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Former title: Lebanese Dental Journal/Revue Dentaire Libanaise

The Journal of the Lebanese Dental Association -JLDA- is a multidisciplinary peer-reviewed journal published biannually (June and December) by the Lebanese Dental Association. JLDA has an ultimate aim of introducing and improving research in contemporary aspects of dental and craniofacial basic and clinical sciences. The JLDA publishes manuscripts on all aspects of dental medicine and surgery, including surgical dentistry, restorative and prosthetic dentistry, geriatric and pediatric dentistry, periodontology and implant dentistry, endodontics, esthetic and cosmetic dentistry, adhesive dentistry, orthodontics and dentofacial orthopedics, oral biology, oral and maxillofacial surgery, oral diagnosis/pathology/medicine, dental research, oral and maxillofacial radiology and imaging, public health dentistry, special care/needs dentistry, forensic odontology and dental mass disaster. Dentistry related fields are broadly defined and may include, for instance, facial growth/embryology, dental and orofacial genetics, orofacial antiaging medicine, dental and maxillofacial tissues engineering, medically compromised patients treated in dental practice, temporomandibular disorders and orofacial pains, sleep medicine in relation to dental practice, clinical trials of drugs relevant to dental/craniofacial practice, dental/oral histopathology, immunopathology and microbiology, dental anesthesiology, dental ergonomics, computer-assisted dentistry, legal dentistry, aeronautic and veterinary dentistry.

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Address: Lebanese Dental Association, Victoria Tower, 2nd floor, Corniche du Fleuve, Beirut, Lebanon
Tel/Fax: 00961-1-611222 / 00961-1-611555
E-mail: lda@lda.org.lb
Website: www.LDA.org.lb

IT Assistant and JLDA Website Manager: Fadi Kayali
Executive Secretary: Samia Bavitch
Advertising and Marketing: Carole Chaccour Kassouf
Layout and Printing: Metni Printing Press
Beirut, Lebanon
Tel: 00961-1-283631
E-mail: matnipress1@yahoo.com
Editor-in-Chief
Chairperson, Department of Research and Senior Lecturer, Departments of Oral and Maxillofacial Surgery, Oral Pathology and Diagnosis, and Basic Science, Director, Oral Pathology and Diagnosis Graduate Program, Lebanese University School of Dentistry, Beirut, Lebanon, Adjunct Research Fellow, Charles Sturt University School of Dentistry and Health Sciences, Orange, NSW, Australia
ziadnari@hotmail.com
editorJLDA@lda.org.lb

Editor-in-Subchief
Michel Goldberg, Chir. Dent., Dr. Sc. Odont., D. Sc., Emeritus Professor, Saint-Pères Biomedical College, INSERM/Unité 747-Équipe 5, Paris Descartes University, Paris, France
mgoldberg.goldberg004@gmail.com
michel.goldberg@univ-paris5.fr

Associate Editors
Maria E. Saadeh, BDS, MS (Hum. Morphol.), Residency Ortho. (AUB), Clinical Associate, Division of Orthodontics and Dentofacial Orthopedics, American University of Beirut Medical Center, Clinical Instructor, Department of Orthodontics, Lebanese University School of Dentistry, Beirut, Lebanon
maria_saadeh@hotmail.com
ms137@aub.edu.lb

Ziad Salameh, Dr. Chir. Dent., DES Prostho, M.Sc., Ph.D., FICD,
Assistant Professor, Department of Research, Lebanese University School of Dentistry, Beirut, Lebanon, Assistant Professor/Researcher, Center for Excellence in Biomaterials and Biomechanics Research, Eng. A.B. Research Chair for Growth and Bone Regeneration, King Saud University Riyadh, KSA
zsalameh@ksu.edu.sa
drzsalameh@gmail.com

Former Professor of Periodontology and Research, University of Padova, Institute of Clinical Dentistry, Padova, Italy, Former Professor of Periodontology and Research and Former Chairperson, Department of Research, Lebanese University School of Dentistry, Beirut, Lebanon
dr.zeniamajzoub@yahoo.it

Jihad M. Fakhouri, Dr. Chir. Dent., CES Odont. Chir., CES Perio., CES Prostho., DU Implant, DU Forensic Dent., DEA (Health Economics), Dr. Univ. (USJ), MSLP, Assistant Professor, Department of Removable Prosthodontics, Saint-Joseph University Faculty of Dental Medicine, Beirut, Lebanon, jihad.fakhouri@usj.edu.lb
jfakhouri@hotmail.com

Amine El-Zoghbi, Dr. Chir. Dent., DU Occlusodont., DEA, Dr. Univ. (USJ), MEACMD, MCNO, Assistant Professor, Department of Prosthodontics and Occlusion, and Director, Occlusion Graduate Diploma, Saint-Joseph University Faculty of Dental Medicine, Beirut, Lebanon, Associate Editor, International Journal of Stomatology and Occlusion Medicine
elnamina@sodetel.net.lb
amine.elzoghbi@usj.edu.lb

Fadl Khaled, BDS, CES Endo., DES Endo., Clinical Instructor, Department of Restorative Dentistry, Beirut Arab University Faculty of Dentistry, Chief of Clinical Services, Department of Endodontics, Lebanese University School of Dentistry, Beirut, Lebanon
fadlkhaled@hotmail.com

Hani F. Ounsi, Dr. Chir. Dent., DES Endo., M.Sc. (Dental Mat.), DEA (Oral Biol.), FICD, MRACDS (Special Endo. stream), Research Associate, Center for Excellence in Biomaterials and Biomechanics Research, Eng. A.B. Research Chair for Growth and Bone Regeneration, King Saud University Riyadh, KSA
ounsh@gmail.com

Assem Soueidan, Dr. Chir. Dent., CES Perio., DU Perio., DU Oral Rehab./Implant., DU Oral Dermatology, DEA (Oral Biol./Biomat.), Dr. Univ. (Nantes), HDR (Nantes), PU, PH, Professor and Chairperson, Department of Periodontology, Nantes University, Faculty of Dental Surgery, Nantes, France
assem.souetidan@univ-nantes.fr

Editors Emeriti
Nadim Baba, DMD, MSD, FICD, FACP
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Levon Naltchayan, DCD, CES Prosth.

English Proofreader
Tala Sabbagh Yaghdi, BA (Transl./Interpret.)
talayaghi@hotmail.com
Editorial Advisory Board

George Tawil, Dr. Chir. Dent., DDS, CES Odont. Chir., CES Perio., Dr.Sc.Odont., FICD, FACD
Professor of Periodontology, Saint-Joseph University Faculty of Dental Medicine, Beirut, Lebanon, Editorial Consultant, International Journal of Oral and Maxillofacial Implants, Clinical Oral Implant Research
gtawil@inco.com.lb

Charles Sfeir, Dr. Chir. Dent., Ph.D
Director, Center for Craniofacial Regeneration and Professor, Department of Oral Biology, University of Pittsburgh, School of Dental Medicine, Pittsburgh, USA
csfeir@pitt.edu

Nabil Tabbara, DMD, FAAFO, FAACP
Adjunct Clinical Professor, University of Western Ontario, Schulich School of Medicine and Dentistry, London, Ontario, Canada
ntabbara@uwo.ca

Jaime S. Brahim, BDS, MS, Dip. ABOM Surg., Dip. ABO Med, FACOMS, FAAOMS, FIAOMS
Professor, Department of Oral and Maxillofacial Surgery, University of Maryland College of Dental Surgery, Baltimore, Maryland, USA
JBrahim@umaryland.edu

Associate Professor and Dental Director, Boston University Institute for Dental Research and Education, Dubai Healthcare City, Dubai, UAE
dina.debaybo@budubai.ae

dinadebaybo@yahoo.com

Nadim Baba, DMD, MSD, FICD, FACP
Associate Professor, Department of Restorative Dentistry, Loma Linda University School of Dentistry, Loma Linda, California, USA
nbaba@llu.edu

Mary Ann Jabra-Rizk, BS, Ph.D
Associate Professor, Department of Oncology and Diagnostic Sciences, University of Maryland Dental School, Baltimore, Maryland, USA
mjrizk@umaryland.edu

Karine Feghali, BDS, DU Perio., Ph.D
Postdoctoral Fellow, Oral Ecology Research Group (GREB), Laval University Faculty of Dental Medicine, Quebec City, QC, Canada
karine.el-feghali@laval.ca

Associate Professor, Department of Restorative Dentistry, Loma Linda University School of Dentistry, Loma Linda, California, USA
Lecturer, Prosthodontics Postgraduate Program, University of California Los Angeles, California, USA
tonydaher@verizon.net

Sukumaran Anil, BDS, MDS, Ph.D., FICD, FPFA
Professor and Consultant, Division of Periodontics, King Saud University College of Dentistry, Riyadh, KSA
dr.sanil@gmail.com

Marwan Dieb Abou Rass, DDS, MDS, Ph.D.
Director, Prince Abdulrahman Advanced Dental Institute, Riyadh, KSA Emeritus Professor, University of Southern California, School of Dentistry, Los Angeles, USA
mabourass@hotmail.com

David Wilson, BDS, MDS (HONS), FFOP/RC Path. (Austr.)
Professor of Oral and Maxillofacial Pathology, Charles Sturt University School of Dentistry and Health Sciences, Orange Campus, NSW, Australia
dwilson@csu.edu.au

Assistant Professor, Department of Comprehensive Dentistry, and Director, Graduate Program of Oral and Maxillofacial Radiology and Imaging, University of Texas, Health Science Center at San Antonio, Texas, USA
Noujeim@uthscsa.edu

Hani Abdul Salam, B.Sc., BDS, M.Sc., Ph.D
Adjunct Professor and Director of Continuing Dental Education for the Middle East and North Africa, McGill University Faculty of Dentistry, Montreal, Canada
hani.salam@mcgill.ca

Ghassan Yared, DCD, DSO, FRCD (Can.), MRCDSO
Former Associate Professor, Department of Endodontics, and former Director of Endodontics undergraduate program, University of Toronto, Faculty of Dentistry, Toronto, Canada
ghassanyared@gmail.com

Professor and Chairperson, Department of Oral Pathology and Diagnosis, Lebanese University School of Dentistry, Beirut, Lebanon, acassia@dm.net.lb

Associate Professor, Department of Prosthodontics, Paris Descartes University Faculty of Dental Surgery, Paris, France
cabinet.marwann@wanadoo.fr

M Fouad Ziade, Ph.D (Biostat.), C. Stat., FRSS, MASA, MIEA
Associate Professor, Lebanese University Faculty of Public Health, Beirut/Tripoli, Lebanon
fouadziade@hotmail.com / mfmziade@ul.edu.lb

Nada E. El-Osta, DCD, DCS Prosth., MS (Biol. Med. Sc.), DIU Biostat., DU Forensic Science
Consultant in Biostatistics / Epidemiology, St. Joseph University Faculties of Medicine and Dental Medicine, Beirut, Lebanon
nada.osta@usj.edu.lb / pronada99@hotmail.com

Biostatistics and Epidemiology Consultants

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ISSN 1810-9632
"How much longer until my braces come off?" and "when am I getting my braces off?" are probably the most frequently asked questions in any orthodontic practice, worldwide. Lengthy treatment and the multitude of appointments required often push many potential patients to decline orthodontic treatment.

Effects of medications and dietary supplements on the rate of experimental tooth movement have been lately a subject of interest and investigation (Bartzela et al., 2009-Krishnan and Davidovitch, 2006 – Kyrkanides et al., 2000 – Arias and Marquez-Orozco, 2006 – and others) and if nonsteroidal anti-inflammatory drugs (such as ibuprofen or aspirin) reduce orthodontic tooth movement -OTM- (probably by diminishing the number of osteoclasts), acetaminophen (paracetamol) doesn't affect it in rats and rabbits (Arias and Marquez-Orozco, 2006- Roche et al., 1997) whereas therapeutic use of eicosanoids resulted in increased tooth movement in monkeys and rats (Mohammed et al., 1989 – Gurton et al., 2004 – Yamasaki et al., 1982-Leiker et al., 1995 – Kale et al., 2004 – Seifi et al., 2003 – Sekhavat et al., 2002 – Kokkinos et al., 1993 – and others) : eicosanoids, a group of signaling molecules, consist of 4 families: prostaglandins, prostacyclins, thromboxanes and leukotrienes, all involved in the regulation of many biological processes such as anaphylaxis, immune and inflammatory responses.

It is proven that biphosphonates strongly inhibit OTM in rats (Adachi et al., 1994 – Igarashi et al., 1994-) and within this group of drugs, risedronate proved to be the most effective in preventing OTM. Keles and co-workers(2007) introduced a mouse model in which they moved the first molar in a palatal direction by a force of 20cN and showed that injections of pamidronate (5mg/kg for over 8 days) resulted in a significant decrease in the rate of OTM.

Effect of dietary calcium on OTM was also investigated in dogs (Midgett et al., 1981) and it was proven that a low-calcium regimen led to a significantly higher rate of OTM, compared to a high-calcium diet, and in a comparable study (Goldie and King, 1984), lactating rats were fed for one week with a low-calcium diet before exerting a 60cN orthodontic molar movement, concluding that this regimen resulted in a faster OTM than in the control animals.

It is also known that vitamin D3 stimulates the rate of OTM (Kale et al., 2004-Takano et al., 1992 – Collins and Sinclair, 1988), as well as corticosteroid hormones, parathyroid hormone and thyroxine that increase tooth movement, despite controversial reports regarding methylprednisolone (Ong et al., 2000 – Kalia et al., 2004). Studies are warranted regarding the effect of exogenous calcitonin on OTM's rate, considering calcitonin's involvement in calcium homeostasis and bone remodeling.

Despite all encouraging results, we cannot consider that the effect of medications on the rate of OTM has been thoroughly evaluated. Consequently, we still cannot rely, on studies to use medications or dietary supplements in order to affect both the rate of OTM and the expected duration of treatment (Gameiro et al., 2007- Tyrovola and Spyropoulos, 2001 – Krishnan and Davidovitch, 2006 – Issacson, 2000).

Adult orthodontics requires longer period for teeth movements and contemporary orthodontics incorporate selective decortication surgery (also called corticotomy) to facilitate orthodontic movements and decrease orthodontic treatment duration (Hosl and Baldauf, 1991).
In February 1998, William M. Wilcko, a practicing orthodontist in Erie, Pennsylvania, USA and his brother M. Thomas Wilcko, a practicing periodontist in Erie, introduced the Accelerated Osteogenic Orthodontics (AOO\textsuperscript{TM}), a procedure that combines corticotomy, alveolar augmentation with bone grafting and orthodontic treatment: the purpose of selective decortication was suggested to provide a blood supply (by penetrating through cortical plates) and help change alveolar process physiology, allowing teeth to move faster (3-4 times faster than conventional orthodontic treatment). Other advantages of corticotomy and alveolar augmentation include fewer permanent teeth extractions, less root resorptions, enhanced alveolar support and greater long-term stability.

And if past century witnessed "block movement" inducing corticotomies to accelerate orthodontic movement, AOO\textsuperscript{TM} procedure has changed the concept of "segmental movement" to "lines and dots decortication" that provokes the so-called regional accelerated phenomenon (RAP), a cascade of physiologic events described by orthopedist Harold Frost (1989), who recognized that surgical wounding of bone leads to a striking reorganizing activity adjacent to injury site. RAP healing includes accelerated bone turnover and a decrease in regional bone densities. Earlier (1985), Shih and Norrdin proved that RAP can potentiate tissue reorganization and healing (in beagles). Later (1994), Yaffe and co-workers also reported RAP phenomenon following mucoperiosteal flap surgery in rats’ mandible and evidence of RAP was first observed after 10 days of healing, whereas almost complete recovery was observed after 4 months. Yaffe, Fine and Binderman (J Periodontol 1994; 65: 79-83) stated that RAP in humans begins few days after surgery, peaks at 1-2 months and takes 6-24 months (sometimes more) to subside: initial phase of RAP is characterized by an increase in cortical bone porosity due to osteoclastic activity increase and authors suggest that RAP may increase teeth mobility after periodontal surgery, a supposition that is consistent with a former publication (Pfeifer, 1965) that proved an increase of osteoclastic activity along the PDL surface following flap procedures (in humans).

In 2001, W.M.Wilcko, M.T.Wilcko, J.E.Bouquot, and D.J. Ferguson (in I J Periodontics Restorative Dent, 21: 9-19) stated that "there is strong indirect evidence that the physiologic events associated with RAP following surgery, ie, calcium depletion and diminished bone densities, result in rapid tooth movement".

One year earlier (2000), S.S. Hajji evaluated AOO\textsuperscript{TM} method (in a master's thesis prepared and defended at St.Louis University, Missouri, USA) and brought evidence of reduced treatment duration (1/4 to 1/3 that of conventional extraction and non extraction orthodontic treatment).

But as early as 1959, Köle reported combining orthodontics with alveolar ridge corticotomy surgery in order to correct occlusal abnormalities in difficult adult orthodontic cases as an alternative to orthognathic surgery or conventional orthodontics: in his paper, Köle claimed to complete the active tooth movement in adult orthodontic cases in 6 to 12 weeks, and found no incidence of root resorption and no pocket formation of loss or tooth vitality.

