525	0.715	0.365	1.075	1.645	140°	L
13.7	M	75.2	19	0.545	0.800	0.415	1.055	1.825	153°	R
				0.565	0.785	0.400	1.000	1.835	155°	L
15.2	F	131.3	24	0.675	0.955	0.385	1.525	2.155	138°	R
				0.685	1.000	0.385	1.575	2.155	142°	L
15.2	F	137.3	24	0.645	0.725	0.415	1.500	2.185	149°	R
				0.635	0.775	0.400	1.500	2.085	150°	L
15.7	M	127.9	26	0.865	0.875	0.445	1.425	2.200	153°	R
				0.855	0.900	0.445	1.455	2.335	155°	L
17.4	F	194.8	32	0.865	1.115	0.635	2.025	2.700	146°	R
				0.865	1.115	0.635	2.025	2.700	146°	L
17.4	F	224.1	32	0.775	1.035	0.535	1.685	2.435	148°	R
				0.785	1.045	0.535	1.585	2.415	148°	L
17.8	F	212.5	33	0.675	1.055	0.500	1.800	2.385	144°	R
				0.700	1.035	0.500	1.825	2.400	144°	L
18.1	M	333.7	34	0.835	1.185	0.645	2.085	2.715	141°	R
				0.825	1.165	0.645	2.035	2.735	136°	L
18.1	F	201.7	34	0.775	1.045	0.600	1.945	2.675	153°	R
				0.775	1.100	0.600	1.965	2.665	146°	L
18.4	M	287.7	35	0.795	0.995	0.615	1.925	2.800	147°	R
				0.815	1.025	0.575	2.000	2.785	145°	L
18.4	F	292.8	35	0.825	1.085	0.535	1.975	2.615	148°	R
				0.900	1.165	0.535	1.945	2.645	146°	L

18.7	M	309.6	36	0.865	1.085	0.585	1.995	2.700	148°	R
				0.895	1.245	0.575	1.965	2.775	151°	L
19.0	M	320.3	37	0.955	1.100	0.555	2.145	2.775	142°	R
				0.925	1.135	0.565	2.165	2.800	148°	L
19.0	F	319.2	37	0.775	1.145	0.525	2.165	2.765	141°	R
				0.755	1.045	0.495	2.225	2.765	132°	L
19.0	F	387.2	37	0.915	1.265	0.545	1.945	2.915	140°	R
				1.000	1.245	0.545	2.055	2.915	130°	L
20.5	F	418.5	42	0.885	1.165	0.555	2.100	2.785	140°	R
				0.825	1.125	0.555	2.100	2.800	135°	L
20.9	F	459.5	43	0.925	1.275	0.665	2.525	3.055	127°	R
				0.935	1.295	0.665	2.500	3.075	130°	L
21.3	M	477.8	44	0.945	1.315	0.735	2.265	3.000	140°	R
				0.875	1.335	0.735	2.275	2.845	138°	L
21.8	F	462.3	45	1.000	1.425	0.855	2.465	3.235	134°	R
				1.015	1.435	0.855	2.465	3.235	131°	L
21.8	M	535.5	45	1.025	1.445	0.700	2.600	3.400	144°	R
				1.055	1.400	0.665	2.615	3.355	140°	L
21.8	F	541.5	45	1.165	1.500	0.845	2.620	3.455	145°	R
				1.100	1.555	0.800	2.655	3.445	148°	L
22.2	F	507.3	46	1.255	1.165	0.665	2.515	3.425	147°	R
				1.145	1.335	0.665	2.445	3.395	147°	L
23.1	M	657.1	48	1.025	1.245	0.800	2.485	3.425	137°	R
				1.035	1.225	0.800	2.475	3.425	148°	L
24.8	F	699.0	52	1.115	1.325	0.675	2.735	3.475	139°	R
				1.175	1.335	0.685	2.725	3.500	138°	L
25.7	M	628.7	54	1.085	1.615	0.965	2.565	3.675	136°	R
				1.100	1.745	0.965	2.600	3.535	138°	L
27.1	M	1956.3	43	1.555	1.875	1.315	3.645	4.915	138°	R
				1.600	2.055	1.300	3.655	4.975	141°	L
27.5	M	1166.4	58	1.275	1.565	1.135	3.135	4.215	151°	R
				1.245	1.600	1.100	3.075	4.075	141°	L
27.6	F	1303.0	60	1.455	1.525	1.045	2.775	4.085	142°	R
				1.465	1.625	1.045	2.745	4.115	150°	L
28.0	F	1560.4	61	1.600	1.715	1.155	3.265	4.425	147°	R
				1.715	1.685	1.100	3.225	4.500	150°	L
28.0	F	995.8	59	1.400	1.500	0.955	2.995	4.000	149°	R
				1.345	1.445	1.965	3.075	3.965	140°	L
28.9	F	1223.7	63	1.300	1.585	0.975	2.655	4.035	147°	R
				1.305	1.575	0.975	2.660	4.055	148°	L
30.3	M	30.3	66	1.500	1.665	0.965	2.865	4.100	144°	R
				1.500	1.765	0.935	2.885	4.275	144°	L

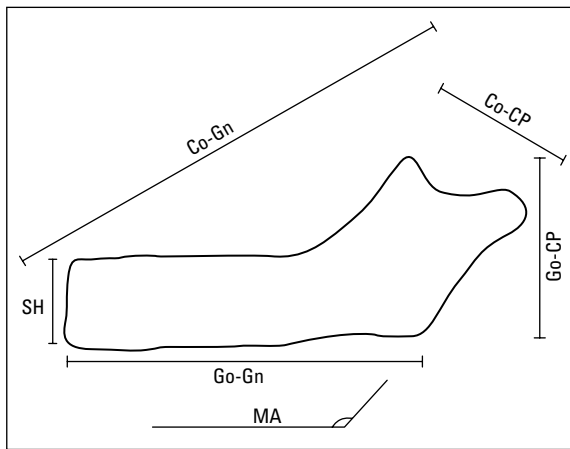


FIGURE 1 - Measurements performed in the hemimandible.

point on the coronoid process.

3. Gonion-Gnathion (Go-Gn): Length from Gonion to Gnathion.

4. Condyle-Gnathion (Co-Gn): Distance between the posterior-most point on the condylar process and the Gnathion.

5. Symphyseal height (SH): Measured on the median area to be occupied by the future central incisors, corresponding to the vertical distance between the upper-most and lower-most portions of the mandibular symphysis.

6. Mandibular Angle (MA): Measured between the posterior margin of the mandibular ramus and the lower margin of the mandibular body.

All measurements were made by one and the same author, using a 0.05 accuracy caliper and a digital scale. The extent of the mandibular angle was measured with the aid of a protractor (Table 1).

The data were collected, tabulated and analyzed with the aid of SPSS software, version 11.0, 2005 (Statistical Package for the Social Sciences, SPSS Inc., USA). One-way ANOVA test was performed to compare the mean values of anatomical measurements of the right and left HMs. Gestational age was divided into Period 1 (13-18 WPC), Period 2 (18-24 WPC),

and Period 3 (24-30 WPC). Level of significance was set at $p < 0.05$.

RESULTS

An analysis of the following data was conducted for all measurements using 5% statistical significance:

Go-CP, Go-Gn, Co-Gn, and Co-CP

A similar growth pattern emerged between the right and left HMs throughout the three periods. The left side exhibited a greater growth rate than the right, although not statistically significant (Figs 2, 3, 4 and 5, respectively).

SH (Symphyseal Height)

A similar growth pattern emerged between the right and left HMs throughout the three periods. The right side had a higher growth rate than the left, although not significant $p > 0.05$ (Fig 6).

MA (Mandibular Angle)

We observed a different growth pattern between periods 1 and 2 and between periods 2 and 3. The mandibular angle of the left HM underwent a greater decrease than the right side between the first and second periods and a greater increase between the second and third periods. When the first and third periods were compared, however, both HMs were found to be identical. These results showed statistical significance ($p < 0.05$) and support the findings of the Malas et al⁶ study, in which significant differences were found between the right and left sides (Fig 7).

Mandibular Body x Mandibular Ramus

Mandibular body growth (length: Go-Gn, height: SH) was higher than that of the mandibular ramus (length: Co-CP, height: Go-CP) from first to third period. The highest growth rate was found for mandibular body height (SH) (Table 2).

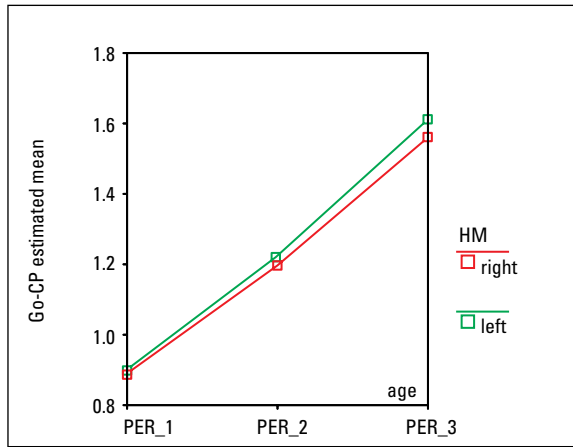


FIGURE 2 - Go-CP estimated means.

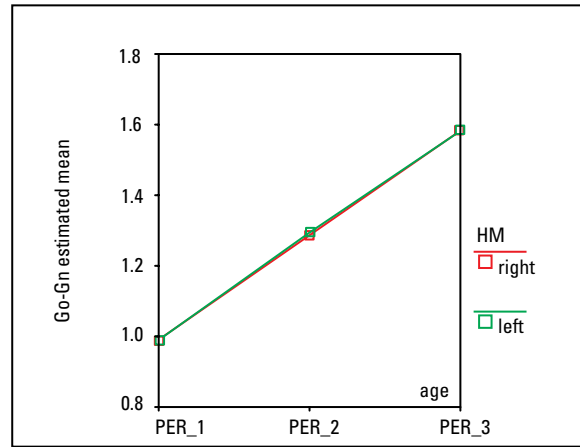


FIGURE 3 - Go-Gn estimated means.

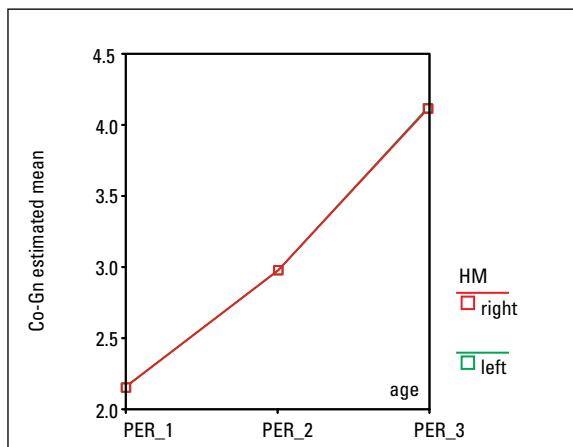


FIGURE 4 - Co-Gn estimated means.

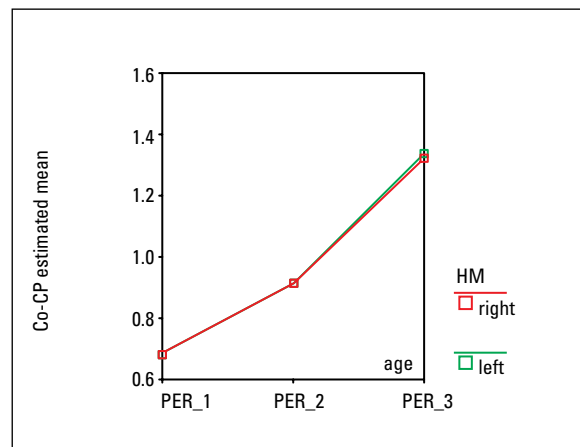


FIGURE 5 - Co-CP estimated means.

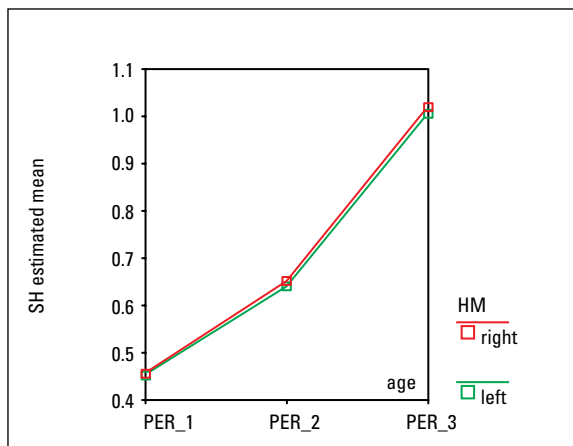


FIGURE 6 - SH estimated means.

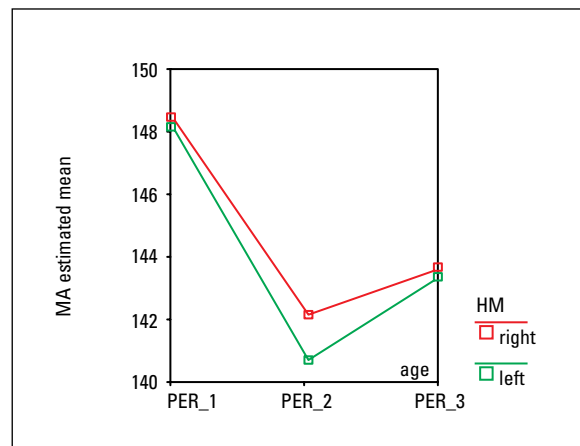


FIGURE 7 - MA estimated means.

TABLE 2 - Growth of mandibular body and ramus.