In 1991, Suya published a chapter ("Corticotomy in orthodontics") in a book ("Mechanical and biological basics inorthodontic therapy") in which he reported the surgical orthodontic treatment of 395 adult Japanese patients using a surgical method that he referred to as "corticotomy-facilitated orthodontics": his technique differed from Köle's with the substitution of a supraapical horizontal corticotomy cut instead of horizontal osteotomy beyond teeth apices. Suya claimed to complete most cases in less than a year, he also reported cases completed in 6 months and recommended completing the major active tooth movements in 3-4 months.

The Wilcko's approach is implemented under local/regional analgesia and IV sedation, labial and palatal/lingual corticotomies are performed during same session using a high-speed handpiece with no 2 round bur: cortical bone is degloved and bone grafting material placed over decorticated areas. Primary teeth should be extracted prior to AOO\textsuperscript{TM} surgery in order to allow gum healing, non-surgerized teeth act as anchors and brackets are placed one week before surgery. AOO\textsuperscript{TM} can be safely combined with orthognathic surgery and orthodontic mini-implants can be used but not in proximity of decortication areas, primary teeth should be extracted prior to surgery, allowing gum healing, endodontic problems are to be solved before AOO\textsuperscript{TM} and any tooth with cracked root is to be extracted.
What results after AOO™ is a change in bone physiology, osteoclasts are pushed to reduce bone mass and trabecular bone will be the first component of bone to give up calcium: corticotomy stimulates RAP and results in alveolar osteopenia, which implies that volume of bone remains the same but mineral content significantly decreases. With this technique, less or no root resorption is expected and treatment duration is dramatically shortened, 7-8 months in mandible and 6 months in maxilla (W M Wilcko and MT Wilcko, 2008).

At the beginning of the 21st century, corticotomy-assisted orthodontics appeared to be a method that reduces cortical bone resistance in order to ensure accelerated tooth movement, especially in adult patients. However, many still wonder why this procedure was judged heretical and controversial, though predictable and standardized.

AOO™ evidence-based studies are still lacking, yet this uncommonly used procedure may transform orthodontic landscape, worldwide, rendering it easier for orthodontists and more desirable for patients.

Ziad Noujeim, Oral Surgeon
Editor-in-Chief

Maria Saadeh, Orthodontist
Associate Editor
Meet the Editor-in-Subchief

Michel Goldberg is one of the leading figures in dental research in France and Europe. He is President and CEO of the French Institute of Dental Research (IFRO) and Emeritus Professor at the INSERM /747 Unit at Paris Descartes University/ Saints-Pères Biomedical College where he leads all research projects related to oral biology, histology, embryology and tissue engineering. His research interests include pulp biology, adult stem cells, biocompatibility of restorative materials with pulp cells, development of dental tissues (dentinogenesis and amelogenesis), extracellular matrix and biomineralizations.

In 1961, Goldberg graduated with a dental degree from the University of Paris Dental School, France, and later earned a "Doctor of Odontological Science" (DSO) degree in 1973 from René Descartes University (Paris) where he sustained a long academic career in basic sciences applied to dental practice. In 1983, he graduated from Pierre et Marie Curie University (Paris) with a "Doctor of Natural Sciences" degree.

Professor Goldberg is currently Vice-Chairperson of the Federation Dentaire Internationale (FDI) education committee and a distinguished member of the editorial board of the Journal of Dental Research (JDR). Being Ad hoc reviewer of 34 international peer-reviewed scientific journals, he has become an internationally recognized expert in basic science and dental and craniofacial research.

Professor Goldberg is the author and co-author of 210 scientific papers in peer-reviewed dental and biomedical journals and more than 100 papers published in French scientific journals, author/co-editor of invited chapters of 15 books, Associate Editor of "Clinical Oral Investigations" and Editor of "Frontiers between science and clinic in odontology" and "Biocompatibility or cytotoxic effects of dental composites (ORE-FDI working group)".

Professor Goldberg was recently invited by the Lebanese Dental Association and JLDA editorial board to serve as Editor-in-SubChief of the Journal of the Lebanese Dental Association.
Zeina Abdel Kader Majzoub graduated with high distinction, with a "Docteur en Chirurgie Dentaire" degree from Saint-Joseph University Faculty of Dental Medicine in Beirut, Lebanon. During her five-year studies, she excelled in didactic and clinical performance, attaining unprecedented academic results. After completing her undergraduate dental education, she initiated a long career at Boston University Henry M. Goldman School of Graduate Dentistry, in Boston, USA, where she earned a Certificate of Advanced Graduate Studies (CAGS) and a Master of Science in Periodontology. And as she finished her postgraduate education, she worked as Clinical Fellow and Clinical Instructor at Boston University and was the first Lebanese woman dentist to be appointed as Assistant Professor in an ADA accredited Dental School.

After six years of intense work as dental educator and researcher, Professor Majzoub moved to Italy where she earned the "Dott. Odont." degree at the University of Padova Institute of Clinical Dentistry, in Padova, where she founded (with Professor Giampiero Cordioli) the Postgraduate Program in Periodontology. She was also appointed Professor of Periodontology and Implant Dentistry at the same institution.

Professor Majzoub also worked (for 3 years) at the Lebanese University School of Dentistry in Beirut, Lebanon, where she was appointed Professor of Periodontology and Research and Chairperson of Research Department, and mentored, during her tenure, seven "Doctorate of Odontological Sciences" dissertations.

Professor Majzoub was the former President of Lebanese Society of Periodontology, and is a nationally and internationally praised lecturer, scientist and clinician, having been a Keynote Speaker in many Lebanese, Arab, European, Asian, North and South American seminars, workshops and conventions.

She is a renown world expert in research methodology, critical thinking, maxillary sinus grafting techniques, bone biology, histomorphometry, and periodontal diagnosis and therapy.


Professor Majzoub maintains private practices limited to Periodontology and Implant Dentistry in Padova, Italy and Tripoli, Lebanon.
Hani F. Ounsi is Research Associate at the Center for Excellence in Biomaterials and Biomechanics Research, Eng. A.B. Research Chair for Growth Factors and Bone Regeneration of King Saud University, in Riyadh, Saudi Arabia, and Teaching Faculty at the Department of Restorative Sciences of Kuwait University Faculty of Dentistry, in Kuwait City, Kuwait. He also worked at Saint-Joseph University Faculty of Dental Medicine, in Beirut, Lebanon, as Clinical Instructor, Clinical Assistant and Teaching Assistant in the Department of Endodontics. He is a recognized expert in research methodology, critical thinking and reading, restoration of endodontically treated teeth, cleaning and shaping, nickel-titanium instrumentation and filling of root canal space.

Dr. Ounsi earned his "Docteur en Chirurgie Dentaire" degree from University of Montpellier I Dental School, in Montpellier, France, and after completing his undergraduate studies, he earned an advanced diploma (Diplome d'Etudes Supérieures-DES) in endodontics at Saint-Joseph University Faculty of Dental Medicine, Beirut, Lebanon, a Masters degree in Biological and Medical Sciences from Saint-Joseph University Faculty of Medicine, and a Research Masters in Biology and Oral Biomaterials from Saint-Joseph University Doctoral College.

He furthered his education at Siena University, in Siena, Italy, where he earned a Research Master and completed the Ph.D curriculum in «Dental Materials and their Clinical Applications», with the Department of Odontostomatological Sciences, in the Biotechnologies Doctoral College.

Between 1999 and 2010, he presented 12 research posters in Kuwait, Lebanon, Italy and USA, mainly on zirconia implants, bonding to fiber posts, all-ceramic crown, endodontic obturation methods, nickel-titanium and the use of energy dispersive spectroscopy.

He also presented, until now, 51 international lectures in Syria, Egypt, Saudi Arabia, Tunisia, India, Lebanon, Nepal, Kuwait, Bahrain, Morocco, Turkey and Switzerland, 21 national presentations and 14 continuing education courses.

He is the author of 20 papers and co-author of 30, mostly tackling bonding to zirconia-based materials, retreatment efficacy of NiTi systems, fracture resistance and failure pattern of endodontically treated teeth, energy dispersive spectroscopy, cyclic fatigue resistance of NiTi rotary instruments, sealing ability of warm gutta-percha, efficiency of microscope and ultrasonics, determination of apical limit, computers in dental office, Dentascan in endodontics, pain control in endodontics, and Thermafil®.

Dr. Ounsi's main research interests include fluid dynamics in irrigation, NiTi rotary instruments dynamics, bonding to zirconia, surface composition of fiber posts, bond strength, microleakage and fracture resistance, cyclic fatigue and fractographic analyses and learning curves of NiTi rotary instruments.

Assem Soueidan is Professor (PU) and Chairperson of Periodontology Department at the University of Nantes Faculty of Dental Surgery, in Nantes, France. He is also a full-time hospital dentist (PH) at Nantes University Hospital dental clinical and research center.

He is the Head of "Innovative projects in odontology" with ERT 2004, a French clinical research team supported by INSERM U791 laboratory LIOAD (Professors P. Weiss, O. Laboux and P. Layrolle) : this group of French scientists endeavor to transfer biomedical innovations to dental practice through dental research protocols applied in dental implantology, filling of bone defects, bone reconstruction and innovations in dentistry.

Dr. Soueidan received the "Docteur en Chirurgie Dentaire-DCD-" degree from the University of Bordeaux, France, Oral Biology and Fixed Prosthodontics Advanced certificates (CES) from the University of Nantes Faculty of Dental Surgery, France, Oral Biology and Biomaterials Advanced Diploma (DEA) from Universities of Paris V and VII, France, Postgraduate Certificate (CES) and Diploma (DU) in Periodontology from Nantes University, Oral Rehabilitation and Implantology Postgraduate Diploma (DU) from Paris VI University, Oral Dermatology Postgraduate Diploma (DU) from Paris V University, "Doctorat d'Université" (in Cell Biology) from Nantes University , and "Habilitation à Diriger des Recherches – HDR " from Chemistry – Biology Doctoral School in Nantes.


His research interests include non-surgical treatment of chronic periodontitis with Er: YAG laser compared to scaling and root planning, biphosphonate in periodontal treatment, Er:YAG laser in clinical management of severe peri-implantitis, surface treatments of titanium dental implants , surface treatments of titanium dental implants for rapid osseointegration, experimental animal models in periodontology, histology and biology of orthodontic tooth displacement, SEM and image analysis for the screening of osteotropic modulators, calcium phosphate biomaterials for the delivery of anti-osteoporotic drugs, hypochlorous acid and taurine-N-monochloramine in periodontal disease, control of bone resorption, local analgesia with no injection (Oraqix ®), desquamative gingivitis, gingival lichen planus, periodontal therapy in aging population, oral follow-up of diabetic patients and rationales for splinting in periodontology, laser treatment of hypersensitivity, growth factors in dentistry, periodontal and peri-implant regeneration(s) , genetic profile of jaw osteonecrosis patients, jaw osteonecrosis in osteoporotic patients, IL-6 periodontal biotherapy in rheumatoid arthritis patients, relationship between periodontal disease and abdominal aneurysms, injectable bone substitutes in furcations and fenestrations, periodontitis and systemic disease, and therapy of tissue aging.
Pierre Riscallah loved Orthodontics, «la plus belle des sciences dentaires»

Joseph George Ghafari, DMD

My teacher Pierre Riscallah deserves to have Orthodontics as his middle name, for the specialty was his center stage and professional love. To him, as he wrote in our Livre d’Or at the American University of Beirut Division of Orthodontics and Dentofacial Orthopedics on the inauguration of the Karekin Tabourian Dentofacial Clinic (May 31, 2007): “Orthodontics is the most beautiful of all dental sciences.” A teacher who describes science in terms of beauty deserves the recognition of a master.

Belonging to a generation fractioned by sequences of an unbounded war of the self-perpetuating Cains and Abels, my remembrance of Pierre Riscallah was necessarily broken in time.

In a panel of this time, I see myself and my classmates in his class at the Université Saint-Joseph. He was knowledgeable, animated, driven, and forceful; yet behind the solid physique and strong character was a soft heart that future years disclosed in its real size.

In another setting, I see us, a number of his students, invited on the yacht that he designed and built. Creative, versatile and handy, Pierre Riscallah was a man of many talents.

In yet another frame, on one of my visits from the USA, I am in his Beirut office, listening to him presenting his orthodontic computer program, at a time when computer programs were known by only a few, let alone self-developed to fit one’s professional needs and maybe serve those of his colleagues.

In a more recent image, I see him visiting us at AUB, where I was recruited to found our present division and program, in essence reconnecting AUB with its past dental history. AUB had established the first school of dentistry (1910-1940) and introduced dental education in the Near East. I invited him at the start of several academic years to give a lecture to our residents on comparative anatomy. I remembered the topic he dwelt on when I was his student. Not only did he address facial anatomy across species, but he also engaged in scientific information about the behavior of these species. I was always gratified that my students were exposed to this topic by the man who interested me in it. Early in our renewed interaction, he presented me with a draft of an orthodontic book that he planned to publish.

This other memorable scene surfaces, at the inauguration of the aforementioned dentofacial clinic over 3 years ago. He was genuinely and absolutely happy to witness the event, as if the occasion was another validation of his own labor and ambition for orthodontics in the country he cherished. Such moments belong to humanity, not quite to us, when mind and heart soar away from persons and names, detached from identity, to acknowledge achievement. He put his thoughts in our commemorative book, in one eloquent sentence, with a “merci” that touches me today more than then. Then, I was happy because he was an integral part of the event. I believe that where we are today, is an extension of where we have been. He and my other teachers from the Université Saint-Joseph, Harvard University, The Forsyth
Dental Center and the University of Pennsylvania are present in my achievements and those of my students. That should hold true for Pierre Riscallah particularly, because I forged my professional path in “his” specialty.

My wish at Pierre Riscallah’s departure is for those of us who knew him to pass on his legacy as one of the pioneer orthodontists and orthodontic educators in Lebanon, who also steered the establishment of the Lebanese Orthodontic Society (1964). I believe that recognizing our peers for their efforts and accomplishments is a moral obligation, not a calculated choice, because their deeds impact everyone in their field. Perhaps what matters is not the recognition after one leaves, or even when one lives. Memories shall fade and fall, unfiltered, in many cracks of time immortal. In the development of a science, an institution or a country, what may matter the most is that pioneers and educators were present, giants or not, to help the next generation inch up to a higher step of evolution, to help improve the quality of a continuing life that eventually leaves everyone of us behind. Let us honor them at least by recognizing this principle: that we build from their shoulders up, not from the ground up.

Pierre Riscallah’s passing makes me think about all my teachers. If ever there is a time to say thank you to him and to each one of them, let it be now, under a bright sun that lights our day today, and someone else’s day tomorrow.

Our teacher Pierre Riscallah deserves a place in our sun. Thank you- merci, from a grateful heart, still beating in our science of orthodontics- la plus belle.

Dr. Ghafari is Professor and Head of Orthodontics and Dentofacial Orthopedics at the American University of Beirut (www.aub.edu.lb). Dr. Ghafari also holds professorial appointments at the Lebanese University and New York University. Contact: jg03@aub.edu.lb

Inscription by Dr. Pierre Riscallah upon the inauguration of the dentofacial clinic, American University of Beirut Medical Center, May 2007.
In Remembrance of  
Professor Pierre Riscallah,  
Orthodontist, Educator, Humanist,  
and Philantropist

One of the most important sources of ideas for development and application of biomechanics has always been the orthodontist. But while many orthodontists only care about advancing tools, instruments and materials for treating their patients, only few have the education, training, talent, gift and commitment to envisage and embrace the most promising and challenging innovations. Sadly, such an orthodontist, Professor Pierre Riscallah died after having shared his knowledge, ideas and expertise with his friends and colleagues.

Dr. Pierre Riscallah received his "Docteur en chirurgie Dentaire" degree from Saint-Joseph University Dental School, Beirut, in June 1957 and began his professional career by specializing in Orthodontics. Between 1959 and 1960, he served, at the same School, as Chief of Clinical Services ("Chef de Clinique") in the Department of Orthodontics. His enthusiasm for teaching and commitment to clinical excellence led him to work with (late) Professor Michel Dechaume in the Stomatology Clinic of Pitié - Salpêtrière Hospital, in Paris, France, and after an intensive training period, he was awarded the Diploma of "Foreign Assistant in Dental Surgery" ("Assistant en Chirurgie Dentaire à titre Etranger").

After four years of academic teaching in the specialty of Orthodontics at Saint-Joseph University, Dr. Riscallah was promoted to the rank of Lecturer (Chargé de Cours) in 1964, and in 1971, he was awarded a full Professorship in Orthodontics.

Professor Riscallah chaired the Saint-Joseph University Department of Orthodontics for more than 20 years, during which he lectured extensively in Lebanon, France and Arab countries. His distinguished tenure in this office will be long acknowledged in terms of seriousness, professionalism, compassion and camaraderie among his colleagues and students.

Professor Riscallah was Editor-in-Chief of the "Revue Dentaire Libanaise" (now JLDA) for many years and his accomplishments as a dentist, scientist and academician were well-known in Lebanese and Arab countries. However, as great as this loss is to orthodontic and dental communities, far greater is the loss of a wonderful and loving man to our world. One cannot remember Professor Pierre Riscallah without recalling his contributions to the specialty of Orthodontics in Lebanon and the Arab world. Apart from being an exceptionally skillful orthodontist, he was an outstanding Faculty Member and a keen professional endowed with a critical mind and a healthy sense of humour.

This sharp educator was marked by intellectual quickness and acuity, generous in always making his time available to his students and to young investigators and unselfish in encouraging all ambitious orthodontists to pursue and further their own projects.

During the last years of his life, he proudly faced the invincible battle with disease that slowly consumed his body, but not his will.

His compassion, leadership and commitment to excellence will always be remembered among his colleagues and patients, and as one of his numerous students, I will always look at him as a fighter who constantly fought, wholeheartedly.

I will also bitterly miss his unique perspectives and insights regarding science, music, arts, mechanics and philosophy.

My remembrance of Professor Riscallah is not unique. He served for decades as a Faculty model and source of inspiration for dental educators, students and postgraduate residents. His passing away makes us even more appreciative of the utmost importance of team approach and critical thinking and we can only hope that he and his likes are adopted as role models by young orthodontists.

Ziad Noujeim
In Memoriam

Pierre Riscallah
(1931-2010)

Mourir n’est pas finir, c’est le matin supérieur.
Victor Hugo, La légende des siècles

Passing away is not the end of one’s day, it is the
supreme daybreak.
Victor Hugo, La légende des siècles

Lebanese Orthodontics has lately lost one of its
most outstanding figures, namely Professor Pierre
Riscallah, who passed away on June 26 after a
battle with disease.

Born in 1931, in Cairo, he was awarded the
diploma of «Docteur en Chirurgie Dentaire» from
Saint-Joseph University in 1957 and a Certificate
of Foreign Assistant of Paris Hospitals in
Dentofacial Orthopedics in 1959 from the
Stomatology Institute in Paris.

He was the founder and head of the
Department of Orthodontics at the Dental school
of Saint-Joseph University from 1959 to 1980.

From 1970 to 1983, he was nominated
President of the Scientific Committee and Editor-
in-Chief of the Journal of the Lebanese Dental
Association.

In 1965, he founded jointly with Drs. Edgard
Debbane, Frédéric Maalouf and Alexandre
Khoury the Lebanese Orthodontic Society (LOS),
one of the oldest scientific societies in the Middle
East over which he was elected President until
1999 and ever since Honorary President.

Following the tragic events that shook the
country, scientific activities of the LOS were
interrupted between 1975 and 1993.

Between 1965 and 1970, Professor Riscallah produced
and presented at the Lebanese Dental Association meetings
three films on different topics in Orthodontics: “Qu’est ce
que l’Orthodontie?, Les anomalies glandulaires, Le
miracle de la denture.”

Between 1980 and 1995, after throughout
fifteen years of endeavors spent in computer
programming, he conceived “Le Melkart”, an
orthodontic software. In 2003, he published a
book “Précis d’Orthodontie” (translated into
English) in which he exposed his philosophy, the
fruit of forty years of experience. As a lecturer, he
participated in national and international
meetings and published many articles. He was a
member of several scientific societies and
organized all meetings of the LOS which regained
life since 1993.

Professor Riscallah practiced as well several
hobbies: He was a talented handyman and having
a passion for the sea, he built, in 1970, a boat, a
real floating house, after fourteen months of
strenuous work. He was also a photography and
music fanatic; he used to edit music on computer
which inspired him with the art of a conductor.

“Pierrot”, as he was affectionately known, was
a real phenomenon. He was a great man, a man of
genius with overflowing ideas. He was loved by
everyone.

Despite the sorrow and grief of separation,
“Pierrot” remains so alive among us. The
sunshine he used to reflect left us enough rays,
souvenirs and friendship to warm up our hearts,
frozen by his absence.

Zouhair Skaf, Joseph Bouserhal
In Memory of
Dr. Edgard Debbane, DCD, MS, FICD
First American trained Lebanese orthodontist

Edgard Felix Debbane was born in 1932 in the historical city of Saïda, Southern Lebanon. After having finished his Lebanese baccalaureate curriculum in 1950, he joined the Dental School of the French Faculty of Medicine at Saint-Joseph University in Beirut, where he received the "Docteur en Chirurgie Dentaire" degree in 1954.

Dr. Debbane was the first Lebanese dentist to specialize in Orthodontics in North America: indeed, and right after achieving his undergraduate dental medicine curriculum in Beirut, he joined the Pedodontic-Orthodontic Department of the University of Rochester Eastman Dental Dispensary in New York, USA, where he earned a Master of Science degree in Orthodontics.

After graduation, he served as Lecturer and Clinical Instructor at Eastman for many years, before establishing, in Beirut, a dental practice limited to Orthodontics and Dentofacial Orthopedics.

Apart from his dental activity in Beirut, Dr. Debbane worked as Visiting Orthodontic Consultant in Saudi Aramco / KSA and Jordan, where he was appreciated and respected for his extreme professionalism and dedication. Many of his colleagues, peers and friends (Dr. Charles Tager, Professors Nabil Barakat and Farès Abou Obeid, Dr. Cedric Haddad, Dr. Joseph Tamari, Dr. Levon Kardjian and others) still recall his honesty, candor, warmthheartedness, altruism, kindliness, grace, devotion, indulgence and gift for fine arts.

After a courageous and dignified fight with disease, Dr. Debbane passed away in his early forties. He will always be merrily remembered by his family, colleagues and friends.

Ziad Noujeim, FICD
Tribute to Professor Joseph Bouserhal
Orthodontist and Educator

Joseph Bouserhal was recently elected member to serve, for the next five years, on the Executive Committee of the World Federation of Orthodontists (WFO) as Representative for Africa and the Middle East. The elections had taken place during the 7th International Orthodontic Congress which was held in Sydney, Australia, on February 6-9, 2010.

Dr. Bouserhal received, in 1982, "Docteur en Chirurgie Dentaire" degree from Saint-Joseph University Faculty of Dental Medicine, Beirut, Lebanon. In 1985, he graduated from Catholic University of Louvain (UCL) Faculty of Medicine with a Specialist Diploma in Dentofacial Orthopedics after having defended a dissertation on "Combined (functional and biomechanical) orthopedic treatment of Class II division 1 of Angle".

He lately earned a specialty certificate in lingual orthodontics from the University of Paris 7 Faculty of Dental Surgery, in Paris, France and a University Diploma in Clinical Dental Research (DURCO) from the Paul Sabatier/Toulouse University Faculty of Dental Surgery in Toulouse, France. Presently, he is a Doctoral Fellow at Liège University, in Belgium, preparing a thesis on "Rapid Palatal Expansion and 3D imaging".

Dr. Bouserhal's academic career began in 1986 at Saint-Joseph University Faculty of Dental Medicine, in Beirut: at that time, he joined the Department of Orthodontics as Teaching Assistant and Clinical Instructor, and after 11 years of didactic and clinical teaching, he was appointed Associate Professor and served with this academic rank for 5 years. He chaired the Orthodontic Department for more than seven years at Saint-Joseph University where he still works as Professor and Director of the Orthodontic Postgraduate Program. He is also Visiting Professor in Tunisia, France, Morocco and Greece, and Instructor at the Tweed Foundation for Orthodontic Research in Tucson, Arizona, USA.

Professor Bouserhal is the author of 7 papers and co-author of 10 papers in peer-reviewed journals, among which l'Orthodontie Française, the American Journal of Orthodontics and Dentofacial Orthopedics, the European Journal of Orthodontics, the Tweed Profile and the Journal of Clinical Orthodontics.

His research interests include sleep apnea, rapid palatal extension, esthetic evaluation of profile incisor inclination, facial typology, custom-made rotational ligatures, orthodontic diagnosis, vertical control and directional forces, shear bond strength of orthodontic brackets, treatment of dental asymmetries, adult and interdisciplinary treatment, transverse dimension and orthodontic mini-implants.

Professor Bouserhal is the President of the Lebanese Orthodontic Society. He maintains a private orthodontic practice in Beirut and Kuwait City.

Ziad Noujeim
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DENTISTRY MEETS TECHNOLOGY.
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Nonsurgical treatment of a patient with facial asymmetry and canted occlusal plane using miniscrew anchorage.

Mona Sayegh Ghoussoub*, Dr. Chir. Dent., CES Ortho., DU Ortho., CECSMO

Abstract

Changing the cant of maxillary occlusal plane in patients with facial asymmetry is difficult to achieve orthodontically without orthognathic surgery. LeFort I osteotomy with asymmetric maxillary impaction is often used to correct this problem. However, canting caused by extruded teeth can now be corrected with conventional orthodontic appliances and temporary anchorage device (TAD). A 15-year-old patient with facial asymmetry, unilateral crossbite and cant of occlusal plane was treated nonsurgically with this procedure using miniscrews. The correction occurred through intrusion of the extruded teeth on one side of the maxilla, thereby avoiding a more aggressive surgical approach.

INTRODUCTION

Facial beauty and proportions have been studied by Leonardo da Vinci and Albrecht Dürer since the sixteenth century. They considered absolute bilateral symmetry as a normal and essential morphologic characteristic. Although perfect craniofacial symmetry does not exist in nature, asymmetry ranges from clinically undetectable to severe deformity. Thompson has stated: “normal asymmetry is not very evident, whereas abnormal asymmetry is quite obvious”.1

Orthodontists are mainly preoccupied with the lateral facial aspect of their patients, whereas the general public tends to judge beauty, symmetry and harmony from a frontal projection. Symmetry is a valuable component of an attractive smile2. Patients with facial asymmetry frequently exhibit improper canting of occlusal plane, which can be caused by unilateral molar extrusion or by asymmetrical mandibular vertical development. The angulation of the occlusal plane affects the relationship between the arches, with both functional and esthetic consequences.3-5

REVIEW OF THE LITERATURE

Lundström assessed mandibular asymmetry in twenty-five dry mandibles. He stated: “the biologic principle of bilateral symmetry is never manifested with mathematical precision, and even in fully homologous organs in the two halves of the body there are almost invariably small differences.6

Shah and Joshi observed that pleasing and apparently symmetrical faces do exhibit skeletal asymmetry, suggesting that facial soft tissues attempt to minimize underlying asymmetry.7

Farkas and Cheung used anthropometry to measure normal soft tissue facial asymmetry and noted that asymmetries were very common although not obvious.8

Relation between asymmetry and neuromuscular function

Investigations done to show the relation between asymmetry and neuromuscular function provide evidence of the impact that facial musculature has on development of skeletal and dental disharmony. Rogers examined a cadaver with marked asymmetry of mandible and cranium. He noted that muscles of mastication on one side of the face were very atrophic, as were the bony processes into which they inserted. He concluded that “asymmetry of the musculature accounted for the asymmetry of the mandible and of any other bony areas on the skull from which the affected muscles arose.”1

In a sample of ancient skulls, A. Björk and L. Björk9 noticed that compensatory asymmetric growth
of maxilla and mandible can occur when cranial base develops asymmetry at early age. Compensatory changes may occur in the growth and development of dentoalveolar structures to enable bilaterally symmetrical function and maximum intercuspation of teeth and to minimize the underlying asymmetry in the spatial arrangement and size of the jaws. Such changes are attributed to the ability of labial and lingual musculature to guide and shape final occlusion.9

**Etiology of mandibular asymmetry**

Mandibular asymmetry may be caused by a combination of genetic and environmental factors. A developmental and acquired classification of mandibular asymmetry is suggested.10-11

**Developmental**

1. Agenesis of mandibular condyle
2. Hypoplasia of mandibular condyle, neck, ramus, body or combinations
3. Hyperplasia of mandibular condyle, neck, ramus, body or combinations
4. Apparent: the two halves of mandible are equal in length and asymmetry is due to a rotation of mandible in transverse, coronal or oblique planes (with asymmetry of glenoid fossae relative to skull base)
5. Combinations or bilateral manifestations of the above, which may be associated with craniofacial anomalies (such as hemifacial hypertrophy, hemifacial atrophy, hemifacial microsomia).

**Acquired**

1. Trauma-ankylosis (of temporomandibular joint)
2. Mandibular tumors
3. Mandibular infections
4. Functional mandibular displacement

Most common asymmetrical deformities appear to be those of “deviation prognathism” where there is generalized increase in the relative size of mandible with increased unilateral growth component and unilateral hyperplasia of mandibular condyle or neck.12

Many patients with facial asymmetry have canted occlusal planes caused by unilaterally extruded maxillary molars or asymmetric mandibular vertical development. Until recently, there was no reliable nonsurgical method to correct this condition because appliances used were highly dependent on patient cooperation. As a result, LeFort I osteotomy combined with mandibular bilateral sagittal split osteotomy (BSSO) was the most accepted method for correcting occlusal plane canting in patients with facial asymmetry.13-14 Recently, miniscrews have been introduced to aid orthodontic mechanics and provide skeletal anchorage to permit molar intrusion.15,16,17 In this case report, we describe a recent approach for correcting a canted occlusal plane using miniscrews, offering the possibility of avoiding LeFort I maxillary surgery. The reported patient had vertical maxillary asymmetry with mandibular deviation to the left, complicated by unilateral crossbite and a cant of occlusal plane. Treatment included orthodontic treatment with temporary anchorage devices (TADs). Miniscrews were placed on maxillary right side to intrude teeth and correct malocclusion. The combined treatment was successful; acceptable stomatognathic function was achieved, along with improved occlusion and esthetics.

**CASE HISTORY**

A 15-year-old male sought treatment for facial asymmetry and difficulty in mastication. He did not have a history of head or jaw injury. He had received orthodontic treatment, starting at the age of 10, to correct an anterior crossbite and mild facial asymmetry, with a satisfactory result. Shortly after that treatment, patient’s occlusion began to change, and facial asymmetry gradually developed. He noticed more apparent facial asymmetry few months before his first visit to our office. Regarding the etiology of the asymmetry leading to the malocclusion, it was most probably developmental combined with craniofacial anomaly, which is hemifacial hypertrophy on the left side and hyperplasia of mandibular condyle on the same side. No signs of dysfunction in the temporomandibular joint region were noticed.

**Clinical examination**

Patient presented a facial asymmetry with mandibular deviation to the left side. The smile line was canted and teeth more extruded on the right side. His profile was convex with unstrained lip closure. His soft tissue characteristics included orthogonal nasolabial angle, shallow mentolabial sulcus, chin
Figure 1. Pre-treatment facial photographs.

Figure 2. Pre-treatment intra-oral photographs.

Figure 3. Panoramic and lateral cephalometric radiographs.
increased in height and chin-throat distance decreased in length. The maxillary dental midline was coincident with facial midline, the mandibular midline deviated 3mm toward the left side. (Fig. 1)

Analysis of pre-treatment intra-oral photographs and dental casts showed a Class I molar on both sides, a Class I canine on the right side and a Class II canine on the left. The maxillary occlusal plane was canted by unilateral extrusion of right maxillary molars and premolars. This extrusion accentuated the asymmetry. A crossbite was also present on the left side from lateral incisors to first bicuspids. The mandibular arch form was asymmetric, with lingual inclination of mandibular left molars. No tooth size-arch length discrepancy was present in either arch. Oral hygiene and periodontal conditions were deficient (generalized gingival inflammation). White spots and decalcifications were obvious on teeth, especially on the left side, probably because of malocclusion and difficulty of mastication due to the crossbite. (Fig. 2)

Radiographic examination

The panoramic radiograph showed that all permanent teeth were present within the arches except wisdom teeth. The maxillary right side appeared more extruded than the left, confirming the cant of occlusal plane. The cephalometric tracing showed a skeletal Class I jaw relationship (ANB=3°) with hyperdivergent pattern and high mandibular plane (MP/SN=40°). (Fig. 3, Table 1)

**TREATMENT OBJECTIVES**

The treatment objectives for this patient consisted of:

- Facial esthetics: improve asymmetric mandibular position and achieve facial symmetry at rest and upon smiling by correction of the canted occlusal plane.
- Maxillary and mandibular dentitions: intrude maxillary right teeth and resolve vertical bilateral dento-alveolar discrepancy.
- Occlusion: correct mandibular midline shift and crossbite on the left side, establish a functional occlusion with optimal overjet and overbite.

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**Figure 4.** Miniscrews placement to intrude right maxillary teeth and correct cant of the occlusal plane.
Figure 5. Post-treatment facial and intra-oral photographs.

Figure 6. Final radiographs and superimpositions (—— Pre-treatment —— Post-treatment)
TREATMENT ALTERNATIVES

The first treatment option was a combination of orthognathic surgery and orthodontic treatment to improve facial asymmetry and the cant of occlusal plane. A double-jaw surgery comprising LeFort I osteotomy in combination with mandibular bilateral sagittal split osteotomy (BSSO) was proposed to correct the underlying skeletal problem. This option was rejected by the patient because of postoperative considerations. A compromised nonsurgical treatment plan was then proposed and accepted; it consisted of correction of vertical discrepancy with the placement of miniscrews and intrusion of maxillary right molars and premolars to reposition mandible and improve smile.