MEASUREMENT	AGE	HM MEAN	AMOUNT OF HM	GROWTH IN PERCENTAGE PER PERIODS
Co-CP	PER_1	0.68639	18	PER_1 - PER_2: 35.40%
	PER_2	0.92938	32	PER_2 - PER_3: 47.83%
	PER_3	1.37389	18	PER_1 - PER_3: 100.16%
Go-CP	PER_1	0.89833	18	PER_1 - PER_2: 36.61%
	PER_2	1.22719	32	PER_2 - PER_3: 32.19%
	PER_3	1.62222	18	PER_1 - PER_3: 80.58%
SH	PER_1	0.45472	18	PER_1 - PER_2: 42.26%
	PER_2	0.64688	32	PER_2 - PER_3: 56.78%
	PER_3	1.01417	18	PER_1 - PER_3: 123.03%
Go-Gn	PER_1	1.46250	18	PER_1 - PER_2: 52.47%
	PER_2	2.22938	32	PER_2 - PER_3: 32.77%
	PER_3	2.96000	18	PER_1 - PER_3: 102.39%

DISCUSSION

In pathological conditions mandibular measurements can vary and alter the mandibular angle, which can lead to malocclusion and orthodontic problems in adults.⁸

In some studies, researchers found variations and decreased values of the condylar angle as the gestational period evolved.^{1,2,13,15} A study of the mandibular angle of 162 fetuses between 9 and 40 WPC showed that the mean values were $122 \pm 8^\circ$ with no significant differences between trimesters nor between left and right HMs.⁷ In another study, the observed mean of $139 \pm 1^\circ$ in 36 fetuses between 13 and 37 WPC showed no significant changes in the angle during the second and third trimesters of pregnancy, comparing the right with the left HM.⁵ In our study, we noted a variation in the mean value of the mandibular angle ($143 \pm 6^\circ$) between 13 and 30 WPC. There was a decrease during the second quarter and an increase early in the third trimester, more pronounced on left side ($p < 0.05$).

But when we compared the mean values at the beginning and end of the period studied, we found no significant differences ($p > 0.05$). Previous studies report that mastication causes a decrease in the mandibular angle between birth and adult life.^{3,8,9} This suggests that the mandibular angle does not complete its development in the intrauterine period but throughout childhood, puberty and early adulthood and is influenced by mechanical factors.

A radiographic study of mandibular growth using 19 fetal mandibles aged between 18 and 41 WPC showed that the total length of the mandible (Co-Gn) and mandibular body (Go-Gn) increases linearly with fetal age.² We found similar results in the present study since the Co-Gn and Go-Gn measurements indicated a slightly greater growth pattern in the left HM, although not statistically significant ($p > 0.05$).

A literature review disclosed contrasting results. During the 2nd and 3rd trimester of prenatal life mandibular growth is allometric.

The mandibular body grows more rapidly than the ramus, both in length (Go-Gn) and height (SH) while symphysis height displays the highest growth rate.⁵ According to some authors, however, the mandibular ramus grows faster than the mandibular body, both in length (Co-CP) and height (Go-CP),^{2,3} and ramus height shows the fastest growth rate.^{2,3} In this study, we found a greater growth rate in the height (SH) and length of the mandibular body (Go-Gn) compared with the length (Co-CP) and height of the mandibular ramus (Go-CP), as shown in Table 2.

Mandibular dimensions (Go-CP and SH) were assessed using multivariate analysis and PCA and revealed higher growth rates on the right side.⁵ All other measurements (Co-CP, Go-Gn, Co-Gn, MA) showed a higher growth rate on the left side, between 13 and 37 weeks of gestation.⁵ In our study, an analysis of graphs reflecting the mean measurement val-

ues showed agreement with those values, except for Go-CP, which showed a growth rate slightly higher in the left HM.

CONCLUSION

The authors concluded that there was a slight asymmetry in the growth rate of measurements Gn-Go, Co-CP, Co-Gn, Go-CP and SH, comparing the left with the right hemimandible between the 2nd and early 3rd trimester of gestation, although not statistically significant. Furthermore, a reduction was found in the mandibular angle (MA) during the 2nd trimester of gestation, which contrasted with an increased MA at the beginning of the 3rd trimester, in addition to a slight asymmetry. These findings showed statistical significance.

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Angle Class III malocclusion with severe anteroposterior discrepancy

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Abstract

This case report describes the treatment of a 36-year-old patient who presented a skeletal and dental Class III malocclusion and missing upper canines. The patient was treated with orthosurgical maxillary advancement (Le Fort 1) and occlusal adjustment of the first premolars, which replaced the canines. This case was presented to the Brazilian Board of Orthodontics and Facial Orthopedics (BBO), as representative of Category 4, i.e., malocclusion with severe anteroposterior discrepancy, as part of the requirements for obtaining the BBO Diploma.

Keywords: Angle Class III malocclusion. Maxillofacial surgery. Corrective Orthodontics.

HISTORY AND ETIOLOGY

Caucasian patient aged 36, female, in good health and with average caries experience. No reported history of serious or chronic diseases. The patient reported in her initial consultation that her facial profile was concave since childhood and her upper canines were extracted at an early age. Her main complaint concerned a disharmony of the anterior teeth and dissatisfaction with the functional and aesthetic aspects.

DIAGNOSIS

A physical examination revealed that the patient had Class III skeletal and dental malocclusion characteristics. Occlusal relationship seemed atypical since the premolars were found to be replacing the canines, which were missing. The first

lower left molar was also absent. Thus, the right side molar relationship was in Class I and the relationship between canines in atypical Class III with the premolars replacing the canines. There was an anterior -4 mm crossbite and a slight lower arch midline shift (1 mm to the left). The posterior crowns seemed enlarged and showed signs of gingival recession (Figs 1 and 2).

A sagittal view of the patient's face showed that the middle third was retruded in relation to the upper and lower thirds. Maxillary deficiency was evidenced by the near absence of zygomatic projection and infraorbital depression. Moreover, the mandible did not show a long chin-neck line¹. In frontal view, no significant discrepancies were noted. The relative vertical expansion of the lower third was well evidenced by the disparity between

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the upper lip, lower lip and chin, which were at a ratio of 1:3, when the ideal would be 1:2.² This disparity gave the impression that half of the lower third looked “heavy”, especially for a female face. The maxillary retrusion further contributed to this impression, which was possibly enhanced by the missing upper canines. Smile aesthetics was also affected by the retrusive maxilla due to a low smile line and inadequate upper incisor exposure (Fig 1).

The panoramic radiograph showed horizontal bone loss in both arches (Fig 3).

Assessment of the lateral cephalometric radiograph (Fig. 4) confirmed the Class III skeletal pattern with ANB equal to -10° ($SNA = 74^\circ$ and $SNB = 84^\circ$) and compensatory inclination of the incisors ($1-NA = 30^\circ$, $1-NB = 19^\circ$ and $IMPA = 84^\circ$). These and other measurements can be seen in Table 1.

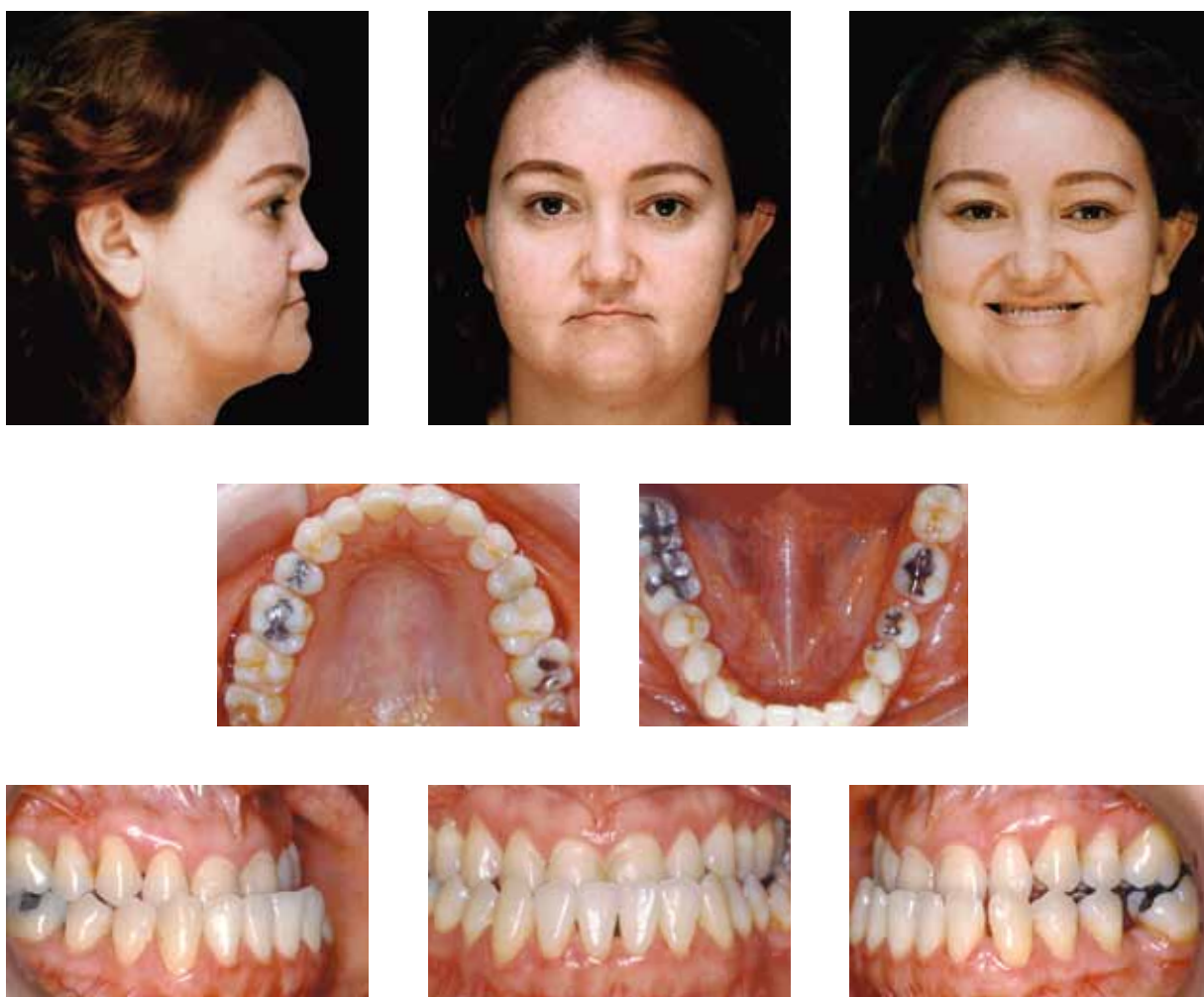


FIGURE 1 - Initial facial and intraoral photographs.

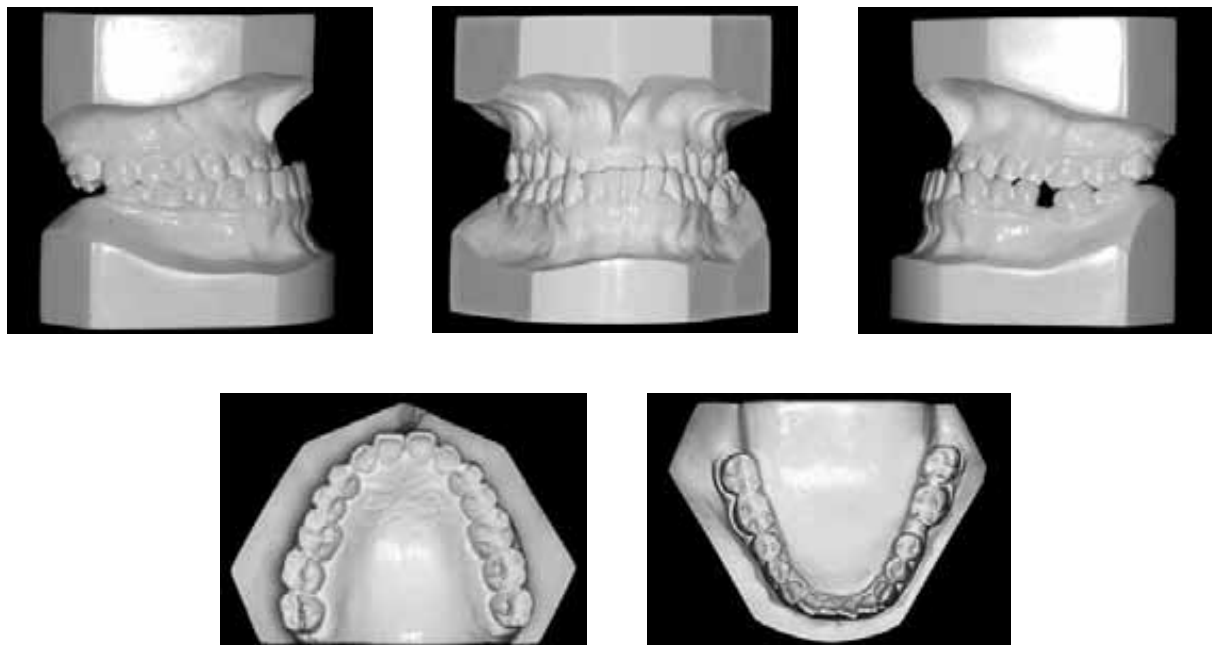


FIGURE 2 - Initial casts.

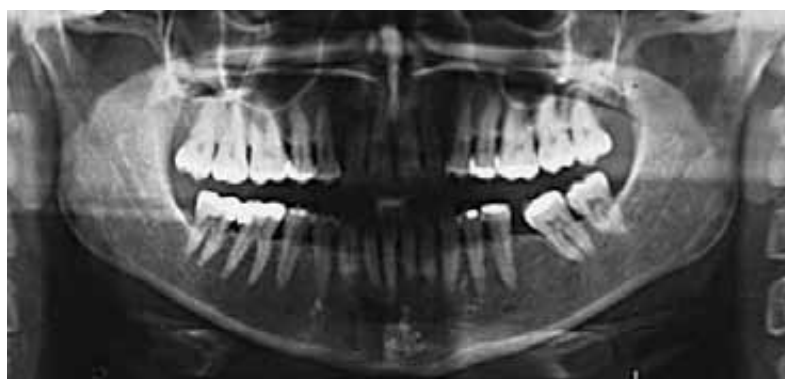


FIGURE 3 - Initial panoramic radiograph.

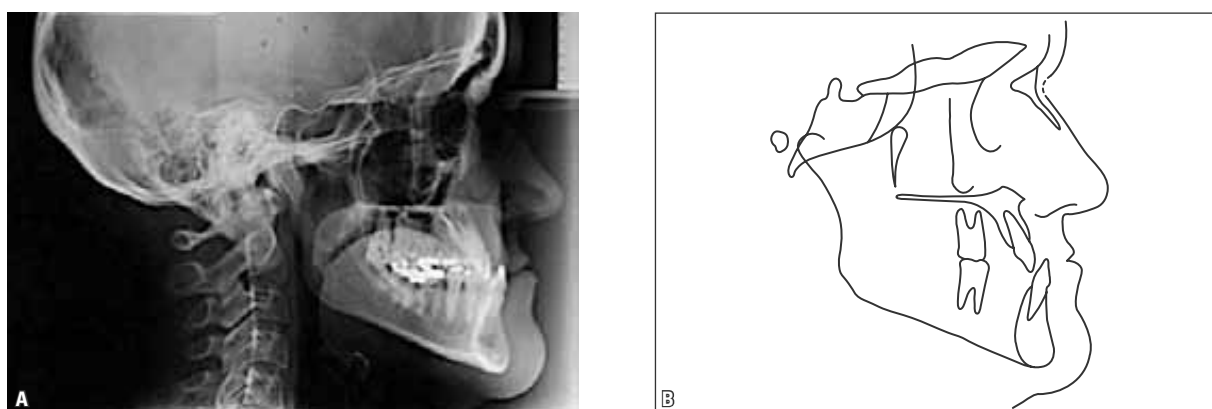


FIGURE 4 - Initial lateral cephalometric radiograph (A) and cephalometric tracing (B).

TREATMENT GOALS

Treatment goals were based on the maxillary deficiency that led to the midface retrusion. The anterior crossbite resulting from the maxillary retrusion and missing maxillary canines required correction by means of surgical maxillary advancement. The establishment of normal occlusion—according to Andrews's six keys to optimal occlusion—was achieved through maxillary advancement and occlusal adjustment of the premolars that replaced the canines. Presurgical orthodontic decompensation was accomplished by aligning and leveling the upper and lower arches. For the lower arch it was decided that the space left by the missing tooth (36) would be closed during the orthodontic mechanics of decompensation. The surgical goal focused on maxillary advancement since the maxilla was retruded in relation to the lower third and the mandible did not show a significant disparity, as attested by the normal length of the chin-neck line.

TREATMENT PLAN

The treatment plan was based on the need for dental decompensation for presurgical preparation. It also consisted in installing the upper and lower fixed appliance (Standard Edgewise system, 0.022 x 0.028-in slot, round 0.012-in, 0.014-in, 0.016-in, 0.018-in, 0.020-in and rectangular 0.019 x 0.025-in arch wires). All orthodontic wires were stainless steel, except the first, which was a NiTi. In the final stage of alignment and leveling with round arches the use of Class II elastics was started with the purpose of decompensating the lingual inclination in the lower anterior crowns and preparing for placement of the rectangular 0.019 x 0.025-in arch wire. The use of Class II-oriented elastics would also serve to assist in closing the space between teeth 37 and 35, caused by the absence of 36.

Following the insertion of the rectangular wires, casts were made of the upper and lower arches to analyze a simulation of the postsurgical occlusion. As soon as the occlusion was prepared additional documentation was ordered for evaluation

and study prior to surgery. The surgery goal was maxillary advancement (Le Fort I) with rigid fixation using plates and screws. The last phase would involve finishing the case with special attention to first premolar torque setting. Before the removal of the fixed appliance an appointment was scheduled for occlusal adjustment and to refine the occlusal contacts and lateral and anterior guides.

Lower retention consisted of a 0.032-in braided wire retainer bonded to the lingual surface of the anterior teeth, from canine to canine. In the upper arch a wraparound removable upper plate was used, made with 0.032-in stainless steel wire.

TREATMENT PROGRESS

The orthodontic appliance was comprised of brackets, which were bonded from premolar to premolar and molar bands, which were placed on the molars (including the third molars). Buccal tubes were bonded to the lower second molars. With the exception of the first 0.012-in orthodontic arch wires, which were NiTi, all others were stainless steel. The use of these arch wires allowed the customization of arch size diagrams and the use of sizes that enabled arch decompensation. In other words, any compensation generated by the initial malocclusion was corrected based on individual features and on the ideal size for the patient's arches. It should be noted that the distance between the canines and lower molars served as a reference for producing upper and lower diagrams. The use of customized contoured arch wires which conformed to such measurements allowed a slow and gradual decompensation. However, the decompensation of the maxillary transverse width caused a decrease in intermolar width, bringing about a stalemate. In fact, the decrease in intermolar width occurred on account of torque correction. Since this was a Class III malocclusion case, even when these teeth are not crossed they do present with lingual root torque compensations.³ Thus, after correcting the torque of the posterior teeth a discrepancy

was found between maxillary and mandibular widths. Whenever the cast models were manipulated to simulate the postsurgical position a lingual crossbite appeared. In fact, maxillary atresia was also expressed in the transverse dimension. Thus, there was a discrepancy between the maxillary and mandibular bone bases which showed up after dental decompensation. The ideal solution to this problem would be maxillary expansion surgery performed either prior to or during

advancement surgery, thus segmenting the maxilla. However, the simulation models showed that the crossbite was negligible. This fact, compounded by the disadvantages of a two-step surgery (expansion and advancement), such as discomfort and compromised esthetics, as well as, on the other hand, the possibility of relapse⁵ after a single-step surgery, led the author to compensate for the transverse discrepancy between the maxilla and mandible by increasing molar buccal root torque,



FIGURE 5 - Presurgical facial and intraoral photographs.

which shortened the intermolar width of these teeth (Table 2). In other words, the proper fit between upper and lower molars in the transverse direction was achieved by dental compensation through molar buccal root torque, which allowed the palatal cusps of the upper molars to occlude with the fossae and marginal ridges of the lower

molars. After such compensations additional exams were ordered for surgical planning and the patient was referred for surgery (Figs 5 to 9).

As expected, an 8 mm maxillary advancement enabled the correction of the anterior crossbite with an atypical occlusion relationship since the upper first premolars had replaced the canines.

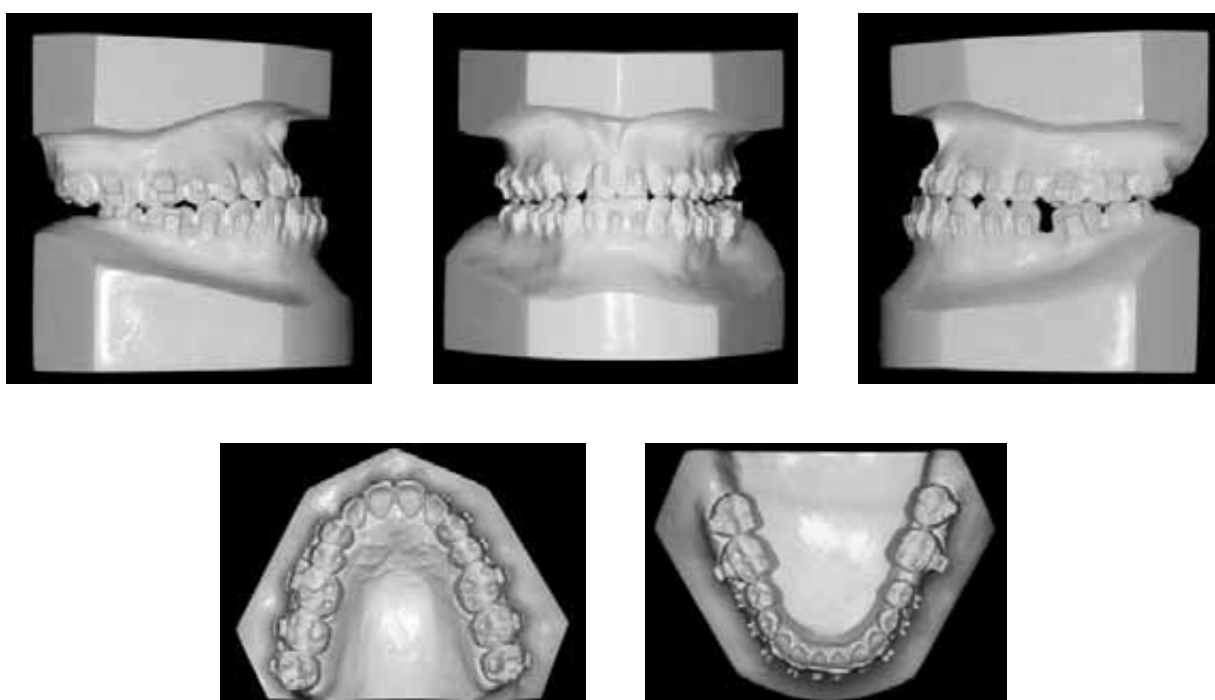


FIGURE 6 - Presurgical cast models.



FIGURE 7 - Presurgical panoramic radiograph.

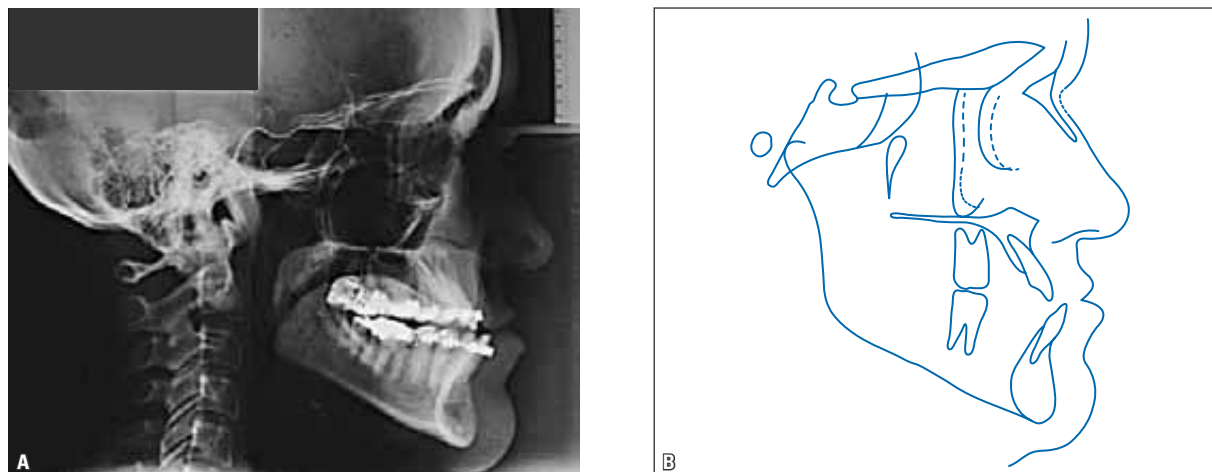


FIGURE 8 - Presurgical lateral cephalometric radiograph (A) and cephalometric tracing (B).

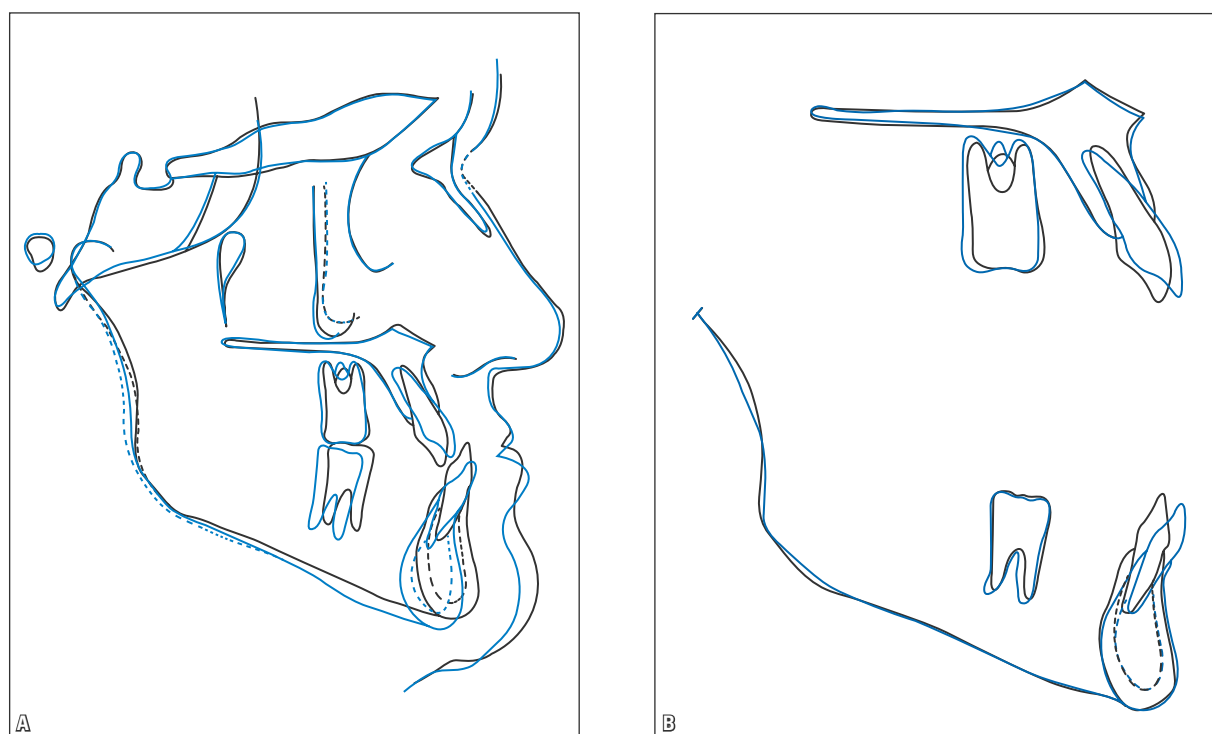


FIGURE 9 - Total (A) and partial (B) superimposition of initial (black) and presurgical (blue) cephalometric tracings.

In the final stage, after the orthodontic adjustments, occlusal adjustment was performed by wearing down the upper first premolar region so that the occlusal contacts were simultaneous and bilateral, exerting equipotent axial forces with no lateral resultant forces. The lateral guides were obtained through group disocclusion so as to not force or traumatize the premolars, which already presented with gingival recession before

treatment. The occlusal adjustments were refined six months after appliance removal. The space left by tooth 36 was closed using orthodontic elastic chains and with the aid of inter maxillary elastics used before surgery (Fig 10).

The planned retainers were used. In the upper arch a removable wraparound appliance and in the lower, 0.032-in braided wire was bonded from canine to canine.



FIGURE 10 - Final facial and intraoral photographs.