TREATMENT PLAN

After review and discussion of treatment options, the patient accepted the following treatment plan:

1. Bond and align teeth on both arches in combination with transpalatal arch
2. Correct extruded teeth by placing miniscrews in maxillary right side
3. Coordinate occlusion using intermaxillary elastics to correct crossbite on the left side and the discrepancy of the mandibular midline
4. Stabilize with fixed and removable retainers

TREATMENT PROGRESS

Maxillary arch was banded and bonded with a .022 x .028-in straight wire appliance. Before placement of TADs, a transpalatal bar 3mm distant from palate was placed to counteract the crown buccal torque that would result from the intrusion force. Two miniscrews (AbsoAnchor, Dentos, Taegu, Korea) were then placed in maxillary right area; the first one (1.5 mm diameter, 6 mm length) in the alveolar bone between canine and first bicuspid; the second (1.3 mm diameter, 8.0 mm length) between second bicuspid and first molar at muco-gingival junction, and at 8mm from the archwire (Fig. 4). A series of archwires were used to achieve alignment and leveling, starting with a .016-in nickel-titanium, and .016 x .022-in nickel-titanium followed by .018 x .025-in wire stainless steel archwires. Loading with an elastic thread with a force of 150 g on each miniscrew was performed.

Mandibular arch was then banded and bonded; after an initial phase of leveling and alignment using a progression of nickel-titanium wires and working up to a .018 x .025-in wire stainless steel to help establish arch form coordination. Few months after the start of miniscrews loading, the maxillary right side was intruded 3.0 mm. Maxillary wire was expanded and mandibular one constricted on the left side to correct unilateral posterior crossbite. A combination of Class II elastics on the left side, and Class III on the right in conjunction with vertical elastics was used to detail occlusion; mandibular midline was overcorrected 0.5mm to the right to decrease the risk of relapse after treatment. Seating of occlusion and achieving proper root parallelism were accomplished as a last phase of treatment. After almost two years of active treatment, fixed appliances and miniscrews were removed. In both maxillary and mandibular arches, patient was given thermoplastic retainers (ESSIX type) in addition to canine-to-canine bonded lingual retainers, patient was asked to wear his retainers full time, for six months and then only at night indefinitely to ascertain stability of final result.

TREATMENT RESULTS

Posttreatment records showed that facial esthetics improved significantly and normal occlusion was achieved with optimal overbite and overjet. Maxillary right molars were intruded 3 mm. Correction of patient’s facial asymmetry, canted occlusal plane and crossbite on the left side were achieved orthodontically. Correction of mandibular midline deviation was achieved, although midlines were slightly tipped to the left because of the existence of a slight underlying skeletal asymmetry that orthodontic treatment tried to compensate. The smile line was more consonant with maxillary anterior teeth (Fig. 5).

Final panoramic radiograph revealed no root resorption of intruded teeth. The post-treatment cephalometric tracing showed decrease of mandibular plane angle probably due to the intrusion performed on maxillary right side, slight proclination of maxillary incisors and uprighting of mandibular ones compensating probably for the late growth of mandible showed in the overall superimposition, whereas the ANB angle was slightly decreased (Fig. 6, Table 1).
DISCUSSION

Treatment of facial asymmetry consists mainly of a surgical-orthodontic approach. LeFort I osteotomy is usually performed to intrude longer side or extrude shorter side of maxilla combined with mandibular surgery in patients with facial asymmetry and maxillary cant. To avoid orthognathic surgery, molar intrusion or extrusion is required to improve maxillary cant, but it is difficult to establish absolute anchorage for molar intrusion with conventional orthodontic mechanics. Recently, TADs (such as miniscrews) have been used for orthodontic anchorage. They have become a reliable method of producing adequate intrusion with minimal side-effects. This new method of intrusion of the maxillary molars on one side can reduce medical costs, surgical risks and discomfort after surgery. Therefore, skeletal anchorage with miniscrews for molar intrusion is considered a new treatment strategy and can be successfully incorporated into the armamentarium of orthodontist’s practice.\(^\text{18,21,22}\) Furthermore, it does not require active patient compliance. In this case report, miniscrews were placed without incision, making this method less invasive. The site of miniscrew implantation should be determined according to root angulation and amount of space available between teeth roots to be intruded.\(^\text{23}\)

They have been loaded immediately after placement with orthodontic force; following the theory stating that early loading permits mechanical retention between screw and bone which is sufficient to withstand normal orthodontic force levels.\(^\text{24}\)

To avoid root resorption, intrusive force levels should be kept near optimal. Umemori and co-workers\(^\text{25}\) used 500g, Park and co-workers\(^\text{15}\) used 200 to 300g, and Paik and associates\(^\text{26}\) used 150 to 250g to intrude molars. The three groups of authors showed pure intrusion without root resorption. About 150g of force per miniscrew were used to intrude teeth in this case and there was no root resorption.

Molar intrusion with buccal force application tends to cause crown tipping. More controlled intrusion of maxillary molars was achieved with an anchorage system consisting of buccal miniscrews and a transpalatal arch distant from palate. This mechanical system allows control of buccal flaring of maxillary molars instead of adding intrusive forces on lingual surface.\(^\text{18}\)

Miniscrews were implanted on attached gingiva areas as near as possible to mucogingival junction to permit sufficient space for intrusion. They showed no clinical mobility and provided good skeletal anchorage during orthodontic treatment.

CONCLUSION

In the past, mild facial asymmetry was disregarded by clinicians because it was believed that normal craniofacial skeletons had some asymmetry. Nowadays, with the increasing concern about facial appearance, patients are complaining of even slight asymmetry. An accurate approach to facial asymmetry is mandatory for proper management in orthodontic practice. This case shows that a combination of conventional orthodontic appliances and skeletal anchorage with miniscrews is a feasible approach to correct undesirable occlusal plane canting caused by molar extrusion\(^\text{27-28}\). This new procedure has the advantage to be a more conservative option than orthognathic surgery and does not rely on patient compliance, though minimizing active treatment time.

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Correspond with:
Mona Sayegh Ghoussoub
mona_gsoub@yahoo.fr
Application and limitation of different methods to assess skeletal age in orthodontic practice.

Chimène Chalala*, BDS, DES Ortho., Residency Ortho. (AUB)

Abstract

Skeletal age indicates the level of maturation of a child's bones and helps pediatricians evaluate normal growth or developmental disorders. Orthodontists determine skeletal maturation to exploit growth potential in the correction of skeletal discrepancies, and to gauge any residual growth that may contribute to post-treatment relapse. To date, staging skeletal development has more predictive growth value than chronologic age or other physiological parameters such as the amount and velocity of body height, dental formation and emergence and pubertal markers. Hand and wrist radiographs have been reliable for bone age assessment. Commonly used methods include: comparisons of individual radiographs to age norms in the Greulich-Pyle atlas; a "bone-by-bone" evaluation in the Tanner and Whitehouse scoring system; and less frequently the Fishman system that uses 4 stages of bone maturation at 6 hand and wrist sites. Not widely used or equally reliable, though more accessible to orthodontists, is the determination of skeletal maturity from cephalometric images of cervical vertebrae, based on shape and lower border of vertebrae and intervertebral space. Recently, bone age was assessed through ultrasound with objectivity, lack of ionizing radiation and easy accessibility. All these methods are described and illustrated in our paper, with emphasis on technological developments, including computerized bone age estimation, which is less time-consuming and more reproducible than human estimates.

INTRODUCTION

Bone age assessment is a way of describing the degree of maturation of a child's bones. This procedure is frequently performed by pediatricians for clinical diagnosis and endocrinopathies monitoring (including hypothyroidism and congenital adrenal hyperplasia) and to evaluate growth disorders. It is also used in the evaluation of short stature and in the prediction of final adult height. In dentofacial orthopedics, evaluating growing patients' skeletal maturation is important to exploit the growth potential for initiating differential growth between jaws (use of functional and head gear therapy). In addition, an understanding of percentage growth remaining after completion of orthodontic intervention is important in predicting post-treatment relapse. Staging of human skeletal development has been assessed using different physiological parameters such as peak growth velocity, dental development and eruption, pubertal markers (voice change in males, menarche in females, breast development, appearance of pubic and axillary hair) and radiographic analyses1,2. All these biological indicators have little predictive value when compared to radiographic analysis, which is widely used to predict timing of pubertal growth, estimate growth velocity and approximate the percentage of residual growth.

METHODS USING HAND AND WRIST AS A REPRESENTATIVE AREA OF THE WHOLE SKELETON

Evaluation of skeletal maturation is based upon changes in the skeleton that can be easily viewed on standardized radiographs, traditionally of the left hand and wrist.

Stages in the ossification of bones of the hand and wrist are considered because of the quantity of different types of bones available in the area3-8. The hand-wrist is placed flat on the x-ray plate with the...
palm down and fingers slightly apart.

There are three commonly used methods for estimating bone age: Greulich and Pyle\textsuperscript{5}, Tanner-Whitehouse\textsuperscript{6,9,10} and Fishman systems\textsuperscript{11-13}.

**Greulich and Pyle method**

The Greulich and Pyle\textsuperscript{5} (GP) method was based on a small sample of American children from the Cleveland (Ohio) area, born between 1917 and 1942. As initially described, this method involves a complex comparison of all the bones in the hand and wrist against reference “normal” radiographs of different ages (six-month intervals of chronological age).

To note that each standard film in the G&P atlas was selected from 100 radiographs of the same age and sex. Skeletal age should be based on the median of skeletal ages assigned to each individual bone of the hand-wrist (there are 29 bones). In practice, however, a skeletal age according to the GP method is generally, yet improperly based on the skeletal age of the standard plate to which the film of a child most closely matches (Fig.1). Unfortunately, this rapid modified version of the technique is used in most institutions.

In general, this method is commonly used because of its simplicity, minimal radiation exposure and the availability of multiple ossification centers for evaluation of maturity. However, this method is not accurate and is prone to deviations because of its subjective nature. Furthermore, the atlas itself, developed in the 1950s, is not fully applicable for today’s children, especially regarding the standard development in other racial groups\textsuperscript{14-16}.

**Tanner-Whitehouse method**

More detailed information about skeletal age can be obtained by using the so-called “bone-by-bone” evaluation. In 1962, Tanner and co-workers\textsuperscript{6} came up with a new method for assessing skeletal maturity (TW1).

Their data were obtained from British children of an orphanage and public schools born between 1940 and 1955.

This method evaluates specific ossification centers of the hand and wrist through two systems: RUS (radio, ulna and selected metacarpals and phalanges) and Carpal that analyzes the carpal bones except for the pisiform.

It is a score system where 20 bones are analyzed: 1. distal radius, 2. distal ulna, 3. first, 4. third and 5. fifth metacarpals, 6. proximal phalanges of the thumb, 7. third and 8. fifth fingers, 9. middle phalanges of the third and 10. fifth fingers, 11. distal phalanges of the thumb, 12. third and 13. fifth fingers, the seventh carpal bones: 14. capitate, 15. hamate, 16. triquetral, 17. lunate, 18. scaphoid, 19. trapezium and 20. trapezoid are analyzed (Fig.2).

Each bone is matched to a series of written criteria describing eight or nine standard maturity stages, labeled A to H or I and each stage is assigned a specific score that differs between boys and girls (Tables 1, 2). In fact, there are three separate scoring systems: one concerns the radius, ulna and finger bones (TW-RUS), another the carpals only (TW-carpo) and a third one both combined (TW-20). The sum of these scores results in a skeletal maturity score (SMS) that can be transformed into skeletal age by comparing with

![Figure 1. Steps of Greulich and Pyle hand atlas matching method (adapted from Google image).](image1)

![Figure 2. 13 long bones (radius, ulna and metacarpals and phalange of the first, third and fifth digits) and 7 round bones (carpal bones) of the hand and wrist are evaluated for the assessment of skeletal age (Image Sciences Institute 2007).](image2)
gender-dependent reference tables (Tables 3, 4).

The Tanner-Whitehouse method had been revisited twice: The TW1 system was superseded in 1975 by the TW2 method, which did not change the characteristics of the stages but altered the scores attached to each stage and differentiated between the sexes. The TW2 system provided separate maturities for the carpal bones and radius, ulna and short bones (RUS). Even the equations for the prediction of adult height have been modified throughout the years. This process led in 2001 to the publication of the new version of this method, termed TW3. The reference values of TW3 are based on samples of European (British, Belgian, Italian, Spanish), Argentine, Japanese and well off American youth from the Houston (Texas) area. The age at attainment of skeletal maturity for the radius, ulna and short bones was lowered to 16.5 years in boys and 15.0 years in girls (it was 18.2 years and 16.0, respectively, in the TW2 version).

**Fishman method**

Fishman developed a system of hand-wrist skeletal maturation indicators (SMIs) using 4 stages of bone maturation at 6 anatomic sites on the hand and the wrist. The 6 anatomical sites are located on the thumb, 3rd finger, 5th finger, and radius (Fig. 3).

**Table 1.** Twenty bone Tanner-Whitehouse maturity score for boys. (Tanner-Whitehouse 1983)

**Table 2.** Twenty bone Tanner-Whitehouse maturity score for girls. (Tanner-Whitehouse 1983)

**Table 3.** Tanner-Whitehouse boys bone age (BBA) for given maturity score (MS) (Tanner-Whitehouse 1983)

**Table 4.** Tanner-Whitehouse girls bone age (BBA) for given maturity score (MS) (Tanner-Whitehouse 1983)
According to this method, eleven distinct adolescent skeletal maturational indicators cover the entire period of adolescent development:

A. Width of epiphysis:  
   - as wide as diaphysis
   - 1. 3rd finger --- proximal phalanx
   - 2. 3rd finger --- middle phalanx
   - 3. 5th finger --- middle phalanx

B. Ossification:  
   - 4. Adductor sesamoid of thumb

C. Capping of epiphysis:  
   - 5. 3rd finger --- distal phalanx
   - 6. 3rd finger --- middle phalanx
   - 7. 5th finger --- middle phalanx

D. Fusion of epiphysis and diaphysis:  
   - 8. 3rd finger --- distal phalanx
   - 9. 3rd finger --- proximal phalanx
   - 10. 3rd finger --- middle phalanx
   - 11. Radius

In order to simplify and facilitate the clinical evaluation of SMIs, a practical observational scheme like the one shown in figure 4 was elaborated. With this approach, key stages are checked first, instead of looking for maturity indicators in numerical order, leading to rapid identification of the applicable SMI.

Average age standards for the eleven SMI’s were established by computing the corresponding means and standard deviations (Table 5).

The percentage of adolescent growth completed is a useful value in the study of maturational changes. It is quite evident that both sexes completed similar percentages of total growth at comparable SMI’s, even though it took place at quite different age periods (Table 6).

An example of bone age assessment using the three methods is elaborated in figure 5.

**METHODS USING CERVICAL VERTEBRAE TO DEDUCE SKELETAL MATURITY**

To avoid exposing the patient to an additional radiograph, some researchers sought to relate maturation with skeletal features other than the bones of the hand and wrist. In 1972, Lamparski created separate standards of cervical vertebral maturation for female and male subjects related to both chronological age and skeletal maturation observed in the hand-wrist radiograph. He studied and analyzed changes in size and shape of five cervical vertebrae from the second one through the sixth. This method was based on the findings of earlier investigations from Todd and Pyle, Elsberg and Duke, Lanier, Bick and Copel and Hink.

**Figure 3.** Location on the hand-wrist of the 6 anatomical sites evaluated in Fishman technique (Adapted from Fishman, 1982).

**Table 5.** Chronologic age values for adolescent skeletal maturity indicators (Fishman, 1982).

**Figure 4.** Hand-wrist observational scheme for a fast and easy SMI evaluation (Fishman, 1982).

**Table 6.** Percentage of adolescent statural growth completed (Fishman, 1982).
These developmental stages of cervical vertebrae are illustrated in figure 6.

The 6 stages in cervical vertebral maturation include the following observations:

1. Before the peak, the accelerative growth phase corresponds to vertebral stages 1 to 3.
2. After the peak, the decelerative phase of growth corresponds to vertebral stages 4 to 6.
3. Pubertal growth peak occurs on average between vertebral stages 3 to 4.

This method has the advantage of eliminating the need for additional radiographic exposure since the vertebrae are already recorded on the lateral cephalometric radiograph.

Regarding the relationship of cervical vertebral maturation and mandibular growth changes, O’Reilly and Yanniello18 evaluated annual lateral cephalometric radiographs of 13 caucasian girls from 9 to 15 years of age and found statistically significant increases in mandibular length, corpus length and ramus height in association with specific maturation stages in the cervical vertebrae according to the method of Lamparski.

An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth was lately conducted26. It consists of 5 maturational stages instead of 6, since the second through the fourth vertebrae are evaluated. This improvement has the advantage of the skeletal maturity appraisal on a single cephalogram and through the analysis of only the second, third, and fourth cervical vertebrae, which usually are visible.