TREATMENT RESULTS

The 8 mm surgical maxillary advancement (Le Fort 1) corrected the sagittal discrepancy of the Class III malocclusion with a reduction in ANB from -10° to 0° (Table 1). Incisor decompensation allowed the anterior crossbite to be corrected and correct vertical and horizontal overlaps were achieved. The space of the missing first lower left molar was taken by the

second molar, which kept a Class II relationship on both left and right sides due to the absence of canines. The premolars replaced the canines and after the necessary orthodontic adjustments and some wearing down of the occlusal contacts also assumed their function. The maxillary advancement also provided aesthetic enhancement since both the profile and the smile showed significant improvement. The profile became more

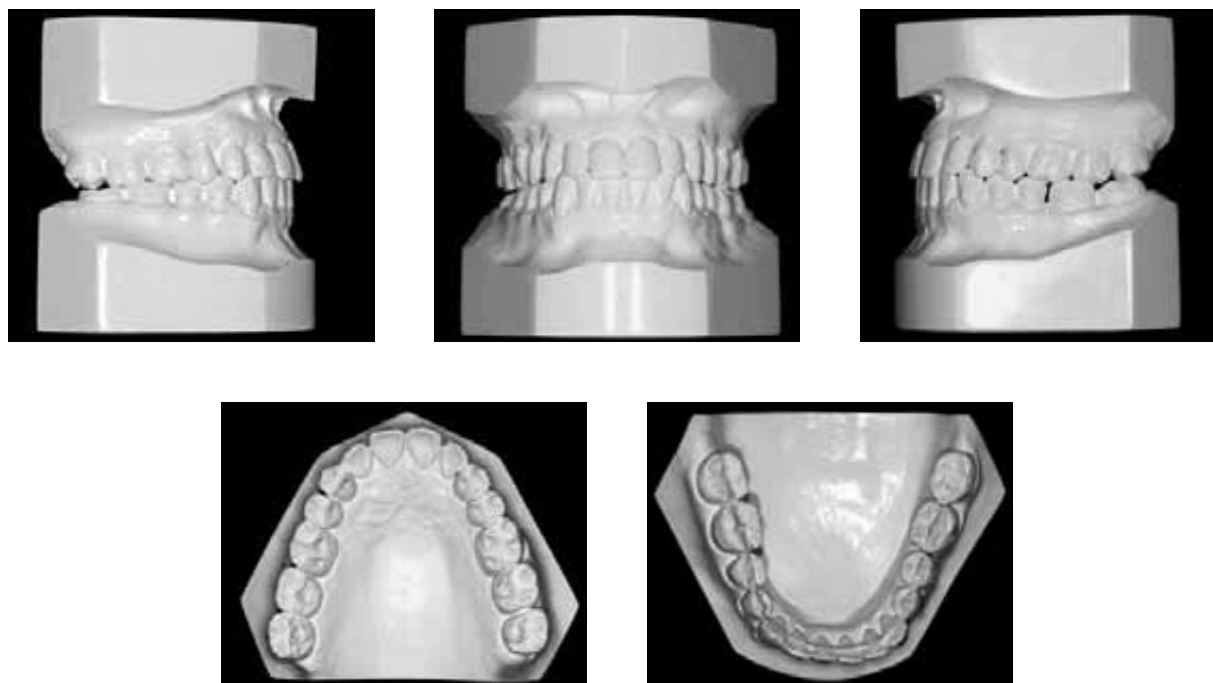


FIGURE 11 - Final cast models.



FIGURE 12 - Final panoramic radiograph.

balanced with well-proportioned facial thirds. The proper positioning and greater exposure of the upper incisors contributed to a balanced smile.⁴ A frontal view of the face at rest showed

improvement in the proportions of the facial thirds and in the relationship between the upper lip, lower lip and mentum, which was increased to 1:2 (Figs 10 to 14).

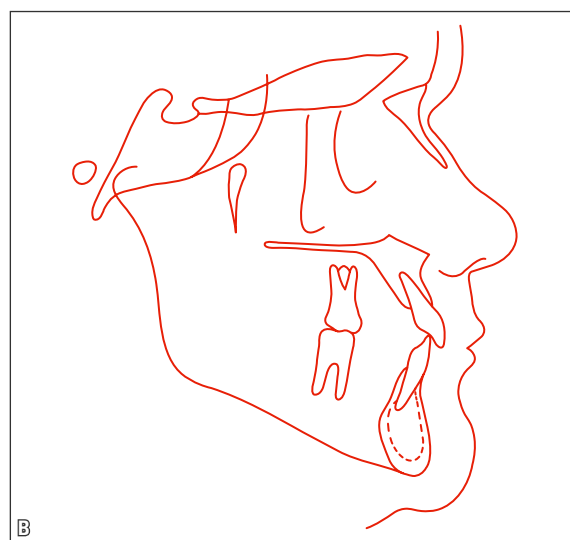


FIGURE 13 - Final lateral cephalometric radiograph (A) and cephalometric tracing (B).

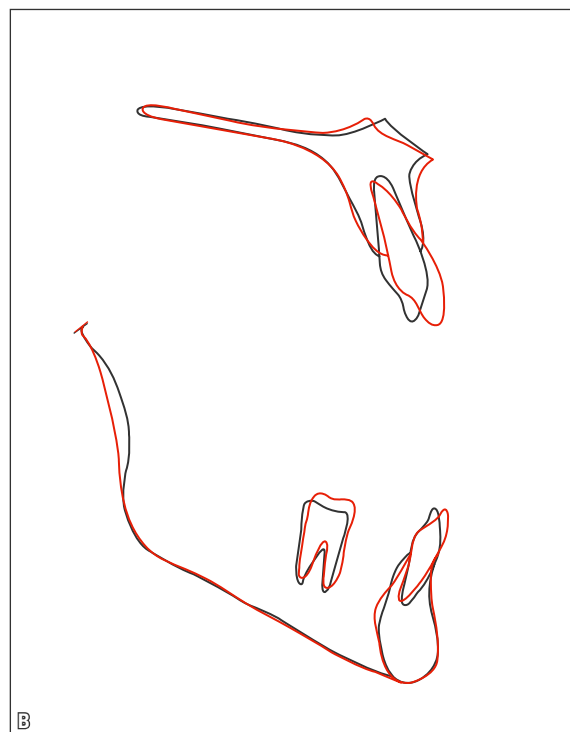
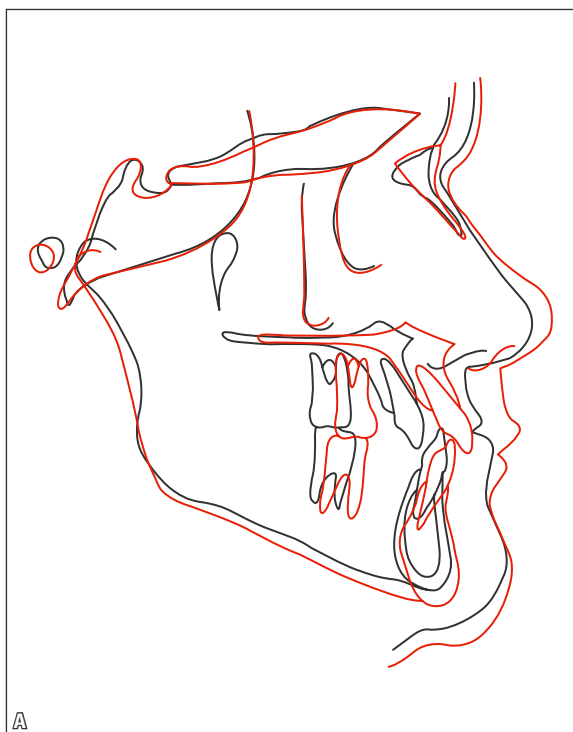


FIGURE 14 - Total (A) and partial (B) superimposition of initial (black) and final (red) cephalometric tracings.

TREATMENT EVALUATION

In view of the fact that this was an adult patient with a Class III malocclusion, surgery was always an option. Maxillary advancement was preferred because the midface was retruded in relation to the upper and lower thirds. This retrusion showed that there was a maxillary atresia which, accompanied by an absence of canines, compounded the retrusive effect with a 4 mm anterior crossbite. Moreover, although there was a discrepancy in position between maxilla and mandible, the mandible was not excessively large. This fact was attested by the

normal length of the chin-neck line. In addition, two factors were crucial to the maxillary surgery. Firstly, there was a risk that mandibular setback might interfere with the reduction of oropharynx space, which might lead to the emergence of a respiratory disorder, in particular, Obstructive Sleep Apnea. Secondly, the possibility of relapse is reduced when a single bone is moved.⁵ Four years later, result stability confirmed this expectation (Figs 15 to 19).

The correction of skeletal and dental problems allowed the occlusal, functional and aesthetic goals to be achieved.



FIGURE 15 - Facial and intraoral control photographs taken four years after treatment completion.

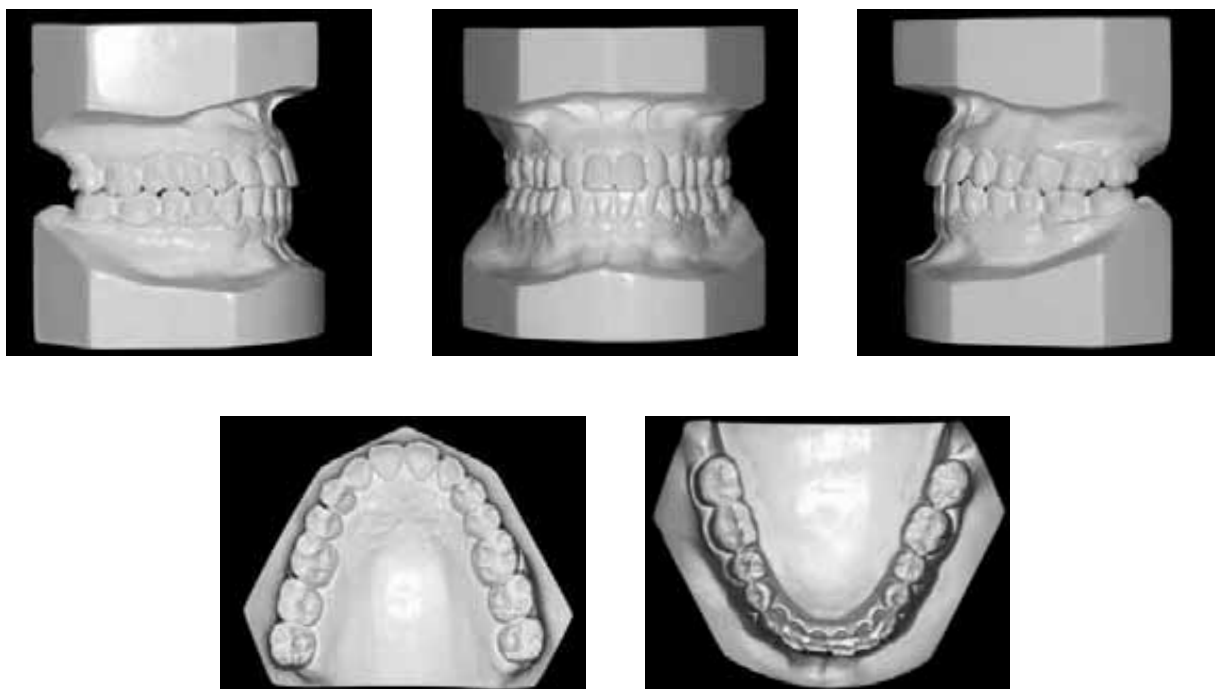


FIGURE 16 - Control casts four years after treatment completion.



FIGURE 17 - Panoramic radiograph four years after treatment completion.

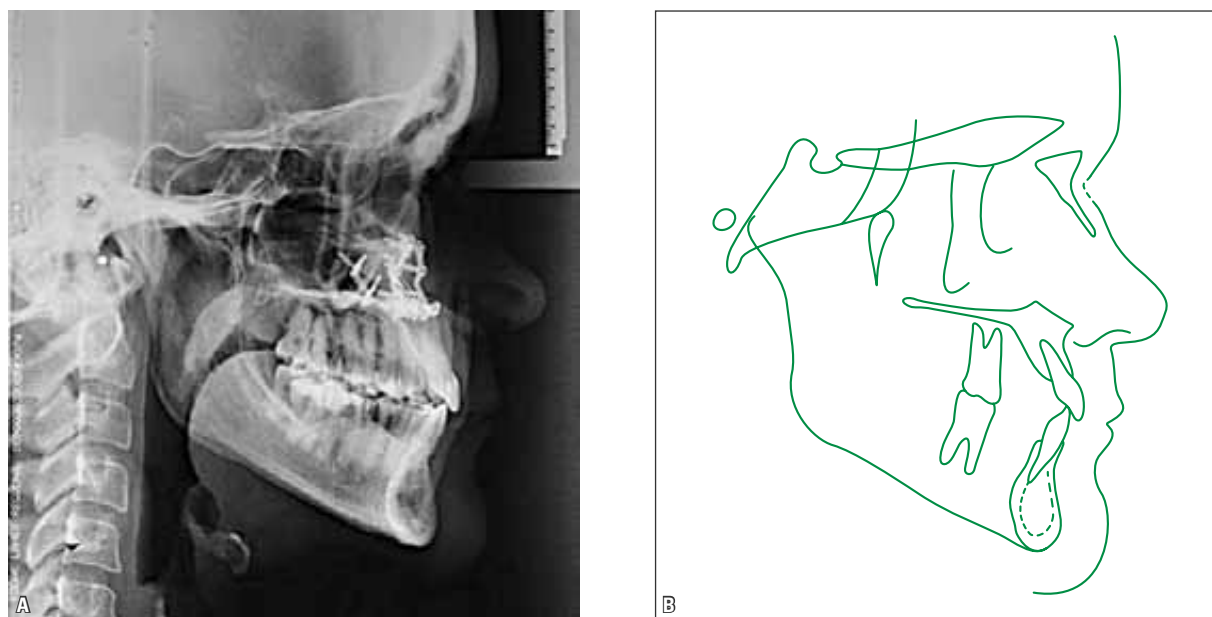


FIGURE 18 - Profile lateral radiograph (A) and cephalometric tracing (B) - four years after treatment completion.

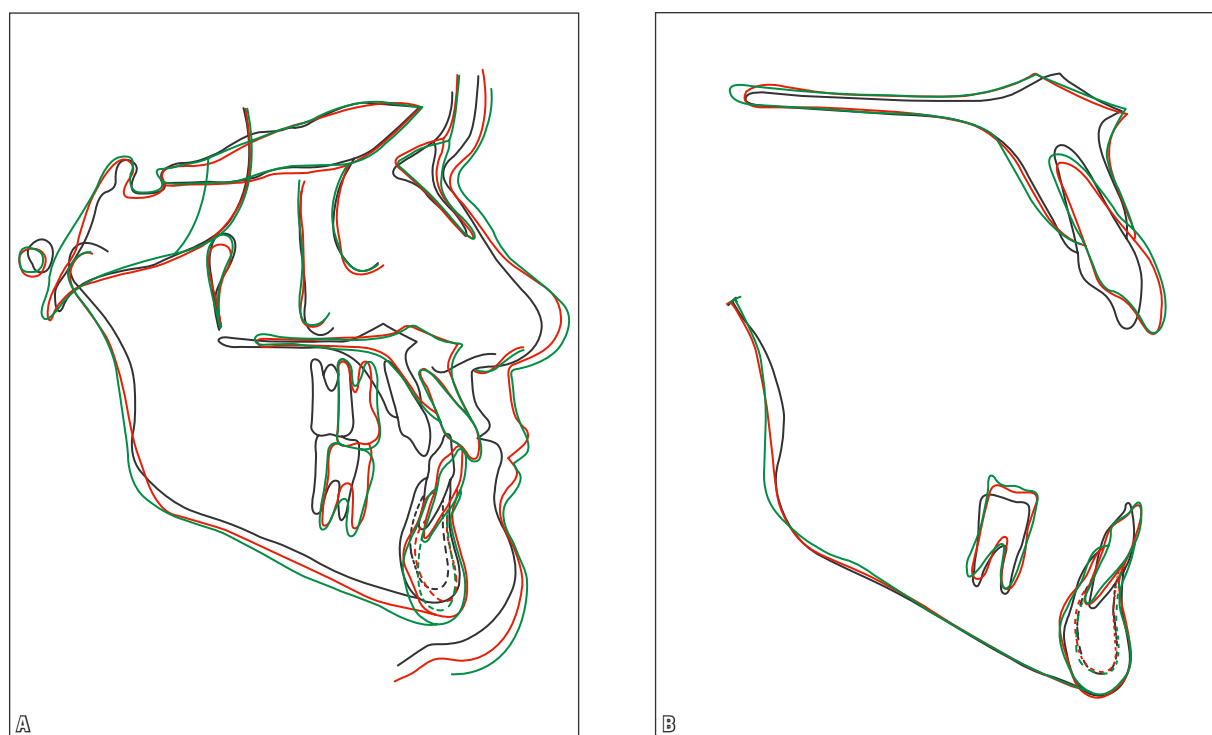


FIGURE 19 - Total (A) and partial (B) superimposition of initial (black), final (red) and control (green) cephalometric tracings four years after treatment completion.

TABLE 1 - Summary of cephalometric measurements.

MEASUREMENTS		NORMAL	A	A1	A2	B	A - B DIFFERENCE	C
SKELETAL PATTERN	SNA (Steiner)	82°	74°	74°		83°	9°	83°
	SNB (Steiner)	80°	84°	83°		83°	2°	83°
	ANB (Steiner)	2°	-10°	-11°		0°	10°	0°
	Convexity Angle (Downs)	0°	-23°	-20°		-4°	19°	4°
	Y Axis (Downs)	59°	50°	50°		50°	0°	50°
	Facial Angle (Downs)	87°	99°	98°		97°	2°	97°
	SN – GoGn (Steiner)	32°	29°	32°		30°	1°	30°
	FMA (Tweed)	25°	16°	17°		17°	1°	17°
DENTAL PATTERN	IMPA (Tweed)	90°	84°	93°		89°	5°	88°
	1 – NA (degrees) (Steiner)	22°	30°	41°		29°	1°	29°
	1 – NA (mm) (Steiner)	4	9	11		8	1	8
	1 – NB (degrees) (Steiner)	25°	19°	30°		22°	3°	23°
	1 – NB (mm) (Steiner)	4	1	6		4	3	4
	1-1 - Interincisal Angle (Downs)	130°	140°	116°		129°	11°	128°
	1 – APo (mm) (Ricketts)	1	6	9		2	4	3
PROFILE	Upper Lip – S Line (Steiner)	0	-4	-3°		0	4	1°
	Lower Lip – S Line (Steiner)	0	-2	2		-2	0	3

TABLE 2 - Upper and lower interpremolar and intermolar widths (in mm).

MEASUREMENTS	A	A1	B	A-B DIFFERENCE	C
Upper Inter-premolar	32	32	32	0	32
Upper Inter-molar	45	44	44	1	44
Lower Inter-premolar	25	25	25	0	25
Lower Inter-molar	45	40	40	5	41

FINAL CONSIDERATIONS

Every orthodontic treatment aims to achieve (a) adequate occlusion while ensuring satisfactory and healthy functioning of the stomatognathic system's physiological routine, (b) optimal facial, oral and dental aesthetics and (c) long-term result stability. Adult patients with functional and aesthetic needs raise the level of difficulty in attaining these goals since, deprived of the ability to change provided by bone growth, they require additional, integrated procedures to achieve the desired goals. Angle Class III malocclusion is a classic example of this situation, where orthodontic possibilities are limited and need support from other specialties, particularly surgery. However, the key to a successful treatment lies in understanding and integrating these two specialties in seeking the best alternatives and procedures. In our case, the treatment was carried out

through orthodontic preparation and orthognathic surgery. Knowledge of the patient's aesthetic and functional needs as well as her expectations and concerns facilitated the correction of the bone and occlusal discrepancy through maxillary advancement and relocation of upper first premolars to perform the functions of the missing canines. Therefore, although unusual, this case met the requirements of the Brazilian Board of Orthodontics and Facial Orthopedics (BBO), which perceives and assesses treatment results by taking into account the ideal and actual precepts underlying an adequate orthodontic treatment.

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Associated dental anomalies: The orthodontist decoding the genetics which regulates the dental development disturbances

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Abstract

This article aims to approach the diagnosis and orthodontic intervention of the dental anomalies, emphasizing the etiological aspects which define these developmental irregularities. A genetic inter-relationship seems to exist determining some dental anomalies, considering the high frequency of associations. The same genetic defect may give rise to different phenotypes, including tooth agenesis, microdontia, ectopias and delayed dental development. The clinical implications of the associated dental anomalies are relevant, since early detection of a single dental anomaly may call the attention of professionals to the possible development of other associated anomalies in the same patient or in the family, allowing timely orthodontic intervention.

Keywords: Genetics. Dental anomalies. Tooth agenesis. Etiology. Orthodontics.

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INTRODUCTION

The transition from the deciduous to the permanent dentition is a complex biological process rich in details and represents one of the nature's expressions of perfection. However, as all natural processes, the dental development can show imperfections and during the mixed dentition, the professional can face some irregularities: The dental anomalies. Dental anomalies may be expressed with different degrees of severity. From the mildest to the most severe manifestation, represented respectively by the developmental delay and by the tooth agenesis, there is a myriad of expressions, including microdontia, changes in dental morphology and ectopias. This article is related to the nature's errors applied to dental development and discusses the etiology of the dental anomalies, the details for an accurate diagnosis, as well as some therapeutic approaches to intercept them appropriately.

The influence of genetic and environmental factors in the etiology of malocclusions represents a subject of great importance in Orthodontics. The higher the genetic contribution in the etiology of a dentofacial irregularity, the lesser the possibility of prevention and, generally, worse is the prognosis for orthodontic/orthopedic treatment.²² And the new directions of dental research are toward the knowledge of the human genotype.³⁰ Several studies have suggested a genetic and hereditary background in the etiology of dental anomalies of number, size, position, as well as timing of development.^{2,4,13,14,15,17,18,20,23,24,25,30} Such evidences come from studies in families,^{17,18,30} monozygotic twins²⁰ and from the frequent observation of associations of certain dental anomalies.^{2,4,13,14,15,23,24,25}

When a particular irregularity shows an increased prevalence in families of affected patients compared to the frequencies expected for the general population, genetics has an important influence in the etiology of the problem. The mandibular prognathism in the imperial

Austro-Hungarian family of the Hapsburgs represents the most classic example of a genetic characteristic of orthodontic interest, transmitted by successive generations.²² Many of the dental anomalies that will be discussed in this article showed an increased prevalence in the family of affected patients (Figs 1 to 7).^{17,18,30} Currently, molecular biology studies can isolate mutant genes in families, since several members express the same irregularity.³⁰

Monozygotic twins share almost identical genetic codes. Therefore, genetically defined features are similarly expressed in both twins. A high correlation for a particular irregularity in pairs of monozygotic twins is an evidence that genetics is an important etiology of such abnormality. Unlikely, dizygotic twins which have different genotypes would show a lower correlation for the same irregularity. Previous studies in twins constitutes important evidences of the genetic etiology of some dental anomalies.^{20,22}

Certain dental anomalies appear often associated in the same patient, more than expected by chance. This occurs because a same genetic defect can determine different manifestations or phenotypes, including agenesis, microdontia, ectopias and delayed tooth development.^{2,4,13,14,15,23,24,25} A simplistic explanation is that a "defective" or mutant gene can express differently in distinct permanent teeth. The association between the unilateral agenesis of the maxillary lateral incisor and the microdontia of its antimere, often observed in clinical routine, well illustrates this condition. In this case, the same genetic defect which determined the agenesis has an incomplete expression in the opposite side of the dental arch, causing microdontia. However, the associations between the dental anomalies are not restricted to this classic example. There are many more interactions between different dental anomalies, which are exposed along this article. The clinical implications are important because the early diagnosis

of a given dental anomaly can alert the professional to the possible development of other associated dental anomalies in the same patient or family, permitting early diagnosis and timely orthodontic intervention.

The aim of this article is to help the clinicians

in recognizing the main genetic dental anomalies, discussing important features of diagnosis and early orthodontic treatment of these abnormalities. Additionally, it aims to promote a comprehension of the pattern of associated dental anomalies.

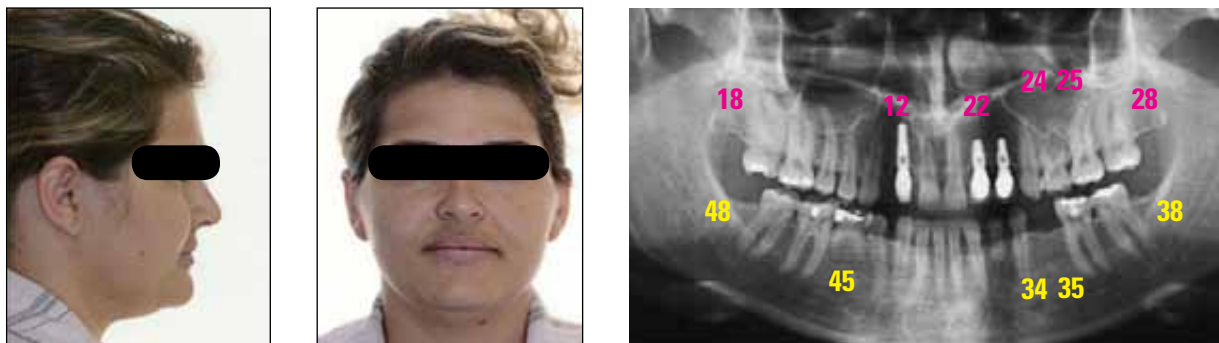


FIGURE 1 - Thirty-year-old female patient showing agenesis of eleven permanent teeth, representing a typical case of oligodontia.



FIGURE 2 - First cousin of the patient illustrated in figure 1. Observe the agenesis of three permanent teeth in the maxillary arch. The mandibular first molars were lost due to extractions.

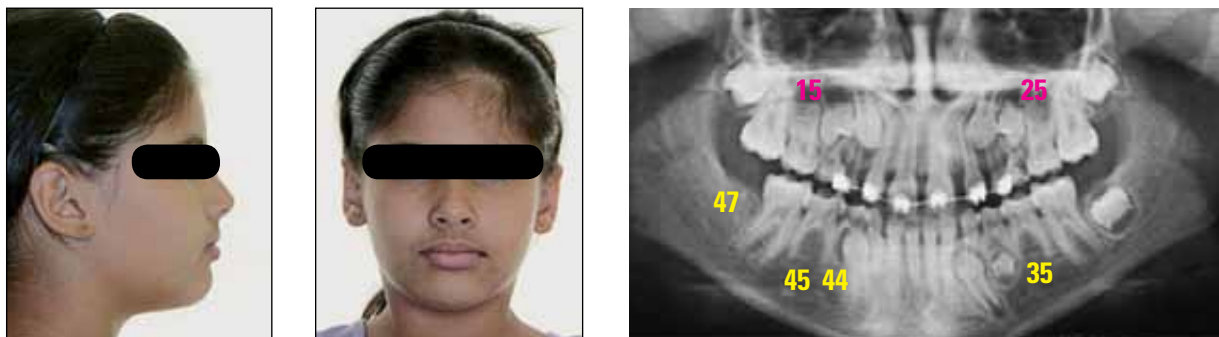


FIGURE 3 - Daughter of the couple illustrated in figures 1 and 2. This 9-year-old child has agenesis of all second premolars, of the right mandibular first premolar and right mandibular second molar. The absence of the third molars cannot be confirmed due to patient early age.

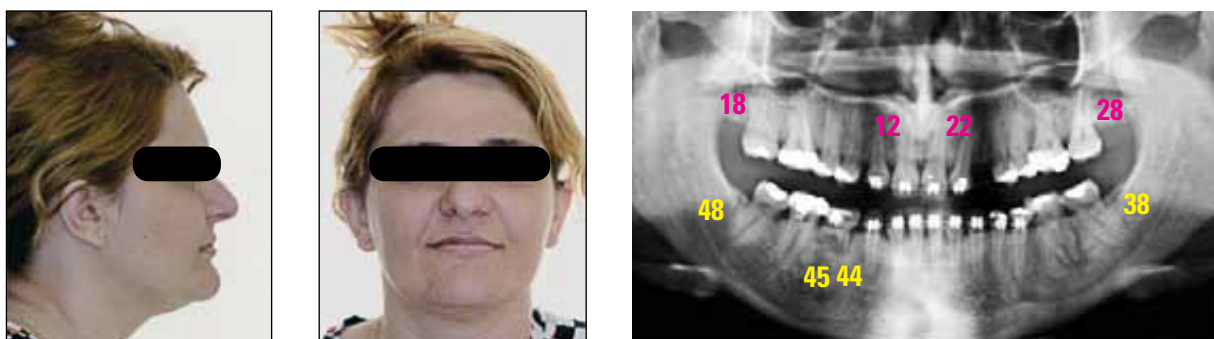


FIGURE 4 - Aunt of the patient illustrated in figure 1. Observe the agenesis of eight permanent teeth including premolars, maxillary lateral incisors and third molars.



FIGURE 5 - Older sister of the patient illustrated in figure 4 showing a similar agenesis pattern.