**Figure 5.** Hand-wrist x-ray of a female patient. The assessment of her skeletal age by:
- Greulich and Pyle method: bone age between 11 and 12 years resulting from the closest match in the book atlas.
- Fishman method: following the observational scheme illustrated in figure 4, the presence of sesamoid bone leads to the next step which is to perceive if any fusion exists at the level of the distal phalanx of 3rd finger. As there is no fusion, the next step consists of assessing if any capping is present at the level of the distal phalanx of 3rd finger. The capping stage is not seen at this site so the subsequent evaluation will be for the capping stage of the middle phalanx of 3rd finger. This phalanx shows the capping stage that corresponds to SMI of 6. By consulting table 5, the corresponding bone age is 12.06 years.
- Tanner-whitehouse method (TW2): By applying the computed Tanner-whitehouse test, the calculated maturity score is 861(866) which corresponds to the skeletal age of 11.3 years.

**Figure 6.** Developmental stages of cervical vertebrae (Adapted from O’Reilly, 1988).

**Stage 1:** All inferior borders of the bodies are flat. The superior borders are strongly tapered from posterior to anterior.

**Stage 2:** A concavity has developed in the inferior border of the 2nd vertebra. The anterior vertical heights of the bodies have increased.

**Stage 3:** A concavity has developed in the inferior border of the 3rd vertebra. The other inferior borders are still flat.

**Stage 4:** All bodies are now rectangular in shape. The concavity of the 3rd vertebra has increased, and a distinct concavity has developed on the 4th vertebra. Concavities on 5 and 6 are just beginning to form.

**Stage 5:** The bodies have become nearly square in shape, and the spaces between the bodies are visibly smaller. Concavities are well defined on all 5 bodies.

**Stage 6:** All bodies have increased in vertical height and are higher rather than wider. All concavities have deepened.
even when a protective radiation collar is worn.

The five stages are illustrated in figure 7.

Figure 7. The newly improved CVM method elaborating five maturational stages instead of six (Baccetti et al 2002).

CVMS I: Lower borders of all the three vertebrae are flat, with the possible exception of a concavity at the lower border of C2 in almost half of the cases. The bodies of both C3 and C4 are trapezoid in shape. The peak in mandibular growth will occur not earlier than one year after this stage.

CVMS II: Concavities at the lower borders of both C2 and C3 are present. The bodies of C3 and C4 may be either trapezoid or rectangular horizontal in shape. The peak in mandibular growth will occur within one year after this stage.

CVMS III: Concavities at the lower borders of C2, C3 and C4 now are present. The bodies of both C3 and C4 are rectangular horizontal in shape. The peak in mandibular growth has occurred within one or two years before this stage.

CVMS IV: The concavities at the lower borders of C2, C3 and C4 are still present. At least one of the bodies of C3 and C4 is square in shape. If not squared, the body of the other cervical vertebra is still rectangular horizontal. The peak in mandibular growth has occurred not later than one year before this stage.

CVMS V: The concavities at the lower borders of C2, C3 and C4 still are obvious. At least one of the bodies of C3 and C4 is rectangular vertical in shape. If not rectangular vertical, the body of the other cervical vertebra is squared. The peak in mandibular growth has occurred not later than two years before this stage.

AUTOMATIC BONE AGE ESTIMATION

To evaluate bone age, radiologists use images in a specially prepared atlas to match visually each bone in the radiograph. Therefore, it is logical to deduce that bone age estimation is time-consuming, costs a lot of effort and depends on proficient experience, although there is considerable rater variability. However, computerized bone age estimation would have the apparent advantages of saving radiologist’s time and increase the reproducibility of the analysis, hence less bias and human error in research projects. Furthermore, computer analysis might also lead to more accurate predictions of adult height.

The Tanner-Whitehouse method, considered the most accurate and reliable, is applied only in a small fraction of cases due to its complexity and long examination time. That is why different computer-aided diagnostic systems based on this technique and others were developed to assist health professionals and make skeletal age assessment easier, faster and more accurate (Fig. 8).

Figure 8. Screenshot of different computerized programs for bone age estimation based on the method of Tanner and Whitehouse (TW2) (Image Sciences Institute 2007).

BONE AGE ASSESSMENT WITH ULTRASOUND DEVICE

Several ultrasound-based techniques (Fig. 9) have been developed to estimate skeletal age without radiation exposure. Conclusions were contradictory regarding the accuracy of these ultrasonographic methods in the estimation of bone age: while some studies confirmed the accuracy of this technique compared to the widely used method of Greulich and Pyle, others reported the lower accuracy of sonographic compared to conventional methods. The obvious advantages of such
developed devices are objectivity, lack of ionizing radiation and easy accessibility. The disadvantage is the need for cooperation since the patient is asked to keep his arm immobile during the measurement. It is therefore limited to 5-year-old children and older.

**DISCUSSION**

Many studies compared the above cited bone age assessment methods and it was found that there are different values for bone age between GP and TW2. The second one is more reproducible and more accurate than the first.44

Concerning the different versions of Tanner-Whitehouse method (TW2 and TW3), there was a statistically significant difference between TW2RUS and TW3RUS mean skeletal ages for both genders: the skeletal ages estimated by the TW2RUS method were older than the TW3RUS method for both genders. It is very crucial to analyze and identify which of these 2 versions is appropriate for the population considered for bone age assessment. For example, compared to TW2RUS method, the skeletal ages estimated by TW3RUS method were closer to Brazilian chronological ages. Therefore, it seems reasonable to recommend the use of the TW3 system rather than TW2 in Brazilian population.45

Ethnic and racial differences in patterns of growth among people do exist and evaluation of bone age based on the widely used method of Greulich and Pyle should be limited to the same ethnicity as the original subjects in their study in 1959. Besides, this extensive technique of GP should be revisited for the different ethnic and racial populations because of the large disparity among studies related to the applicability of the original Greulich and Pyle atlas.46,47 For this reason, a new digital hand atlas was created in order to collect up-to-date data from healthy Asian, African American, white and Hispanic children in the United States.48

As for the reliability of cervical vertebral methods for assessment of skeletal age, Hassel and Farman49 reviewed lateral cephalometric and left hand-wrist from the Bolton-Brush Growth Study at Case Western Reverse University to develop an index based on the lateral profiles of the second, third and fourth cervical vertebrae. They stated that the cervical vertebral analysis had a comparable high reliability and validity as the hand-wrist bone analysis in the assessment of individual skeletal maturity.

Further studies50-52 were considered, concluding that vertebral analysis on a lateral cephalogram is as valid as the hand-wrist bone analysis.

**CONCLUSION**

Bone age is a state of skeletal maturity and its assessment is a frequently employed procedure in pediatric practice. Many diseases and syndromes affecting growth result in a significant discrepancy between bone age and chronological age. A quantitative assessment of skeletal maturity is also useful for predicting adult height.

Skeletal maturation is generally determined by using stages in the ossification of bones of the hand and wrist because of the quantity of different types of bones available in the area. There are two common approaches to bone age assessment based on the hand-wrist radiograph: Greulich and Pyle and Tanner-Whitehouse methods. The skeletal evaluation is also determined by the analysis of cervical vertebrae.

It should be kept in mind that:
- The gold standard remains the hand-wrist Greulich and Pyle matching method in different medical specialties, especially in pediatrics, because of its practicality. As the bones do not develop at the same rate, the Tanner-Whitehouse technique was considered for its accuracy.
- The subjective nature of Greulich-Pyle method and the considerable complexity of TW2 method, make the automation of bone age assessment a highly...
desirable goal, in order to assist the radiologist in performing a more objective, fast and accurate analysis without the intrinsic variability of human activities.

- By using a routinely taken diagnostic radiograph (lateral cephalometric), the orthodontist would have a reliable diagnostic tool to aid in formulating treatment options without the need for an additional radiograph. But CVM method is only used by orthodontists and is not universal.

- The sonography-based technique (ultrasound) may be a possible alternative to conventional methods for the assessment of skeletal age but still, the discrepancy between results of diverse studies made the applicability of this technique not current yet.

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Correspond with:
Chimène Chalala
chalalachimene@yahoo.com
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Premolar and additional molar extraction in treating Class II high angle patients: a case report.

Elie William Amm*, Dr. Chir. Dent., DES Ortho.

Abstract

The purpose of this paper is to present a report of a Class II high angle patient. The treatment points out the advantages of premolar extraction and the unusual additional molar extraction along with a high pull head gear (HPHG) to control vertical dimension while correcting the sagittal discrepancy.

INTRODUCTION

Premolar extraction is still widely used for correction of tooth arch discrepancy, sagittal discrepancy and profile convexity. However, extraction for vertical control purposes is not well explored in the orthodontic literature and the advantage of molar extraction is underestimated.

The dogma stating that first molar is the “key of occlusion” leads many clinicians to abide by it in all cases to the extent that some finish their cases with additional premolar extraction and a contact between canine and first molar, and this to correct a residual overjet and Class II molar relationship after four premolar extractions.1,2

Merrifield3 suggested that in Class II patients with an anterior deficit larger than 16 mm and an ANB difference larger than 9º, first molars could be extracted after four premolar extractions.

When premolar extraction alone does not yield enough space for the correction of excessive overjet and Class II molar relationship, the clinician faces two options: Class II mechanics or additional extractions.

Moving the first molars distally is difficult and requires from the patient to wear head gear; the net space available for anterior retraction is also much smaller. Moreover, moving first molars distally produces a “wedge effect” and worsens the high angle tendency.4

In this case report, we present a high angle Class II malocclusion patient treated with four premolars and additional first molar extraction.

DIAGNOSIS AND ETIOLOGY

The patient is a Lebanese girl aged 12 years 11 months. She was seeking orthodontic treatment because she was self-conscious of her teeth.

Clinical examination showed a symmetrical face, incompetent lips with contraction of mental muscle, convex general profile and a retrusive chin (Fig. 1).

Analysis of intra-oral photographs and the plaster models (Fig. 2) showed a Class II division 1 malocclusion with an overjet of 5 mm, and an overbite of 80%. Upper midline was deviated 1 mm to the right. Upper cuspids were in an ectopic blocked out position in buccal mucosa which was the result of lack of space in maxillary arch. In mandibular arch, tooth arch discrepancy was 5 mm in anterior portion and 2 mm in the buccal portion, while depth of the curve of Spee was 2 mm.

Radiographic analysis of panoramic radiograph showed incomplete eruption of mandibular second molars and presence of third molars at the crown formation stage (Fig. 3).

Lateral cephalogram analysis showed a skeletal Class II relationship (ANB=9º) due to a retrognathic mandible (SNB=72º), with a hyperdivergent pattern (FMA=32º, FHI=.62º). Mandibular incisors were significantly proclined (FMIA=47º, IMPA=101º). The Z angle (66º) indicated a convex profile due to the
Figure 1. Pre-treatment photographs.

Figure 2. Pre-treatment dental casts.
retrusive chin (Figs. 4, 5). The complete differential diagnostic analysis sheet is shown in annex 1.

TREATMENT OBJECTIVES
1. Improve sagittal skeletal relationship between maxilla and mandible: reduce or maintain SNA angle and encourage mandibular anterior growth.
2. Maintain vertical dimension and control clockwise rotation of mandible.
3. Reduce overjet and incisors protrusion.
4. Respect all limits of dentition.
5. Improve lip incompetence and harmonize facial profile.

TREATMENT ALTERNATIVES
Three treatment options were considered:
Option 1: extraction of four first bicuspids along with Class II mechanics. Third molars would be also extracted.
Option 2: extraction of maxillary first bicuspid and mandibular second bicuspids along with third molars extraction.
Option 3: extraction of four first bicuspids, maxillary first molars and mandibular third molars.
Option 3 was selected because it was the best means to correct the malocclusion, maintain vertical dimension and improve facial profile.

TREATMENT PROGRESS
Sequential directional forces system with .022 standard edgewise single brackets were used. Treatment duration was 32 months.
Denture preparation: After extracting the 4 first bicuspids, mandibular first molars were banded and the rest was bonded sequentially, and the first wire was .018x.025 SS. Retraction of mandibular cusps and vertical control were ensured by a HPHG j-hook. Maxillary arch was bonded sequentially, the first wire was .017x.022 SS bypassing maxillary cusps.
After alignment of mandibular arch, lateral incisors were bonded and retraction of mandibular cusps was continued with power chains. In maxillary arch, after eruption of cusps, bonding was completed and HPHG j-hook was used to retract them.
At this stage, all rotations were corrected and both arches were leveled and aligned.
Denture correction: Mandibular second molar was bonded and mandibular incisors were retracted by a .019x.025 SS closing archwire. The upper space was closed by a .020x.025 SS closing archwire.
At this stage, overjet and Class II relationship remained uncorrected; the decision was made to extract maxillary first molars (fig. 6).

Maxillary cuspids and bicuspsids were retracted using the HPHG j-hook to a Class I relationship, spaces were then closed reciprocally using a .020x.025 SS closing archwire.

At this stage, all spaces were closed, overjet and overbite corrected, and Class I relationship established.

**Denture completion:** final space closure and alignment were done. Black triangle between maxillary central incisors was arranged by a minor stripping to improve contact and esthetics (fig. 6).

**Denture recovery:** Mandibular lingual retainer was bonded from cuspid to cuspid. Patient was given a wraparound retainer and instructed to wear it 24 hours per day for one month and at night time thereafter.

**TREATMENT RESULTS**

The final lateral cephalogram and cephalometric analysis are shown in figures 7 and 8. There was no favorable forward mandibular growth, however sagittal relationship between maxilla and mandible improved from an ANB of 9º to 6º and vertical dimension was controlled with counter-clockwise rotation of mandible (FMA form 32º to 29º and the FHI from .062 to .067).

Maxillary incisors were retracted and moved backward without tipping (Figs. 9, 10), overjet was reduced form 5mm to 1mm and overbite from 80 % to 5%, with a mild overcorrection. Maxillary first molar
### Annex 1: Differential diagnosis analysis

**Patient’s First Name:** XXX  
**Init.:** X  
**Last Name:** XXXXXXX  
**Begin TX Age:** 12y 1m  
**Sex:** F  
**Birthday:** 23/11/1990  
**Treatment Time:** 32 Months

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- **FMIA:** 67  
- **FMA:** 25  
- **IMPA:** 88  
- **SNA:** 82  
- **SNB:** 80  
- **ANB:** 2  
- **AO-BO:** 0 mm  
- **OCC PLANE:** 10  
- **Z ANGLE:** 75  
- **UPPER LIP:**  
  - **TOTAL CHIN:** mm  
  - **POST. FACIAL HT.:** 45 mm  
  - **ANT. FACIAL H1.:** 65 mm  
  - **FAC. HT. INDEX:** 0.70  
  - **FAC. HT. CHANGE:** xxxxxx
  - **MAND. CUSPID WIDTH:** 27 mm  
  - **MAND. MOLAR WIDTH:** 47 mm  

**Cranial Facial Analysis**

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**Total Space Analysis**

- **Anterior Tooth Arch Disc.:** -5  
  - **Headfilm Disc.:** -14  
  - **Total:** -19  
- **Mid Arch Tooth Arch Disc.:** -2  
  - **Curve of Spee:** -2  
  - **Total:** -4  
- **Horizontal Occlusal Disharmony:** -10  
- **Posterior Tooth Arch Disc.:** -28  
  - **(-) expected Increase:** -8  
  - **Total:** -10  

**Space Analysis Total:** -33  
**DIFFICULTY INDEX:**

- **Mild:** 0 - 60
- **Moderate:** 60 - 120
- **Severe:** over 120

**DIFFICULTY INDEX:**

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**Figure 8.** Post-treatment cephalometric tracing.

**Figure 9.** Cephalometric tracing superimposition on SN at S.

**Figure 10.** Maxillary composite and mandibular composite superimpositions.

**Figure 11.** Post-treatment photographs.

**Figure 12.** Post-treatment dental casts.
position was distalised and intruded.

Mandibular incisors were retracted and mandibular molars uprighted without extrusion (Figs. 9, 10).

Dental and facial changes are obvious by comparing pre-treatment and post-treatment dental casts and photographs (Figs. 11, 12).

Final panoramic radiograph showed acceptable root parallelism and no signs of root resorption (Fig. 13). Facial profile became harmonious and less convex, and lip incompetence was improved (Fig. 14).

**DISCUSSION**

In high angle cases, Class II mechanics always lead to vertical undesirable reactions; the distal movement of maxillary denture and the side effect of the Class II elastics on mandibular arch create a clockwise rotation of the mandible and worsen the Class II high angle situation. To prevent these unwanted results in high FMA cases where bicuspid have been extracted for intra-arch deficit, the clinician must consider molar extraction to correct Class II relationship. 5

Guidelines provided by Merrifield 3 can always be a good diagnostic decision tool; in our case, anterior deficit was 19mm, ANB was 9º and FMA 32º, where these factors make the extraction decision of 4 bicuspid and maxillary first molars justifiable. In addition to these advantages, Class II mechanics require more patient cooperation than molar extraction. 2

If post-treatment facial balance is to be a reality for patients with average to high FMAs, the following three objectives are proposed by Klontz 6:

**Objective 1:** mandibular incisors must be uprighted over their bony support after treatment; in line with this objective, it would have been more desirable if lower incisors were more uprighted and retracted in our case. But we overtorqued anterior portion of the closing archwire and there was lack of compliance from the patient in wearing the HPHG J-hook for the mandibular cuspids retraction. We were lenient in order to encourage patient’s cooperation for maxillary retraction before and after molar extraction.