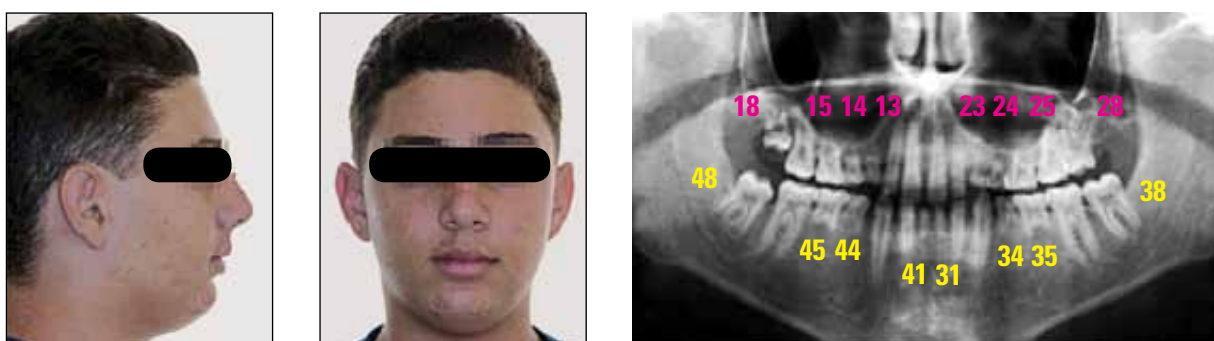


FIGURE 6 - This 15-year-old male patient is nephew of the patient illustrated in figure 1. He presents agenesis of sixteen permanent teeth including mandibular central incisors, maxillary canines, all the premolars and third molars.



FIGURE 7 - Younger brother of the patient showed in figure 6. With 10 years of age, he presents agenesis of seven permanent teeth, excluding the third molars.

TOOTH AGENESIS

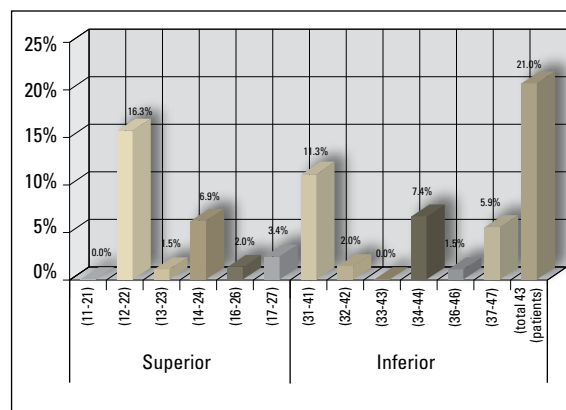
Tooth agenesis constitutes the most common developmental anomaly of the human dentition, occurring in approximately 25% of the population.¹³ Third molars represent the most affected tooth, showing a prevalence of agenesis of 20.7%.¹³ Excluding third molars, the prevalence of tooth agenesis is approximately 4.3 to 7.8% and the mandibular second premolars are the most commonly missing teeth, followed by the maxillary lateral incisors and maxillary second premolars.²⁶ In White patients, the frequency of tooth agenesis can be classified as *usual*, when it affects mandibular second premolars, maxillary lateral incisors and maxillary second premolars; *less usual* which includes in a descending order of occurrence the mandibular central incisors, the mandibular lateral incisors and maxillary first premolars, maxillary canines and mandibular second molars; and *rare* comprising, in a descending order of frequency, the agenesis of maxillary first and second molars, mandibular canines, mandibular first molars and maxillary central incisors.²⁶ It is important to highlight the ethnical differences in the prevalence of tooth agenesis. Epidemiological studies showed a lower prevalence of agenesis in Blacks compared to Whites, while the Asians tended to show an increased prevalence of agenesis.²⁶ Even comparing White subjects from distinct continents, the frequencies of agenesis are slightly different.²⁶ For example, European and Australian Caucasians present a higher prevalence of tooth agenesis than North-American Caucasians.²⁶ There are also sexual differences in the prevalence of tooth agenesis. In general, women are more affected than men.²⁶ The great majority of patients with agenesis (76 to 83%) has the absence of only one or two permanent teeth.²⁶ The unilateral occurrence is predominant, except for the maxillary lateral incisor agenesis, which bilateral occurrence is more common than the unilateral one.²⁶

Genetics probably represents the primary

etiological factor of tooth agenesis. The prevalence of agenesis is higher in families of affected patients.²² Figures 1 to 7 show members of a large Brazilian family with consanguineous marriage showing agenesis of multiple permanent teeth. Recently, a mutation in gene *MSX1* of the chromosome 4 was identified in a large family whose all members showed agenesis of second premolars and third molars.³⁰

An interesting study in twins showed a high frequency of agreement for tooth agenesis in monozygotic twins, while pairs of dizygotic twins showed disagreement for this dental anomaly.²⁰

In the 60's, Garn and Lewis¹⁴ observed that patients with third molar agenesis presented higher prevalence of agenesis of other permanent teeth. The prevalence of agenesis of other permanent teeth in patients with third molar agenesis was 13-fold higher than the same prevalence in patients with all third molars. Even very stable teeth, such as central incisors, canines and first premolars were absent in the sample with third molar agenesis. The explanation is that one genetic defect can give rise to many dental anomalies. In other words, two or more tooth agenesis in a same patient can have a



GRAPH 1 - Prevalence of agenesis of permanent teeth, excluding third molars, in patients with second premolar agenesis (Source: Garib, Peck, Gomes,¹³ 2009).

common genetic origin.

Similar results were observed in orthodontic patients with second premolar agenesis¹³ (Graph 1). In this sample, the frequency of occurrence of other permanent tooth agenesis, excluding third molars, was 5-fold increased (21%) compared to the general population. The prevalence of third molar agenesis was more than 2-fold increased (48%) in comparison to the general population. Interestingly, the higher the number of missing second premolars, the higher was the prevalence rate of agenesis of other permanent teeth. Patients with one or two missing second premolars presented an approximate prevalence rate of 15% of agenesis of one or more other permanent teeth. Conversely, nearly 50% of patients in the sample with three or four missing second premolars presented agenesis of other permanent teeth.

Tooth agenesis is frequently associated with other dental anomalies, including microdontia,¹⁵ ectopias (ectopic eruption of maxillary canines towards the palate, tooth transpositions, distoangulation of mandibular second premolars and maxillary first molar ectopic eruption),^{2,4,13,14,15,23,24,25} infraocclusion of deciduous molars,^{2,13} delayed dental development¹ and generalized enamel hypoplasia.² These evidences highlight the importance of genes in the etiology of tooth agenesis, as well as help the clinician to better understand their patients. In summary, when a dental anomaly is identified, the professional should be attentive and look for the development of other dental anomalies.

Microdontia

Tooth agenesis is frequently associated with small teeth.^{2,13,15} A reduction in tooth size represents an incomplete expression of the same genetic defect which defines tooth agenesis. This explains the classical association between the unilateral agenesis of the maxillary lateral incisor and the microdontia of its antimere (Fig 8).

Approximately 20% of the patients with second premolar agenesis also present small upper lateral incisors^{2,13} (Fig 9).

Patients with tooth agenesis show a generalized and significant reduction of tooth size. This reduction is not homogeneous, once the anterior teeth (incisors and canines) are smaller than the posterior teeth (premolars and molars).¹⁵ In patients with multiple tooth agenesis (oligodontia), the reduction of tooth size is even more remarkable¹⁵ (Fig 10).

This information presents important clinical implications. Rarely an orthodontist observes crowding in patients with tooth agenesis, while spacing is a common finding. In this way, the comprehensive orthodontic treatment hardly evolves tooth extractions. The major challenge in these patients will be closing the generalized spaces, mainly when the facial profile dictates that posterior tooth mesial movement should be performed instead of anterior tooth retractions.

Ectopic eruption of maxillary first molars

During the initial stages of the mixed dentition, the permanent first molars erupt in the dental arch using the distal aspect of the deciduous second molars as an eruption guide. Maxillary first molars show an occlusal and mesial eruption path. In this way, the distoangulation of the tooth germ in the maxilla is corrected during eruption and the maxillary first molars erupt in a upright position related to the occlusal plane. However, in 4% of children the maxillary first molars overdeviate its eruption path toward mesial, stimulating a partial root resorption of the adjacent deciduous second molar⁵ (Fig 11). This eruption disturbance is known as ectopic eruption of permanent first molars.⁵ Approximately half of the cases are reversible and the first molars erupt spontaneously in the dental arch. In irreversible cases, the maxillary first molars are unable to resorb deciduous second molar enamel, remaining retained.⁵



FIGURE 8 - Association between unilateral agenesis of maxillary lateral incisor and the microdontia of its antimere.



FIGURE 9 - Panoramic radiograph of a patient presenting association between multiple tooth agenesis and microdontia of the maxillary lateral incisors.

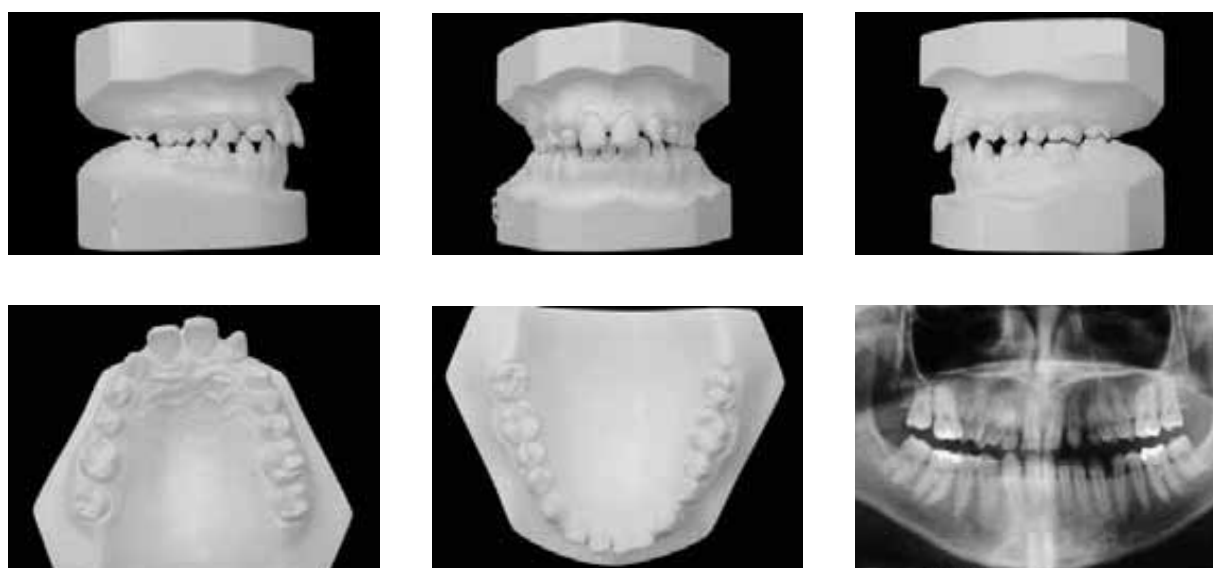


FIGURE 10 - Case presenting associated tooth agenesis, including the third molars, the maxillary lateral incisors and the right maxillary canine. Note the generalized reduction in the size of the permanent teeth.

What is the etiology of this eruption disturbance? During the 80's, the ectopic eruption of permanent first molars was related to space deficiency in the posterior region of the maxilla. However, Kurol and Bjerklin¹⁷ showed that the prevalence of this dental anomaly in the family of affected patients corresponded to approximately 20%, a higher prevalence compared to the general population (4%). These evidences denounced a genetic background in the etiology of first molar ectopic eruption. Almost 10 years later, Bjerklin, Kurol and Valentin⁴ have confirmed these evidences when they demonstrated the association between the ectopic eruption of permanent first molars and other dental anomalies of genetic etiology such as second premolar agenesis, palatally displaced canines (PDC) and infraocclusion of deciduous molars. The prevalence of these anomalies in patients with ectopic eruption of maxillary first molars was 6.5%, 5.4% and 20.7%, respectively, a higher frequency than the expected for the general population. Shifting the focus of observation, Baccetti² showed that patients with infraocclusion of deciduous molars, agenesis of second premolars or upper lateral incisor microdontia had two to three fold higher prevalence of ectopic eruption of maxillary first molars. With all these evidences, the ectopic eruption of first molars was added to the list of the genetically determined dental anomalies.

The frequency of occurrence of permanent first molar ectopic eruption justifies that the professional follow the eruption path of these teeth in patients during the first transitional period of the mixed dentition. During this stage, the clinical sign represented for the partial eruption of the maxillary first molar (Fig 11A) and the radiographic aspect of early root resorption of the deciduous second molar associated with a mesioangulation of the permanent first molar (Fig 11B) infer the ectopic eruption path of the first molar. This dental anomaly should be

treated early in order to avoid premature loss of second deciduous molars and arch perimeter reduction. The intervention is simple and brief requiring a distal light force on the first molar crown (Fig 11C). The goal is to obtain a slight tipping movement of the maxillary first molar. A diversity of appliances can be used with this purpose. After treatment, the prognosis of maintenance of the deciduous second molar in the dental arch is good, even in face of the atypical and early root resorption.

Mandibular lateral incisor-canine transposition

Tooth transposition is a tooth ectopia defined as an inversion in the natural position of adjacent teeth.⁶ Two types of tooth transpositions are reported in the literature as having a genetic background and therefore are commonly associated with other dental anomalies: Maxillary canine-first premolar transposition and mandibular lateral incisor-canine transposition.²⁵

An incomplete mandibular lateral incisor-canine transposition results from a distal ectopic eruption of the mandibular lateral incisor, during the first transitional period of the mixed dentition. In these circumstances, the ectopic tooth is the lateral incisor. The permanent mandibular canine shows a normal eruption path. When the mandibular lateral incisor "misses" its eruption path it deviates distally showing a remarkable distoangulation, with the crown presenting a mesiolingual rotation close to first deciduous molars while the apex is normally located close to its normal position (Fig 12). At the end of the second transitional period of the mixed dentition, the mandibular canine erupts in its normal position, defining a tooth transposition.

This dental anomaly is rare showing a prevalence of approximately 0.03% and affects mostly female patients (75% of the cases). The bilateral expression corresponds to 17%, and in the unilateral expression cases, the right side (68%) is

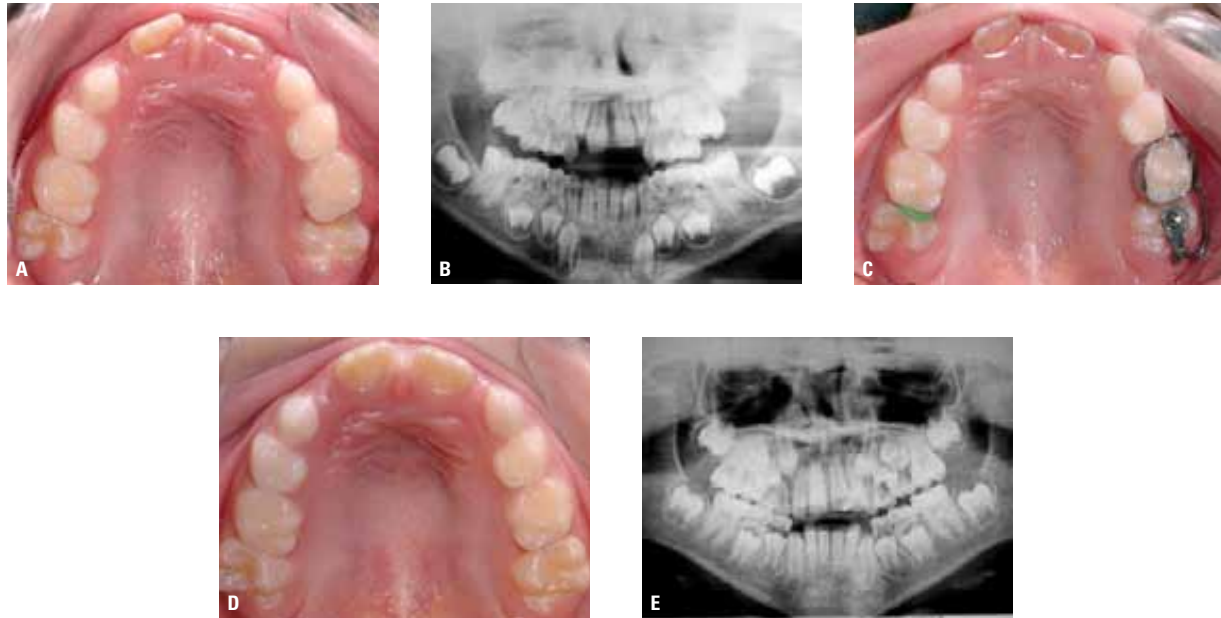


FIGURE 11 - Ectopic eruption of maxillary first molars. **A)** Clinical aspect showing partial eruption of the right first molar. **B)** Panoramic radiograph reveals the premature root resorption of the adjacent second deciduous molar besides the mesioangulation of the permanent first molar. **C)** Treatment with partial fixed space maintainer appliance. **D)** Posttreatment clinical aspect. **E)** Posttreatment panoramic radiograph. Observe the consequences of first molar ectopic eruption, represented by the partial and irreversible root resorption of the deciduous second molar.

more affected than the left side (32%).²³

There are some evidences that the etiology of mandibular lateral incisor-canine transposition present a genetic background.^{23,25} Peck, Peck and Kataja,²³ in a remarkable sample of 60 patients showing this type of transposition, found an increased prevalence of associated permanent tooth agenesis and conical upper lateral incisors (Table 1). More specifically, this modality of tooth transposition was associated with a high prevalence of second premolar and third molar agenesis, while the prevalence of maxillary lateral incisor agenesis was not different from the prevalence expected for the general population.²³

In the permanent dentition, the orthodontic treatment of mandibular lateral incisor-canine transposition is restrict to tooth alignment, maintaining the interchanged position of

evolved teeth.²³ Two reasons justifies this therapeutic approach. The first one is the presence of a more parallel position between the roots of mandibular canine and lateral incisor in transposition.²³ Other morphologic feature which prevents attempting to correct the tooth order is the thin faciolingual alveolar width in the mandible. Differently, when the ectopic eruption of mandibular lateral incisors is identified early, in the mixed dentition, an early orthodontic intervention may prevent the establishment of tooth transposition. Before the eruption of the mandibular canine, only the crown of lateral incisor is malpositioned, while the apex is in the normal position.^{23,29} In this stage, the orthodontic upright of mandibular lateral incisor with a 2 by 4 mechanics can prevent the lateral incisor-canine transposition²⁹ (Fig 13).



FIGURE 12 - Radiographic image illustrating the ectopic eruption of a mandibular lateral incisor in the right side. Note the remarkable distoangulation of the mandibular lateral incisor in the panoramic radiograph.

TABLE 1 - Prevalence of tooth agenesis and conical shape maxillary lateral incisor in patients with mandibular lateral incisor-canine transposition (n = 60) compared to population reference values (Source: Peck S, Peck L, Kataja,²³ 1998).

DENTAL ANOMALIES	PREVALENCE IN PATIENTS WITH MANDIBULAR LATERAL INCISOR-CANINE TRANSPOSITION	REFERENCE VALUES
Tooth agenesis (including third molars)	40%	25%
Third molar agenesis	37%	21%
Tooth agenesis (excluding third molars)	12%	5%
Agenesis of second premolars	8%	2%
Agenesis of maxillary lateral incisors	2%	2%
Conical shape lateral incisors	10%	2%

Ectopic eruption of permanent maxillary canines

Permanent maxillary canines represent the teeth which develop more distant from the dental arch, close to nasal cavity, and therefore they have the longest eruption path compared to other permanent teeth. For this reason, their root has the greatest length. During eruption, the bulging crown of maxillary canines can be felt on the facial aspect of alveolar ridge above the deciduous canines.¹⁰ When the palpation is positive, it means that maxillary canines have a good prognosis of spontaneous eruption.¹⁰ However, in approximately 1.5% of population, the canines show an ectopic eruption path towards the palate relatively to the lateral incisors, remaining retained.¹³

The palatally displaced canine (PDC) repre-

sents a dental anomaly which raises orthodontic concern due to two biologically relevant aspects. Besides preventing the canines to erupt spontaneously, in a significant number of cases, the maxillary canine ectopic eruption leads to root resorption of neighboring teeth.¹¹

The question is: What is the etiology of PDC? What conducts the canines to an unusual eruption path?

The buccal retention of maxillary canines relates to arch size deficiency and is one of the clinical manifestations of crowding.¹⁶ On the other hand, the majority of cases of PDC shows enough space in the dental arch for the permanent tooth alignment.¹⁶ In the 90's, Peck et al²⁴ compiled some evidences from the literature that PDC present an essentially genetic etiology. The authors have listed strong evidences



FIGURE 13 - Early treatment of an ectopic right mandibular lateral incisor (Source: Silva Filho, Zinsly, Okada and Ferrari Junior,²⁹ 1996).

to sustain such hypothesis, as the frequent observation of associated anomalies, family history, bilateral occurrence and the distinct prevalence of PDC between the genders and among different ethnical populations. Such assertive produced indignation from the orthodontists which believed in the hypothesis that maxillary canines show an ectopic eruption path because of local factors, as the morphology of lateral incisor root, the absence of maxillary lateral incisors or due to a “resistance” of the deciduous canines to be resorbed.³

A few years later, the same authors found that patients with PDC present a higher frequency of permanent tooth agenesis (17% excluding third molars), and the second premolars are the teeth most affected (14% of the cases).²⁵ Additionally, the authors observed that PDC is associated with maxillary lateral incisor microdontia in 17% of the cases, not necessarily at the same side of PDC. These researchers concluded that PDC, tooth agenesis and microdontia are biological co-variables which share a common genetic origin.

Additional evidence of the genetic background of PDC was the observation that patients with this anomaly can present delayed tooth development and generalized reduction in tooth size. The later can inform why the majority of patients with PDC does not show crowding and receive a nonextraction orthodontic treatment.

In an inverse association, there is evidence that patients with tooth agenesis, maxillary lateral incisor microdontia, deciduous molar infraocclusion and generalized enamel hypoplasia present a higher prevalence of PDC.^{2,13} These data present extreme clinical relevance when the early diagnosis of PDC is considered. The clinician should be aware that generally, a child has a risk of 1.5% of developing maxillary canine ectopic eruption towards the palate, while a child with second premolar agenesis has a 5-fold increased probability to develop the same dental

anomaly¹³ (Fig 14). The association of PDC with microdontia is even greater. A study in the Italian population showed that 34% of the patients with conical shaped upper lateral incisors has PDC.² The infraocclusion of deciduous molars (Fig 15), as well as the generalized enamel hypoplasia (Fig 16) also are risk indicators for PDC.² This information undoubtedly refines the ability for PDC early diagnosis. Taking into account that the ectopic eruption of maxillary canines can be treated early,⁹ preventing root resorption of adjacent incisors and canine impaction, it is imperative that the clinician be attentive to the maxillary canine development during the mixed dentition, especially in children who present any dental anomaly associated with PDC. These dental anomalies work as early risk indicators for PDC development.

Maxillary canine-first premolar transposition

Excluding third molars, the maxillary canines constitute the permanent teeth which more frequently show eruption disturbances. Besides PDC, another important but less frequent ectopia of maxillary canines is the canine-first premolar transposition. The typical picture shows the permanent maxillary canine buccally erupting between two premolars. Frequently, the canine is distally rotated and the first premolar is mesially rotated showing a distoangulation of its crown. This is the most common type of tooth transposition in humans with a frequency of 0.03 to 0.25%. Approximately ¼ of the cases show bilateral expression and the occurrence in females is higher (female-male proportion is 1.5:1).²⁵

The etiology of maxillary canine-first premolar transposition correlates to genetic factors.²⁵ Many case reports in the literature showed one or more family members presenting the same feature, without history of trauma in the dentofacial region. Patients with maxillary canine-first premolar transposition present



FIGURE 14 - Patient showing agenesis of mandibular second premolars and second molars at 10 year of age (A) and at 14 years of age (B). Observe the development of an ectopic pathway of eruption of maxillary canines (towards the palate). It is important to highlight the dentition developmental delay at 10 years of age.



FIGURE 15 - Patient showing infraocclusion of deciduous molars during the intertransitional period of the mixed dentition (A). The longitudinal follow up of the dental development permitted the early diagnosis of the ectopic eruption of the left maxillary canine, during the late mixed dentition (B). In the second radiograph, the permanent mandibular left second molar showed mesioangulation.

an increased prevalence of permanent tooth agenesis excluding third molars corresponding to 37-40%²⁵ (Fig 17). This type of transposition is associated with a high prevalence of agenesis of second premolars (12%) and maxillary lateral incisors (26%), while the prevalence of third molar agenesis is not different from the reference values for the general population.²⁵ The maxillary lateral incisor microdontia represents another dental anomaly frequently associated to maxillary canine-first premolar transposition, observed in 16% of the cases.²⁵

In the permanent dentition, when the aim is to correct the inverted position of the related teeth, the orthodontic approach for this type of transposition is challenging.⁶ It demands a

more complex orthodontic mechanics and a longer period of treatment. For this reason, maxillary canine-first premolar transpositions are generally treated with tooth position maintenance, moving first premolars toward mesial and leveling the canine between premolars.⁶ The frequent association with tooth agenesis and microdontia makes the treatment planning even more difficult.

Maxillary canine-first premolar transposition may be treated early in the mixed dentition. The most ideal period for intervention is very specific: right after maxillary first premolar eruption and before canine eruption. In these cases, the first step consists in the correction of the tipping of the first premolar with fixed appliance.

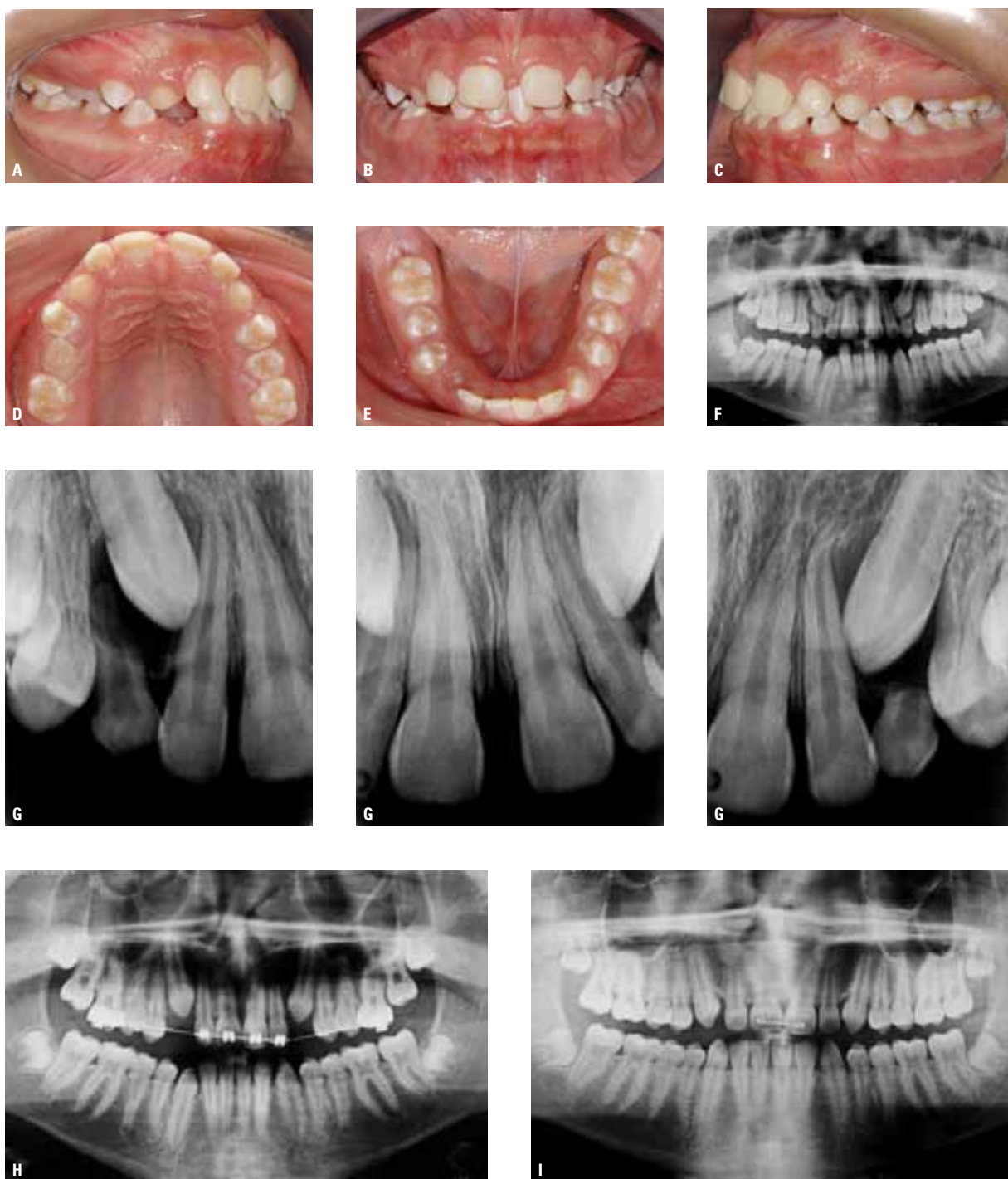


FIGURE 16 - Association between generalized enamel hypoplasia (**A** to **E**) and palatally displaced canine (**F**, **G**). The enamel hypoplasia represents a clinical red flag for an increased risk of developing PDC. After early diagnosis and early intervention with deciduous canine extraction, the eruption path of the tooth #13 was normalized (**H**) and the tooth has erupted spontaneously in the dental arch (**I**).