**Objective 2:** maxillary anterior tooth position must be controlled; Even though we did not get a favorable sagittal mandibular response, and the uprighting of mandibular incisors was insufficient, profile and lip incompetence were improved. This improvement was probably due to the retraction and torque control of maxillary incisors as shown by Ozaki and co-workers. 4

**Objective 3:** posterior vertical dimension control; During treatment, FMA decreased from 32º to 29º and FHI increased from .62 to .67, indicating mandibular counterclockwise rotation and good vertical control. 7

This is indebted to favorable vertical mandibular response on one hand, and to vertical control of mandibular first molars and maxillary second molars (in a more intruded position of maxillary first molars) on the other hand.

One of the most challenging phases in these treatments is the recovery phase; mandibular third molars must be extracted and evolution of maxillary third molars must be controlled. Orthodontists should be careful not to order removal of third molars too early.
REFERENCES

Correspond with:
Elie William Amm
elieamm@hotmail.com
Treatment of a Class II division I preadolescent patient with congenitally missing mandibular central incisor and second premolars.

Saro Ghougassian¹, Dr. Chir. Dent., DES Ortho., Zouhair Skaf², Dr. Chir. Dent., DU Ortho.

Abstract

This case report describes the orthodontic treatment of a preadolescent girl with congenitally missing mandibular central incisor and second premolars, presenting a Class II malocclusion. Management of mandibular second premolar agenesis is emphasized. Keeping the deciduous molars was the adopted treatment option. The age of the patient and the type of her malocclusion were influencing factors in the treatment planning.

INTRODUCTION

Congenital absence of teeth is often a challenge to dental practitioners and its treatment involves more than a discipline in dentistry. The most frequently absent tooth, after the third molar, is the mandibular second premolar. A prevalence of 2.5% to 4% is reported in the literature, with the agenesis being bilateral in 60% of the time¹⁻². Some studies found out that maxillary lateral incisors are more frequently absent than mandibular second premolars³⁻⁴. Several treatment options are available, but factors such as timing of diagnosis, sagittal occlusion, tooth size/arch length discrepancy and the condition of the deciduous second molar orient the treatment in one direction or another. This case report describes various treatment alternatives for managing congenital absence of mandibular second premolars when a mandibular central incisor is also missing, and a Class II division I malocclusion is present in a growing patient.

HISTORY

An 11 years 9 months old girl presented for an orthodontic evaluation at the department of Orthodontics at the Lebanese University, School of Dentistry. Her chief complaint was the protrusion of the maxillary incisors. She was in good health. Dental history included trauma to the maxillary left central incisor, four years earlier, that had resulted in an incisal edge fracture. The parents were not aware of the congenital absence of teeth nor did they report the occurrence of missing teeth in the family. The patient was in a prepubertal stage of maturation.

DIAGNOSIS

The patient had a convex profile with lip incompetence at rest. The lower lip was interposed between maxillary and mandibular incisors due to excessive overjet. Less than full crown of the maxillary incisors was displayed upon smiling (Fig. 1).

Intra-oral examination showed coincident maxillary and mandibular midlines which were aligned with the facial midline; a proper transverse occlusion and a deep bite of around 50%. In the sagittal dimension, the occlusion was a full Class II molar and canine on both sides with an overjet of 10.5 mm. Deciduous second molars and left central incisor were present on the ovoid-shaped mandibular arch. The maxillary arch was tapered and the right second molar was the only remaining primary tooth. There was excess space of 2mm in the mandible and 4.5mm in the maxilla. An anterior tooth size discrepancy was present, indicating a mandibular excess. The periodontium appeared healthy with an acceptable oral hygiene despite the presence of staining on maxillary posterior teeth (Fig. 2).

On the panoramic radiograph, it was observed that the mandibular second premolars and the left central incisor were congenitally missing. All third molar buds
were present. The maxillary right second premolar had not erupted yet (Fig. 3). Periapical radiographs showed that almost half of the roots of the mandibular deciduous second molars were resorbed. The mandibular deciduous central incisor presented a completely resorbed root (Fig. 5).

Cephalometrically, the patient had a decreased lower facial height, a retrognathic mandible in a skeletal Class II relationship with the maxilla. The facial pattern was normodivergent, the maxillary incisors were proclined, whereas the mandibular incisors were well positioned. Holdaway line showed a convex subnasal profile (Fig. 4, Table 1).

A hand-wrist radiograph indicated a skeletal maturation age of 12 years using the templates of Greulich and Pyle5 (Fig. 4).

Functional examination showed inadequate protrusive and excursive movements, but no signs and symptoms of temporomandibular joint dysfunction were noted.

**TREATMENT OBJECTIVES**

A major treatment objective is the management of the congenital absence of three mandibular teeth. Equally important objectives are the correction of the mandibular retrognathism and subsequently Class II malocclusion. The spaces for mandibular second premolars and the left central incisor could be either maintained or closed. Orthopedic correction of the mandibular retrognathism was to be addressed, reducing the facial convexity and correcting the Class II dental occlusion. Another contributing factor in reducing facial convexity is the retroclination of maxillary incisors, which would also eliminate lip incompetency and lower lip interposition. Proper overjet and overbite had to be achieved for a better functional occlusion. This last objective cannot be achieved if the treatment plan includes the closure of the space of the missing mandibular left central incisor. The option of preparing a space for a central incisor implant was disregarded due to the lack of supporting data on the success of such a treatment modality. The first option consisted of the extraction of mandibular deciduous second molars and space closure. This would eliminate the need for future restorations. Nevertheless, there were many disadvantages for this treatment modality: space closure would lead to a retroclination of the mandibular incisors, which are well positioned. The subsequent maxillary incisor retraction, in its turn, would affect the profile negatively. Another disadvantage would be the resulting Class III molar relation, which is undesirable from an occlusal perspective. A longer treatment duration is considered an additional disadvantage.

A second option included the maintenance of mandibular deciduous second molars. Because deciduous second molars are mesiodistally larger than the replacing premolars, the resulting occlusion would present an edge to edge Class II molar relationship. Although more conservative, this option compromises the final occlusion.

A third option of preparing space for future restorations was discussed. It would require a relatively shorter treatment time, minimize the retroclination of mandibular incisors as an adverse effect and finish with Class I molar relationship. Having a Class I molar- Class I canine occlusion as an objective requires a mesiodistal reduction of deciduous second molars to the size of a second premolar. Deciduous molars would be maintained in the arch until the timing of implant restoration to avoid bone loss.

**TREATMENT PROGRESS**

The third option was adopted after explaining the treatment alternatives to the patient and her parents and obtaining their informed consent. Treatment was started using an activator for the orthopedic correction of mandibular retrognathism, as a first phase. The patient was then 11 years 10 months old. An overcorrected Class I canine occlusion was obtained 7 months after orthopedic treatment. At this stage, the maxillary right deciduous second premolar had not exfoliated yet. The patient was referred for the
A hand-wrist radiograph indicated a skeletal maturity of 12 years using the Ghougassian S.

Functional examination showed inadequate protrusive and excursive movements, but no

Figure 1. Pre-treatment facial photographs.

Figure 2. Pre-treatment intra-oral photographs.

Figure 3. Pre-treatment panoramic radiograph.

Figure 4. Pre-treatment hand-wrist and lateral cephalometric radiographs.

Figure 5. Pre-treatment periapical radiographs.
extraction of this tooth along with the mandibular deciduous incisor to enhance the eruption of the maxillary right second premolar and benefit from the spontaneous space closure in the mandibular incisor region by the drifting of adjacent teeth. Meanwhile, the activator was used to retain sagittal correction. Twelve months into treatment, .022 x .028-in edgewise brackets were bonded on all maxillary teeth, including the right second premolar which had erupted.

Similar brackets were bonded on mandibular teeth bypassing deciduous second molars. Both arches were leveled and aligned using .016-in NiTi wires. At 14 months into treatment, mandibular deciduous second molars were reduced mesiodistally using a carbide bur. About 1.5 mm of enamel from each tooth was removed. Elastomeric chains were used to close the remaining spaces on a .018-in stainless steel wire. Wires as high as .019 x .025-in stainless steel in the maxilla and .017 x .025-in stainless steel in the mandible were reached at 20 months into treatment. A second round of mesiodistal enamel reduction, of around 1 mm per tooth, was performed on mandibular deciduous second molars, followed by polishing of the stripped surfaces with Fine and Ultrafine polishing disks. Full time Class II elastics (1/4-in, 4.5 oz.) were delivered bilaterally to close the created spaces and achieve a Class I molar occlusion. Six months later, Class II elastics were stopped and finishing bends were applied on the maxillary six anterior teeth to adjust the root parallelism as assessed on a progress panoramic radiograph. Archwire coordination and the application of a labial root torque on the maxillary left central incisor had already been started 5 months earlier. The appliances were removed after a total treatment duration of 30 months. A maxillary Hawley appliance and a mandibular fixed .0215-in multistranded wire were used for retention.

**TREATMENT RESULTS**

Treatment resulted in a better facial harmony. Lip incompetency and lower lip interposition were eliminated due to maxillary incisor repositioning. A straight facial profile was obtained (Fig. 6). Intraorally, a better maxillary incisor inclination was established. The maxillary midline was coincident with the middle of mandibular central incisor. Because one mandibular incisor was missing, a less than ideal overbite and overjet relationships were obtained. A Class I molar and canine occlusion was achieved, with proper interdigitation of the buccal segments. No interferences were noted in protrusion and laterality. The reshaped mandibular deciduous molars appeared like second premolars in shape and size, which favored the proper seating of the occlusion. Excess space was eliminated in the maxillary arch, achieving a proper alignment and well coordinated ovoid-shaped arches (Fig. 7).

Post-treatment panoramic radiograph showed parallel roots except for maxillary lateral incisors that could have benefited from an additional positive angulation. More space was provided for the eruption of mandibular third molars, which should be monitored as they develop. Mandibular deciduous second molars underwent root resorption and almost one fourth of their roots were still present on the arch at the end of treatment (Fig. 8, Fig. 10).

The lateral cephalometric radiograph and

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**Table 1.** Pre-treatment and post-treatment cephalometric measurements.
Figure 6. Post-treatment facial photographs.

Figure 7. Post-treatment intra-oral photographs.

Figure 8. Post-treatment panoramic radiograph.

Figure 9. Post-treatment lateral cephalometric radiograph.

Figure 10. Post-treatment periapical radiographs.

Figure 11. Superimpositions: Pre-treatment (—) and post-treatment (—)
superimposed tracings showed favorable skeletal and dental changes with treatment. A more anterior and downward position of the mandible was observed due to orthopedic treatment and growth, improving both chin extension and lower facial height. Some growth of the nose occurred as expected at the patient’s age. The maxillary incisors were retruded and a minor repositioning of the mandibular incisors was noted. The above mentioned changes led to a harmonious soft tissue profile as indicated by the Holdaway line (Fig. 9, Fig. 11, Table 1).

DISCUSSION
Space opening was adopted for this patient for the many advantages it presented: implants placement was delayed until the end of growth, since they are known to impede normal alveolar growth leading to infraoccluded crowns in growing individuals. The appropriate age for implant placement is determined by the cessation of vertical facial growth by superimposing serial cephalometric radiographs. It is established that, on average, girls’ facial growth continues until about 17 years of age, whereas the boys’ average growth is complete at about 21 years of age. According to the latest reports, the overall survival rate of posterior single-tooth implants is 98.9%, with minimal complications on adjacent natural teeth, at 10-year evaluation. On the other hand, extracting deciduous molars and waiting until the completion of growth would result in bone loss at the edentulous areas and compromise future implant placement.

For the above mentioned reasons, an appropriate strategy is to maintain deciduous molars in the arch, after reducing them mesiodistally to the size of second premolars. This procedure allows a proper fitting of the occlusion with a Class I molar and canine relationship. A concern is the divergence of the deciduous molar roots that may lead to a root contact during space closure. In this situation, the deciduous tooth’s roots will resorb and will be replaced by bone, preparing an ideal site for implant replacement. A common question is the susceptibility of these teeth to caries. Recent studies show that it is possible to obtain, after stripping, well polished surfaces that are comparable to unaltered enamel on both permanent and deciduous teeth. Moreover, in teeth that underwent mesiodistal stripping, no increase in the incidence of caries was reported at 10-year evaluation.

More treatment options would have been available if the patient was seen at a younger age. Extraction of deciduous second molars, before the eruption of the permanent first molars is believed to create favorable conditions for spontaneous space closure and to cause minimum tipping of the molars. However, diagnosis at this age is unreliable due to the wide range of variability in the calcification of mandibular second premolars. To avoid misdiagnosis, it is recommended to delay extraction of deciduous second molars till the age of 9, which will also result in a spontaneous closure of the majority of the space, provided that the extraction is carried out before complete root development of the mandibular first premolar and before the emergence of the second permanent molar.

Controlled slicing and hemisection treatment are described in the orthodontic literature as ways to minimize anterior loss of anchorage and the resulting negative effect on the facial profile. The technique consists in the sequential trimming of the distal surface or amputating the distal root of deciduous second molars in order to enhance a spontaneous mesial movement of permanent first molars and prevent any distal drift of anterior teeth. Though, again, significantly poorer results were obtained in older patients (10 to 11-years-old) compared to 8 to 9-year-old patients.

Autotransplantation of teeth could have also been considered for this patient. High success rates were found especially when root formation is not complete. Although the third molars, undergoing root development, could be used as donor teeth, their size would prevent a proper fitting of the occlusion.

A more conservative option would have been to maintain deciduous second molars in situ without any alteration of their size and shape. Reports indicate high survival rates of these teeth on the long term. According to one study, only 7% of mandibular deciduous second molars were lost due to root resorption, infraocclusion or caries, from 12 years of age to adulthood. Earlier studies report survival rates
of more than 96% on the long term\textsuperscript{23,24}. It must be borne in mind that these studies included deciduous molars presenting at least three fourths of their roots, which was not the situation in this patient. The present option has two disadvantages. A first common disadvantage is the resulting compromise on the molar occlusion, since deciduous second molars occupy a larger mesiodistal space than second premolars. A second disadvantage, in this particular patient, is that her deciduous molars had half of their roots resorbed at the initial examination. Since a considerable amount of root resorption is expected until age 20, according to the previously mentioned studies\textsuperscript{22,23}, the patient would be left with insufficient amount of root substance on the deciduous molars at adulthood. Therefore, this treatment modality could not be considered as permanent solution for the present patient.

Conventional or resin-bonded bridges could be substitutes for implant restorations. Despite their high long-term survival rate\textsuperscript{25}, preparation of abutment teeth for conventional bridges require the removal of a considerable amount of tooth substance, compromising pulp vitality in young patients. The prognosis of resin-bonded bridges as permanent restorations is questionable.

An ideal approach would be to eliminate the need of any prosthetic replacement in the future by extracting the deciduous molars and closing the spaces. Today, with the use of mini-implants, the negative effect of retroclination of mandibular incisors can be avoided\textsuperscript{26}, but the disadvantage of a resulting Class III molar relation is still present, which is undesirable from an occlusal standpoint.

REFERENCES


Correspond with:
Saro Ghougassian
saro_gh@hotmail.com
Nonsurgical treatment of a severe anterior open bite: a case report.

Chadi Kassir¹, BDS, DES Ortho., Antoine Saadé², Dr. Chir. Dent., CES Ortho., DU Ortho., CECSMO

Abstract

Open bite malocclusion has long been considered a great challenge to orthodontists because its etiology is generally multifactorial and can be due to a combination of skeletal, dental and soft tissue factors. Many treatment modalities to correct open bites have been proposed (orthognathic surgery or dental compensations). Dental compensation, such as intruding posterior teeth, uprighting and extruding anterior teeth is a feasible option for patients with originally proclined incisors. This article illustrates the successful orthodontic treatment of a severe anterior open bite case complicated with severe crowding in mandibular arch, treated with extractions of maxillary and mandibular premolars.

A 27 years 7 months female presented with an anterior open bite of 10 mm and 15 mm of overjet, increased facial height, and severe crowding in mandibular arch. The orthodontic treatment consisted of extracting maxillary and mandibular first premolars and the mandibular left supernumerary premolar to retract the upper incisors and to relieve the lower crowding. After active treatment of 30 months, Class I molars and canines occlusion was achieved with proper overbite and overjet. Retraction of maxillary incisors helped correct the anterior open bite.

INTRODUCTION

The anterior open bite was described by Subtelny and Sakuda¹ and Worms and co-workers² as a negative overbite between incisal edges of maxillary and mandibular teeth, with posterior teeth in occlusion.

Etiology of anterior open bite is generally multifactorial and can be due to a combination of skeletal, dental and soft tissue disharmonies. Many potential causative factors have been considered, including unfavorable growth patterns,³⁴ digit sucking habits,⁵⁻⁷ enlarged lymphatic tissue,⁵⁻⁸ heredity⁶⁻⁹ and oral functional matrices.¹⁰ Most anterior open bite cases are characterized by excessive gonial, mandibular and occclusal plane angles, short mandibular body and ramus, increased lower anterior facial height and decreased lower posterior facial height, decreased upper anterior facial height, retrusive mandible, Class II tendency, divergent cephalometric planes, steep anterior cranial base¹¹, intrusion of incisors and overeruption of molars which are the most common causes of anterior open bite¹²⁻¹⁵ and inadequate lip seal³. Some studies have found a correlation between orofacial musculature and facial structure, suggesting a relationship between weak musculature and a long face/anterior open bite pattern.¹⁶, ¹⁷

Skeletal anterior open bite is one of the most difficult malocclusions to treat orthodontically. The treatment of severe anterior open bite in adult patients consists mainly of double jaw surgery. However, there are some patients who do not wish to undergo surgical treatment because of its risks. For such patients, various alternatives can be considered: molar intrusion with temporary anchorage devices, vertical-pull chin cups, multiloop edgewise archwire therapy, extraction therapy¹⁸ and nickel-titanium wire with intermaxillary elastics.¹⁹ Extrusion or eruption of anterior teeth is also a common method of bite closure. Finally, extrusion of maxillary anterior teeth might compromise esthetics. For all of these reasons, closing anterior open bites by dental extrusion is contraindicated in certain patients especially those who display gingiva upon smiling.²⁰

The following case report illustrates the treatment
of a skeletal Class II malocclusion with severe crowding in mandibular arch, an anterior open bite of 10 mm and a severe hyperdivergence.

**CLINICAL PRESENTATION**

A female, 27 years 7 months old, presented to the Orthodontic Department at the Lebanese University, seeking orthodontic treatment. The patient’s chief complaints were proclined maxillary anterior teeth and crowding in mandibular arch.

Extra-oral features: Pre-treatment facial photographs (Fig. 1) show a convex profile, an acutenasolabial angle, an increased lower facial height, lips incompetency at rest and inadequate extension of the chin. When she smiles, less than full crown of the maxillary incisors are shown as well as mandibular incisors display.

Intra-oral features and study model analysis: The pre-treatment intra-oral photographs and dental casts (Fig. 2) revealed an anterior open bite of 10 mm with an overjet of 15 mm. In addition, two distinct occlusal planes were present in maxillary arch. Severe crowding was noticed in mandibular arch with the canines completely blocked out as well as the left first premolar and a supernumerary premolar were lingually blocked. Maxillary dental midline was on, coinciding with the facial midline and the lower midline was deviated 2mm to the right. Sagittally, molars were in class III of 2mm, canine on the right side was in Class III and the canine on the left side was in full Class II. Maxillary arch was V-shaped and mandibular arch parabolic.

**Radiographic findings**

Mandibular right first molar was restored, mandibular canines and premolars were mesially inclined and a supernumerary tooth was noticed between maxillary central incisors (Fig. 3).

The initial cephalometric analysis (T1) (Fig. 3) showed a skeletal Class II relationship (ANB=7º) with bimaxillary protrusion (SNA=91º) (SNB=84º). Mandibular plane angle was very steep and the gonial angle severely increased (MP/FH=36º), but the mandibular body length and ramus height were within normal ranges. Maxillary incisors were severely proclined (U1/SN=117º), while mandibular ones were retroclined (L1/MP=81º) (Table 1).

The patient was a mouth breather and had a tongue thrust at rest. Temporo-mandibular joint examination revealed clicking on both sides with bayonet closure. She did not report any joint pain. However, after consultation with an occlusion specialist, it was decided to start orthodontic treatment since the patient’s symptoms were not severe.

**TREATMENT OBJECTIVES**

The ideal treatment objectives were the following:

- Extra-orally: correct convex profile, decrease lower facial height, and widen maxilla to improve the V-shaped arch form.

- Intra-orally: achieve a Class I molar and canine relationship with ideal overjet and overbite, relieve
Figure 2. Initial intra-oral and study models photographs.
crowding and extract supernumerary mandibular premolar.

**TREATMENT ALTERNATIVES**

Two treatment alternatives were suggested to the patient:

The first option consisted of a combined orthodontic and orthognathic surgery treatment: a double jaw surgery with maxillary anterior set down and set back and mandibular advancement to correct the convex profile and achieve an optimal occlusion. The orthodontic preparations would consist of maxillary and mandibular first premolars extraction to relieve crowding and achieve a Class II canine relationship before surgery.

The second option (nonsurgical) consisted of extracting maxillary and mandibular first premolar and mandibular supernumerary premolar to retract maxillary incisors and close anterior open bite, relieve crowding in mandibular arch and correct class III molars and class II canine on the left side.

The third option is similar to the second plus a genioplasty.

**TREATMENT PLAN**

The first treatment alternative was recommended to the patient. As the surgery was judged risky by the patient, she opted for the second option, with four first premolars extraction.

**TREATMENT PROGRESS**

After caries control and oral hygiene instructions, Nance and transpalatal bars were cemented on maxillary first molars. 0.022-0.028 inch slot preadjusted edgewise appliances (Roth prescription) were placed in both arches with maxillary incisors bypassed. Stainless steel arch was used passively in mandibular anterior region to prevent any flaring. The four first premolars and mandibular supernumerary tooth were extracted when a 0.018 inch stainless steel wire was reached. Maxillary and mandibular canines were distalized with double J-hooks on maxilla and mandible since maximum anchorage was planned.

Stripping for mandibular left second premolar was done to have symmetrical mandibular premolars. The patient was instructed to wear the double J-hooks 10
hours per day. While maxillary and mandibular canines were being distalized, bite closure was noticed due to space created for maxillary incisors to align. Maxillary incisors were bonded once the space was enough for their alignment. Retraction of maxillary anterior teeth was done by closing loops mechanics. Posterior vertical elastics were delivered to achieve good interdigitation and help closing the bite. The fixed appliances were removed when a good overbite and overjet were achieved and a maxillary Hawley retainer was delivered (some acrylic was removed anteriorly as a tongue position reminder). In addition, a maxillary 2-2 and a fixed mandibular 3-3 retainers were bonded (0.215 inch twist flex). Total treatment time was 30 months. Retention was mainly directed toward preventing relapse in the vertical dimension. The patient was instructed to wear her maxillary Hawley retainer for 6 months, full time, then for 6 months at night only then at night, 3 times a week. The lingual retainers were planned to be kept permanently to enhance long-term stability of the results.

RESULTS

The treatment objectives were achieved, due in part to the perfect patient cooperation with the double J-hooks, intraoral elastics and to optimal oral hygiene.

Extra-oral features: Profile convexity improved as well as lip closure. When the patient smiles a maxillary arch expansion can be noted as well as full vertical maxillary crown display (Fig. 4).

Intra-oral features and study model analysis: Post-treatment intraoral photographs and study casts (Fig. 5) show bilateral Class I molars and canines relationships. Both dental midlines were fairly aligned with the facial midline, and optimal overjet and overbite were achieved.

Radiographic findings: The post-treatment cephalometric tracing and superimposition analysis revealed a similar ANB angle as T1 (Figs. 6, 7; Table 1). No significant clinical changes in the vertical measurements were noticed, indicating that the mechanics used controlled the vertical movement of posterior teeth (Fig. 6, Table 1). Maxillary incisors were extruded and retroclined, mandibular incisors were slightly proclined and extruded. Soft-tissue analysis revealed an improvement in lower third convexity by backward position of lower lip according to the Holdaway line which improved the lip closure at rest.

The post-treatment panoramic radiograph showed that teeth roots were fairly parallel. Supporting tissues appeared healthy and no root resorption was noticed, even though a supernumerary tooth was present between maxillary central incisors, since no interference with their movement was present (Fig. 6).

The extraction in maxillary arch allowed anterior teeth to be retracted, thus helping in the bite closure and the overjet reduction. This method results in an effective treatment for anterior open bite where the maxillary incisors are originally proclined.

DISCUSSION

Skeletal open bite is ideally treated with a
Figure 5. Final intra-oral and study models photographs.
combination of orthodontics and orthognathic surgery. The advantages of surgical option are that overbite can be overcorrected, gummy smile corrected and post-treatment stability is better than that with a nonsurgical option\textsuperscript{22}. In a nonsurgical plan, orthodontic treatment consists of camouflaging skeletal discrepancies to an extent that overcorrection, esthetics and functional concerns can be achieved as much as the case can allow. According to Hiller\textsuperscript{21}, nonsurgical correction usually requires longer treatment and is more difficult, especially for stability and retention.

This case report documents successful orthodontic treatment of an adult patient with a severe hyperdivergent pattern characterized by an open bite, overjet and severe crowding in mandibular arch that was originally intended to be treated with surgery to achieve the ideal objectives of treatment, but the patient refused surgery and the nonsurgical option was chosen.

Extraction of maxillary and mandibular premolars to relieve crowding and allow maxillary incisors retraction and step down on maxillary incisors with anterior vertical elastics were used to achieve an ideal overbite.

Simple extrusion of anterior teeth to correct open bite has been criticized as being unstable, and Ellis and McNamara\textsuperscript{23} even reported that vertical height of anterior maxilla was already increased in the open bite group. Our patient could afford some extrusion of maxillary incisors so a full crown would be displayed upon smiling.

According to Sarver and Weissman\textsuperscript{24}, some adult patients with anterior open bite can be treated nonsurgically with extraction and retraction of anterior teeth. They discussed clinical results using extraction and retraction for dental open bite correction. Patients who are candidates for this type of therapy should meet the following criteria: (1) proclined or procumbent maxillary or mandibular incisors, (2) little or no gingival display on smile, (3) normal craniofacial pattern, and (4) no more than 2 to 3 mm of maxillary incisor exposure at rest. According to those criteria, this case did qualify some of them.

Stability is a particular concern in open bite malocclusions.

The relapse rate ranges from 35% to 42.9% in the studies of long-term results of anterior open bite treated orthodontically as well as surgically\textsuperscript{22,25}.

Denison and co-workers\textsuperscript{22} reported that the cause of relapse was due to dentoalveolar changes rather than skeletal changes. Therefore, dental compensation is counterindicated in surgical cases. It is important to prevent labial flaring of incisors. Placing retainers with occlusal coverage may be helpful in preventing further molar eruption, especially in patients with remaining growth. The elimination of anterior open bite cause is primordial to enhance stability and decrease amount of relapse. In the case of abnormal tongue posture, placement of a tongue crib may improve stability in patients with post-treatment open bites. In selected cases in which tongue posture or function is an apparent factor, some form of crib therapy during or after treatment may offer promise to enhance stability\textsuperscript{26,27}. Prolonged retention with fixed or removable retainers is advisable and necessary in most
cases of anterior open bite treatment.

According to Lopez-Gavito and co-workers\textsuperscript{25} and Denison and associates\textsuperscript{22}, the high rate of relapse found in patients treated for an open bite may appear discouraging, and it should be noted that relapse rate included some patients who experienced a reduction of post-treatment overbite but did not progress to an open bite, thus overcorrection has to be the objective while treating open bites. Although correction of an open bite cannot always be perfectly maintained, there are many patients who will benefit considerably from treatment with only orthodontic appliances. Careful selection of patients with anterior open bite to be treated orthodontically can produce very acceptable and outstanding treatment results.

Chang and Moon\textsuperscript{28} reported that there is a difference in stability between open bite treatments that involve nonextraction versus extraction approaches. The extraction approach seems to be more stable.

Treating this patient nonsurgically did not improve the convex profile. Enhanced stability could also have been achieved with orthognathic surgery. However, dental objectives were achieved as far as overbite, overjet and alignment.

Genioplasty was suggested to the patient as an option to reduce lower vertical height and convexity by vertical reduction and advancement, the patient also refused this option.

**CONCLUSION**

The final treatment result of this hyperdivergent phenotype with an anterior open bite and severe crowding in mandibular arch was a great improvement in both function and esthetics, although stability of the open bite closure is questionable. The main reason this patient could be successfully treated nonsurgically was the initially proclined maxillary incisors and the smile which benefited from the retroclination of maxillary anterior teeth and the patient was very compliant.

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chadikassir489@hotmail.com
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Multidisciplinary management of an impacted maxillary central incisor due to a cyst-like lesion, a mesiodens and a supernumerary maxillary lateral incisor.

Antoine Darazé¹, BDS, Specialist Ortho./Dentofac. Orthop. (UCL), Marwan Hoteit², BDS, CES Ortho., DU Ortho., Hiba Younès³, BDS, DU Ped. Dent., Assaad Salloum⁴, BDS

Abstract

Delayed eruption of the maxillary central incisor is a commonly encountered problem during early mixed dentition in the anterior jaw. It has several etiologic factors and could compromise facial growth, other teeth eruption, occlusal development and self-esteem.

The present case describes the treatment sequence of a nine-year-old healthy child, who complained of an absent maxillary left central incisor. Radiographic examination revealed a mesiodens, a supernumerary lateral incisor and a cyst-like radiolucency as well as an impacted maxillary left central incisor. Treatment protocol included surgery. An orthodontic treatment followed spontaneous eruption of supernumerary maxillary lateral incisor replacing the extracted maxillary left central incisor. Follow-up and results after fifteen years are presented.

This case emphasizes the importance of a multidisciplinary management for a comprehensive and conservative treatment plan and delivers good care leading to a successful outcome.

INTRODUCTION

Tooth eruption is a physiologic process that appears to be regulated by genes, expressed in the dental follicle at chronologically specific times¹. However, variations in eruption sequence and emergence of teeth in the oral cavity are common¹.

Suri and co-workers² considered a normal biologic eruption time when dental root reaches approximately two thirds of its final length as the tooth erupts and delayed biologic eruption when tooth eruption occurs despite the formation of two thirds or more of the dental root².

They also defined the chronologic delayed tooth eruption when the eruption time is greater than 2 standard deviations (SD) from the mean expected for a specific tooth (chronologic norm of eruption). SD may be different for each tooth, lower for the early erupting teeth (about 0.5 years for incisors) and higher for late erupting teeth (about 1.5 years for cuspids, bicuspid and second molars)³. Tooth eruption is in general earlier in females than in males⁴.

It is not uncommon to observe, in children, variations in normal eruptive patterns of maxillary incisors. By virtue of location of these teeth, parents are often anxious when eruption patterns do not follow the norms and this will usually prompt the parent to seek orthodontic treatment in order to prevent psychological sequelae that might result from abnormalities of anterior teeth⁴. Therefore, when facing a delayed tooth eruption, orthodontists should gather information to eliminate the possibility of systemic conditions such as syndromes, vitamin deficiencies, hormonal disturbances or local conditions, like obstacles, trauma or even complete tooth agenesis before making a therapeutic decision.

In this patient, delayed eruption was due to the presence of a cyst-like radiolucency, two supernumerary teeth, one of them similar in size and shape to the associated tooth (maxillary left lateral incisor)⁵.

There are four morphological types of supernumerary teeth:
- Conical or peg-shaped (mesiodens)
- Tuberculate or invaginated
- Supplemental or incisiform
- Odontome-like4,6,7

Cysts could be classified into developmental (naso-palatine, globularo-maxillary…) and odontogenic (dentigerous, primordial, keratocyst, residual …)9.

These anomalies occur because developing teeth are negatively influenced by joint interaction of genetic and environmental variables9.

**CASE REPORT**

**Patient Evaluation**

A nine-year-old child presented with chief complaint of unaesthetic appearance resulting from the delay in eruption of left maxillary permanent central incisor while permanent laterals were fully erupted (Fig. 1).

A thorough evaluation was performed in order to establish etiology and treatment plan accordingly.

The patient was in good health. Clinical intraoral examination revealed an early mixed dentition stage in the mandibular arch (Fig. 2). The maxillary teeth showed a more advanced stage of eruption. Maxillary permanent left central incisor was absent, while permanent right central and both lateral incisors had already erupted. Intra-oral inspection and palpation of the anterior maxilla revealed signs of buccal and palatal bulgings (Fig. 2).

Orthopantomogram showed a maxillary impacted left central incisor located below nasal floor and a well-circumscribed cyst-like radiolucent lesion with a well-defined radiopaque margin on the upper anterior left side of the maxilla, a mesiodens and a supernumerary maxillary left lateral incisor (Fig. 3).

A tentative radiographic diagnosis of a follicular cyst was suggested. Lateral cephalogram showed a horizontal high position of the impacted maxillary left central incisor (Fig. 4).

**Treatment alternatives**

Different treatment alternatives were possible to manage this multidisciplinary case. The orthodontist’s task was to ensure the least hazardous and risky orthodontic treatment.

Extraction of the mesiodens and enucleation of cyst-like lesion was part of all treatment plans with
three alternatives:
1- Extract the impacted maxillary left central incisor as well as the supernumerary maxillary lateral and replace them with an osseointegrated implant.
2- Extract the supernumerary maxillary lateral and tract the impacted maxillary left central incisor to the dental arch.
3- Extract the impacted maxillary left central incisor and wait for the spontaneous eruption of the supernumerary maxillary lateral incisor.