The procedure is possible due to the buccal position of the germ of the maxillary canines. After the correction of first premolar position, the deciduous canines are extracted at the same side and closed mesial traction is placed on the permanent canine.



FIGURE 17 - Panoramic radiograph of a patient presenting maxillary first premolar-canine transposition in the right side associated with agenesis of the maxillary right lateral incisor.

Distoangulation of mandibular second premolars

The most common ectopia related to mandibular second premolars is the distoangulation of the germ.¹⁹ Such ectopia is associated with the agenesis of the contralateral second premolar²⁸ (Fig 18). Shalish et al,²⁸ using a sample of patients with unilateral agenesis of mandibular second premolar, showed that the contralateral germ presented a mean of more than 10° distal angulation, compared to a control group without agenesis. The authors concluded that distoangulation of mandibular second premolars represents a different phenotype or an incomplete expression of the same genetic defect which causes second premolar agenesis. This association is similar with the classical clinical picture including unilateral agenesis of a maxillary lateral incisor and the microdontia of its antimere.

The frequency of distoangulation of mandibular second premolar in the general population is rare, considering the prevalence of 0.19%.¹⁹ Differently, patients with agenesis of



FIGURE 18 - Association between mandibular second premolar agenesis and palatally displaced canines. The patient also presented distoangulation of the mandibular left second premolar and a generalized enamel hypoplasia.

at least one second premolar show a prevalence of 7.8% of distoangulation of mandibular second premolars.¹³ Therefore, the relative risk of patients with second premolar agenesis to demonstrate this dental anomaly would be 45-fold increased. An interesting information is that distoangulation of mandibular second premolars is not only observed in patients with unilateral agenesis of mandibular second premolars but also in patients with agenesis of maxillary second premolars.¹³ Approximately 25% of the patients with distoangulation of mandibular second premolars had only maxillary second premolar agenesis while 75% of these patients presented absence of one mandibular second premolar.¹³ In summary, the clinician should not be surprised to find this dental anomaly in patients with tooth agenesis.

The mandibular second premolar distoangulation frequently self-corrects and do not demand intervention.¹² This ectopia is defined at early stages of the dental development. During root formation, tooth germ spontaneously uprights and erupts in the dental arch (Fig 19).

The longitudinal follow up of dental development is the only need in these cases. However, when the distoangulation is severe, showing a more horizontal position of tooth germ, the spontaneous eruption becomes unpredictable (Fig 20). In these cases, distoangulation is frequently associated with delayed tooth development and may need orthodontic traction.¹²

Infraocclusion of deciduous molars

Infraocclusion of deciduous molars occurs in approximately 8.9% of children and is characterized by the location of deciduous molar occlusal surface below the occlusal plane.¹⁸ It is suggested that infraocclusion of deciduous molars is a consequence of tooth ankylosis. In any point of the periodontal ligament, a bridge of mineralized tissue can establish a linkage between the alveolar bone and the cement. From this moment, the tooth is unable to erupt showing a progressive infraocclusion while the face grows.

A sequence of evidence has pointed that genetics has an important role in the etiology of infraocclusion. Kurol¹⁸ verified that the prevalence



FIGURE 19 - Longitudinal follow up of a mandibular second premolar with distoangulation. Observe the association of this ectopia with the agenesis of the contralateral tooth. The ectopic tooth germ of 35 has uprighted gradually during dental development and erupted spontaneously in the dental arch.

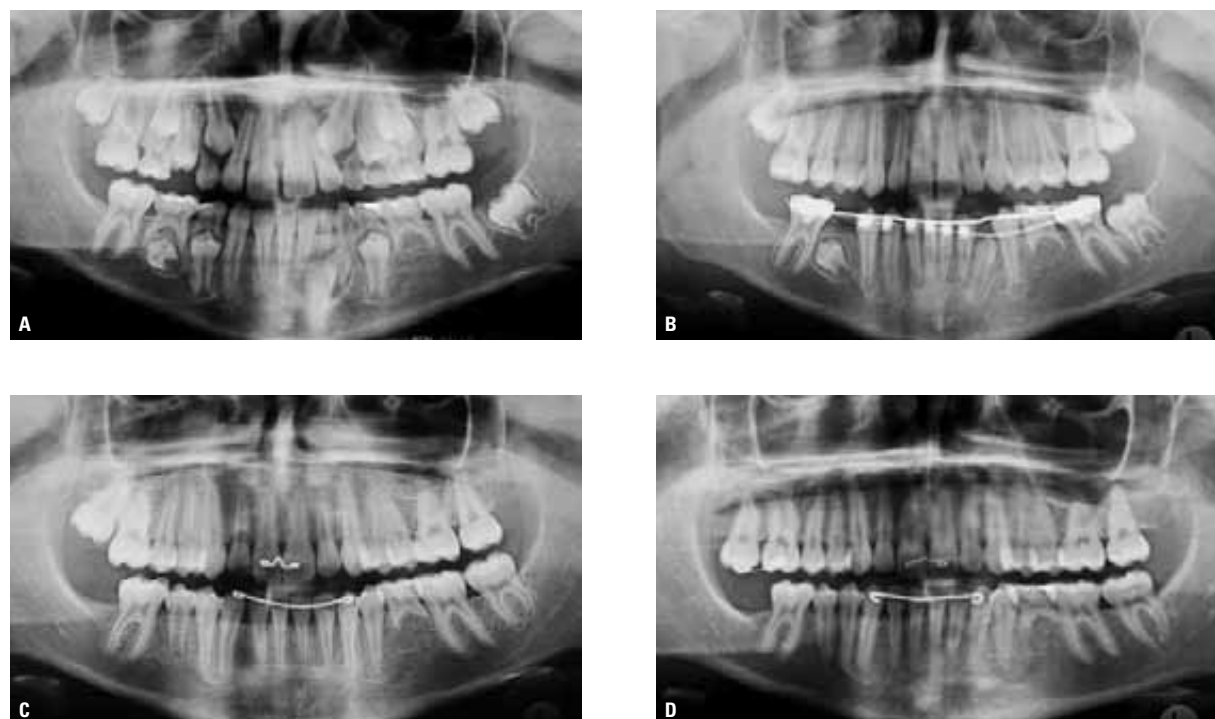


FIGURE 20 - Patient presenting association between agenesis of the mandibular left second premolar and a severe distoangulation of its antimerie (A). After 1.5-year follow up of tooth #45 (B), orthodontic traction was performed. At the end of orthodontic treatment (C), tooth #45 is upright and 5 years after the end of treatment (D), its root formation is complete.

of infraocclusion is increased among siblings of affected patients being 2-fold higher compared to the general population (20%). Bjerklin, Kurol and Valentin⁴ found an association of deciduous molar infraocclusion with the ectopic eruption of maxillary first molars, PDC and second premolar agenesis. Baccetti² observed that patients with deciduous molar infraocclusion present a significantly increased prevalence of second premolar agenesis (14%), small maxillary lateral incisor (13%), first molar ectopic eruption (18%) and PDC (14%). Besides, this researcher verified a reciprocal association once subjects selected for one of these dental anomalies presented higher prevalences of deciduous molar infraocclusion. Garib, Peck and Gomes¹³ showed that 25% of the patients with second premolar agenesis presented infraocclusion of deciduous molars.

This prevalence was significantly increased compared to the prevalence of the general population (8.9%). This means that subjects with second premolar agenesis present a 3-fold increased probability to show infraocclusion than the general population.

Infraocclusion of deciduous molars do not interfere with the tooth development of the permanent successor tooth which generally erupts in the expected time, with a maximum of 6 months delay. Therefore, slight or moderate infraocclusion requires only longitudinal follow up. Conversely, severe infraocclusion needs intervention because the occlusal aspect of the deciduous molar is below the interproximal contact with the adjacent teeth (Fig 15A). In these conditions, the deciduous molar cannot work as a space maintainer and there is a risk of arch perimeter loss. Besides, the

deciduous molar can become covered below the gingival tissue with the infraocclusion progression. Under this light, the most reasonable therapeutic approach is the extraction of the affected deciduous molar followed by the placement of a space maintainer appliance (Fig 15B).

Delayed dental development

Patients with tooth agenesis can show a slower dental development and the dental age delayed compared to the chronological age.¹ This information may be explained by an inter-relationship in the causality of these dental anomalies and deserves the professional attention. In general, subjects with tooth agenesis reach occlusal maturity later. The permanent dentition can be completed years later than the usual age (Fig 14). Based on this knowledge, phase two of the orthodontic treatment should be postponed. Early diagnosis and late comprehensive orthodontic treatment is the perfect combination for patients with a pattern of associated dental anomalies.

Besides the generalized delayed dental development commonly observed in patients with tooth agenesis, a specified tooth can show a remarkable delay in tooth development: The second premolars. The second premolars present a great developmental instability. Besides the high

prevalence of agenesis, these teeth commonly show delayed development, especially when there is agenesis of other permanent teeth (Figs 21 and 22). It seems that the developmental delay of second premolars represent an incomplete expression of the same genotype of tooth agenesis. The initial mineralization of mandibular second premolars occurs in a mean age of 3 years (ranging from 2 years and 3 months to 3 years and 7 months),²¹ however these teeth can appear later.²⁷ The delayed appearance of second premolars occurs until age 6,²⁷ and some case reports showed the radiographic appearance of second premolars in a more advanced age, after 9 or even at 13 years of age.⁸ When the second premolars appears later, they also erupt later, frequently after the eruption of the second molars which are the last teeth to reach the occlusal plane excluding the third molars.

Under the light of this knowledge, the observation of non-erupted second premolars after the adolescence should not be a reason for orthodontic concern (Figs 21 and 22). If the tooth germs are well positioned and there is no local pathology, it means that second premolars are only delayed. The longitudinal follow up will permit the clinician to observe its spontaneous eruption in the dental arch, even though the remarkable delay.



FIGURE 21 - Delayed development of a maxillary right second premolar. Note an association of this anomaly with the agenesis of other second premolars.

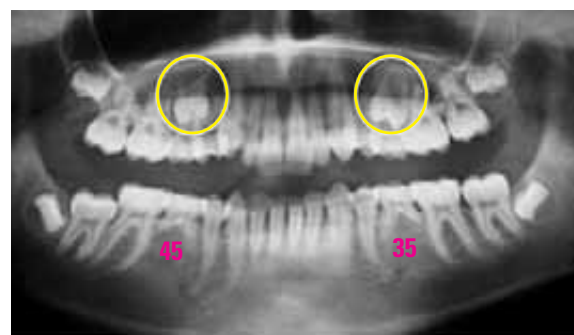


FIGURE 22 - Delayed development of maxillary second premolars in a patient with mandibular second premolar agenesis.

Enamel hypoplasia

Although it is not very explored in the literature, there is some evidences that generalized enamel hypoplasia is in the list of genetically regulated dental anomalies (Figs 16 and 18). The enamel hypoplasia is frequently diagnosed associated to other dental anomalies, most commonly than randomly expected.² Besides, in a sample of subjects selected for the presence of enamel hypoplasia, a higher prevalence of tooth agenesis, microdontia and ectopias including PDC was observed.²

Therefore, the observation of generalized white spots in the enamel of permanent teeth,

decoupled with environment causes as fluorosis and history of antibiotic intake, can work as a clinical alert for the development of other dental anomalies during childhood.

CONCLUSION

The clinical implications of associated dental anomalies patterns are very important, since the early diagnosis of a particular dental anomaly as the agenesis of a second premolar or a small maxillary lateral incisor may alert the professional to the possible development of other associated anomalies in the same patient or in the family, allowing early diagnosis and timely orthodontic intervention.

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Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

Registration of these trials has been proposed in order to (a) identify all clinical trials underway and their results since not all are published in scientific journals; (b) preserve the health of individuals who join the study as patients and (c) boost communication and cooperation between research institutions and with other stakeholders from society at large interested in a particular subject. Additionally, registration helps to expose the gaps in existing knowledge in different areas as well as disclose the trends and experts in a given field of study.

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At the same time, the International Committee of Medical Journal Editors (ICMJE) has suggested that editors of scientific journals require authors to produce a registration number at the time of paper submission. Registration of clinical trials can be performed in one of the Clinical Trial Registers validated by WHO and ICMJE, whose addresses are available at the ICMJE website. To be validated, the Clinical Trial Registers must follow a set of criteria established by WHO.

2. Portal for promoting and registering clinical trials

With the purpose of providing greater visibility to validated Clinical Trial Registers, WHO launched its Clinical Trial Search Portal (<http://www.who.int/ictrp/network/en/index.html>), an interface that allows simultaneous searches in a number of databases. Searches on this portal can be carried out by entering words, clinical trial titles or identification number. The results show all the existing clinical trials at different stages of implementation with links to their full description in the respective Primary Clinical Trials Register.

The quality of the information available on this portal is guaranteed by the producers of the Clinical Trial Registers that form part of the network recently established by WHO, i.e., WHO Network of Collaborating Clinical Trial Registers. This network will enable interaction between the producers of the Clinical Trial Registers to define best practices and quality control. Primary registration of clinical

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WHO proposes that as a minimum requirement the following information be registered for each trial. A unique identification number, date of trial registration, secondary identities, sources of funding and material support, the main sponsor, other sponsors, contact for public queries, contact for scientific queries, public title of the study, scientific title, countries of recruitment, health problems studied, interventions, inclusion and exclusion criteria, study type, date of the first volunteer recruitment, sample size goal, recruitment status and primary and secondary result measurements.

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Yours sincerely,

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