Limitations
Alternatives and limitations of both surgical and orthodontic procedures were well explained to patient and parents, considering their expectation and the minimal treatment risk. Parents were eager to start a treatment leading to a successful outcome.

The first limitation during orthodontic treatment was the highly positioned impacted maxillary left central incisor, distal to nasal floor. The second was the horizontally angulated and impacted maxillary left central incisor.

Timing and treatment decision
A careful atraumatic surgical procedure during which extraction of the mesiodens and the impacted maxillary left central incisor as well as the enucleation of the cyst-like lesion was planned. The decision to intervene was split between an early or late treatment\(^{10,11}\). The advantages of the early compared to late treatment were the following:
1- It answers the parents’ and patient’s anxiety,
2- It prevents anterior space loss and midline deviation\(^{12}\),
3- It takes advantage of the potential of a spontaneous eruption of the supernumerary maxillary lateral incisor (two thirds of root formation stage)\(^{13}\).

The spontaneous eruption of the supernumerary maxillary lateral incisor was a goal to achieve, since it enhances the quality of the periodontium\(^{13}\).

The esthetic outcome and its impact on patient’s self-esteem were considered conclusive for the treatment’s timing.

A treatment plan was subsequently established, consisting of four steps:
1- Surgical intervention (apically repositioned flap)
2- Clinical follow-up to monitor the spontaneous eruption of the supernumerary maxillary lateral incisor
3- Space management and alignment of the supernumerary left lateral incisor by unimaxillary fixed orthodontic appliance in the maxillary arch
4- Bimaxillary fixed orthodontic appliance treatment to correct the class II malocclusion.

Multidisciplinary approach
After having decided to extract the mesiodens, the impacted maxillary left central incisor and to enucleate the cyst-like lesion, eruption of the supernumerary maxillary lateral incisor could be guided by two techniques\(^{11}\).

1- Closed flap: eruption could occur through this flap with no clinical supervision\(^{11}\).

2- Open flap: eruption could occur through the open and apically repositioned flap, considering the position of the supernumerary maxillary lateral incisor and the healing process that enhance spontaneous eruption of the tooth, which favors a good attached gingiva and prevents discrepancies in the gingival levels between exposed tooth and their neighborhood\(^{11}\).

DISCUSSION

Treatment alternatives
1- Extract the central incisor as well as the supernumerary maxillary lateral incisor and replace them with an implant. The implant choice was the most expensive. In addition, the outcome of an anterior implant is still questionable at the gingival level and it should not be placed before the end of vertical growth of the face for the best long-term esthetic and functional prognosis\(^{14}\).

2- Extract the supernumerary maxillary lateral incisor and pull down the central incisor. Even though finalizing this alternative maximizes dental esthetics, traction of the impacted maxillary left central incisor, from a site located distal to nasal floor down till the occlusion, risks root resorption, ankylosis or damage to neighboring structures. The rate of success of this
alternative was compromised by horizontal position of impacted maxillary left central incisor and absence of both cortical and spongy bone in the cyst-like lesion area.

3- Extract the impacted maxillary left central incisor and wait for the spontaneous eruption of the supernumerary maxillary lateral incisor. This alternative has the least risks. The good shape of supernumerary maxillary lateral incisor showed several advantages: proximal position to the recipient site, ideal stage of root formation (two third, no apex closure), angulation and adequate space on the arch, directly at the site of the incisor.

Surgical step

During surgery, when flap was raised, the supernumerary maxillary lateral incisor appeared to be positioned labially and the mesiodens palatally (Fig. 5a). The surgeon decided to displace a buccal flap apically to reach the impacted left central incisor and the cyst-like lesion (Fig. 5b). The mobility of the impacted maxillary left central incisor was grade 3 due to the palatally positioned lesion proximity and growth, which might be responsible of the high position of central incisor.

The mesiodens was extracted first (Fig. 5b), followed by the impacted maxillary left central incisor with a two third root formation and an open apex. A cyst-like of 10mm was enucleated in one piece, leaving no cortical bone and a hole on the buccal side (Fig. 5c, d, e). The mobility of the supernumerary maxillary lateral incisor was checked. An apically repositioned flap (Fig. 5f) was performed aiming for a spontaneous eruption of the supernumerary maxillary lateral incisor, which eventually occurred after 9 months.

Orthodontic treatment

The first phase of orthodontic treatment in the maxillary arch was achieved after the spontaneous eruption of the supernumerary maxillary lateral incisor, bypassing maxillary deciduous canines to align maxillary teeth (Fig. 6). At the same time, it helped respecting the normal scalloping of the gingiva.

Two years later, a bimaxillary fixed orthodontic treatment was performed in order to correct Class II and deep bite (Figs. 7, 9).

The width difference between maxillary right central incisor and the supernumerary maxillary lateral incisor was 1.6mm, creating a Bolton discrepancy that could be managed by stripping on mandibular incisors.

Kokich and co-workers\textsuperscript{15} mentioned later that lay people have no negative perception on small asymmetric dental situation, when the values were less than 2mm. In this patient, a 1.6mm difference in size did not affect the patient’s esthetics. He was satisfied and refused stripping on mandibular incisors and coronoplasty on supernumerary maxillary lateral incisor.

Correction of mandibular anterior teeth angulation reduced the negative effect of the Bolton discrepancy in favor of mandibular teeth. Avoidance of stripping deepened slightly the patient’s bite (55% instead of 33%).

Microesthetics

After fifteen years of follow-up, the patient does not consider the presence of two lateral incisors; one replacing the central and the other were it should be, as an unaesthetic result. His major argument is that the lateral width (mesio-distal diameter) has never been noticed by others. The patient is satisfied with this result where neither implant nor prosthetic element were performed.

Height-width relationship

The supernumerary maxillary lateral incisor respected the 80% normal ratio between width and height. As for the 50-40-30 connector rule, it was not respected on the left side since the crown of the supernumerary maxillary lateral incisor was shorter and no crown restorations were done\textsuperscript{16} (Fig. 10).

Gingival heights, shape and contour

Since height and elliptical shape of the gingiva were respected, overall appearance of the maxillary incisors was satisfactory. Furthermore, gingival height of the supernumerary maxillary lateral incisor, the maxillary left lateral incisor and maxillary left cuspid respected the up-down-up configuration producing a normal and attractive dental appearance (Fig. 10).
Figure 5a. The supernumerary maxillary lateral incisor appears buccally and the mesiodens palatally.

Figure 5b. The labial flap repositioned apically.

Figure 5c. Enucleation of the cyst-like lesion.

Figure 5d. No cortical bone left after removal of the impacted left central incisor and the cyst-like lesion.

Figure 5e. The mesiodens, the impacted left central incisor and the cyst-like lesion.

Figure 5f. The apically repositioned flap after suture.

Figure 6. The first phase orthodontic treatment in maxilla.

Figure 7. The second phase bimaxillary orthodontic treatment.

Figure 8. A consonant smile arch after 15 years follow-up.
Occlusion

A 0.8mm midline deviation to the left was present at the end of the second phase of orthodontic treatment. A Class I molar and canine was achieved on right and left sides. An overbite of 55% was present due to the compensation of the Bolton discrepancy (Fig. 10).

Stability

The two-phase orthodontic treatment ended with a Class I molar and canine on right and left sides. Teeth retention was ensured by the occlusion and by a lower canine-to-canine fixed lingual retainer. The retention period was extended until nowadays (15 years of follow-up) on a yearly basis and the result was stable (Figs. 8,10).

CONCLUSION

A comprehensive multidisciplinary treatment planning can save the patient’s psychological trauma. In general, the decision-making is case-dependent. The combination of surgery and orthodontics in this patient delivered good care and led to a successful result for the patient and established an ideal class I molar and canine relationship.

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Correspond with:
Antoine Darazé
a.daraze@cyberia.net.lb
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Extraction of first molars: report of two adult patients treated with conventional versus microimplant-assisted orthodontic mechanics.

Zouhair Skaf1, Dr. Chir. Dent., DU Ortho., Fidel Nabbout2, BDS, DU Ortho., CES Ortho., DEA, Dr. Univ.

Abstract
This article reviews the literature on orthodontic treatment involving extraction of first molars and highlights many clinical considerations when applying such treatment modality. Two adult patients, the first treated with conventional mechanics, the second using microimplant-assisted orthodontic mechanics, illustrate the potential problems and indicate some of their solutions.

“My father extracted my four first molars and my occlusion is perfect. You can all come and see…”
—Rudolph Hotz (EOS meeting, Brussels, 1947).

Extraction of permanent first molars has been advocated in dental literature, long time ago, and was considered as a controversial topic in orthodontic treatment.

When orthodontic extraction is indicated, the tooth that immediately comes to mind is the first premolar. First molar extraction may be a viable alternative to premolar extraction in many cases because of the doubtful long-term prognosis of the molars.

According to Mills2: “First permanent molar extractions doubles the treatment time and halves the prognosis”. This statement is no longer necessarily true. Nowadays, high standards in orthodontics combined with recent advances and technology would qualify the achieved results of the latter cases as unacceptable3.

Daugaard-Jensen4,5 suggested that first molar extraction is better than premolar extraction in terms of anchorage management, with no significant difference in treatment duration.

Stepovich6 proved that satisfactory space closure was best achieved in children and young adults rather than in older patients.

Hom and Turley7 stated that although most cases showed a crestal bone loss mesial to mandibular second molars at the end of treatment, acceptable results could be achieved when closing the space of mandibular first molar area in adults.

Extraction of unopposed maxillary first permanent molars after removal of mandibular counterpart was thought to prevent the likely over eruption of maxillary tooth8. Compensating extractions were not systematically advised after loss of maxillary first permanent molar because space closure in the mandibular arch was more problematic.

Williams and Hosila9 as well as Richardson10,11 have studied in detail the effect of various extraction patterns on space provision, both anteriorly and posteriorly. They showed that first molar extraction cases display less adverse facial profile change than premolar extraction cases. They also stated that first molar extraction cases have a 90% chance of successful third molar eruption compared to 55% chance in premolar extraction cases.

CLINICAL INDICATIONS
There are two groups of clinical situations in which extraction of first permanent molars should be considered:4,12-21

1. Endodontic indications:
   • Extensively decayed first molars
   • First molars with enamel hypoplasia
• Heavily restored first molars with perfectly healthy premolars
• Endodontically treated first molars with periapical lesions

2. Orthodontic indications:
• Severely blocked maxillary canines
• Posterior crowding with well positioned third molars
• Class II malocclusions and doubtful growth prospects
• Lack of patient cooperation in wearing headgear
• High angle patterns
• Anterior open bite cases
• Asymmetrical situations.

This article describes the extraction of first molars in two adults with two different clinical situations:
- An open bite case with heavily filled first molars and missing maxillary lateral incisors treated with conventional orthodontics.
- An asymmetrical molar relationship case treated with microimplant-assisted orthodontic mechanics.

HISTORY AND ANALYSIS OF PATIENT 1

A 24-year-old female presented for orthodontic evaluation with a chief complaint of “unattractive smile and poor bite”.

Clinical extraoral examination revealed a straight profile with an obtuse nasolabial angle. The face was slightly asymmetrical with the chin deviated to the right. Upon smiling, all teeth were showing with a posterior bilateral gingival display of 4 mm (Fig. 1). Functional assessment revealed normal range of motion with no signs of temporomandibular joint dysfunction.

Intraorally, she presented a Class II molar and canine on the right and an end-on Class II on the left, with no overbite at the level of the maxillary right central incisor. An anterior open bite till the second premolars was present. There was no overjet. The maxillary midline was deviated 1.5 mm to the left and the mandibular midline 1.5 mm to the right. A posterior crossbite was noticed on both sides.

The maxillary lateral incisors were missing. The maxillary and mandibular right first molars were heavily filled. The maxillary left first molar was extracted. Maxillary arch was V-shaped with 2 mm crowding, while the mandibular arch was U-shaped with 4 mm crowding (Fig. 2).

Panoramic radiograph confirmed missing maxillary lateral incisors and extraction of the maxillary left first molar. It showed also an endodontic treatment on the maxillary right first premolar and the mandibular right first molar. Mandibular third molars were present (Fig. 3).

Analysis of the lateral cephalometric radiograph demonstrated a skeletal Class III anteroposterior relationship (AOBO= -3 mm) combined with a high mandibular plane angle (FMA= 38°). Maxillary incisors were slightly retruded (IFPA = 96°), the mandibular incisors normally inclined (IMPA = 88°) and the soft tissue analysis disclosed a retruded upper lip (Fig. 4, Table 1).

### Table 1. Cephalometric measurements summary.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Norm</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
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<tr>
<td>Z Angle</td>
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| Upper Lip    | mm   | 13mm          | 13mm          |
| Total Chin   | mm   | 15mm          | 16mm          |

TREATMENT ALTERNATIVES

Two treatment options were considered:

1- Combined surgical-orthodontic treatment consisting of a Le Fort I maxillary impaction with advancement, genioplasty and replacing missing maxillary lateral incisors by mesialization of the canines.
Figure 1. Pre-treatment facial photographs.

Figure 2. Pre-treatment intraoral photographs.

Figure 3. Pre-treatment panoramic radiograph.

Figure 4. Pre-treatment lateral cephalometric radiograph.
2- Non surgical orthodontic treatment involving the extraction of maxillary right first molar, mandibular first molars and replacing missing maxillary lateral incisors by mesialization of the canines.

TREATMENT PROGRESS

After discussing the two possible treatment alternatives with the patient, the second option was selected.

Before appliance placement, reshaping of maxillary canines to simulate lateral incisors was performed according to Tuverson.22

Orthodontic treatment was initiated after extraction of the maxillary right first molar and mandibular first molars. A preadjusted (Roth prescription) fixed orthodontic appliance (.022 x .028-inch) was placed on both arches. Initial leveling was started with a progression of continuous archwires beginning with .014-inch Nitinol and working up to .020-inch. Maxillary and mandibular archwires were progressively increased to .019 x .025-inch stainless steel.

At this stage, maxillary extraction space was almost closed spontaneously and mandibular molar protraction was done with closing loop mechanics and light Class II intermaxillary elastics. A palatal bar 2mm distant from the palate was fabricated and cemented on the maxillary second molars in order to control the vertical dimension.

Directional forces (High Pull Head Gear, with double J-Hooks) were used anteriorly on both arches only at night time in order to counteract the effects of Class II mechanics, reduce the gummy smile and induce a counter-clockwise rotation of the occlusal plane.23,24

Finishing and detailing of the occlusion were accomplished as the last phase of active treatment.

The fixed appliance was removed after 2 years of active treatment. It was replaced by a maxillary Hawley retainer for full-time wear the first 6 months and at night time only after this period. A .0215-inch twist wire was also bonded on the palatal aspect of maxillary incisors.

On the mandibular arch, a .0215-inch twist wire was bonded on the lingual aspect of incisors and canines.

TREATMENT RESULTS

A Class II molar and pseudo Class I canine was achieved with optimal buccal intercuspation and adequate overbite and overjet resulting in a normal function in protrusion and laterality. The posterior crossbite was corrected. Dental midlines were on, coinciding with the facial midline. Reshaped maxillary canines appeared well integrated in terms of size, shape and color (Fig. 5).

Post-treatment photographs showed no facial change, while the smile had significantly improved, displaying an ideal amount of tooth structure (Fig.6).

Panoramic radiograph showed a good root parallelism with no sign of root resorption (Fig. 7).

The superimposition of the pre and post-treatment lateral cephalometric tracings revealed the changes obtained with treatment (Figs. 8, 9).

DISCUSSION

Ideal treatment for this patient would have been a combination of orthodontics and orthognathic surgery in order to improve facial esthetics (decrease the nasolabial angle, reduce the lower facial third and increase the convexity of the profile). This option was rejected by the patient.

The benefit of the orthodontic option was to dispose of compromised teeth with a questionable prognosis.

Extraction of the vital maxillary right first molar instead of the endodontically treated maxillary right first premolar was preferred for symmetrical and occlusal reasons (missing laterals).

The presence of third molars (acceptable morphology, size and position) and high angle pattern (still controversial)13-18,21 were factors in favor of our decision.

HISTORY AND ANALYSIS OF PATIENT 2

A 17-year-old male consulted with a chief complaint of “unesthetic smile”.

Pretreatment facial examination showed a convex profile with an average nasolabial angle and marked
Figure 5. Post-treatment intra-oral photographs.

Figure 6. Post-treatment facial photographs.

Figure 7. Post-treatment panoramic radiograph.

Figure 8. Post-treatment lateral cephalometric radiograph.

Figure 9. Superimpositions: Pre-treatment (——) and Post-treatment (——)
mentolabial sulcus. The face was symmetrical. Upon smiling, he showed all teeth with a slight gingival display (Fig. 10). Functional assessment revealed normal range of motion with no signs of temporomandibular joint dysfunction.

Analysis of pretreatment intraoral photographs showed a Class I molar and canine relationship on the right and a Class II molar and canine on the left (Class I subdivision left). Anteriorly, an overjet of 5 mm was observed, with 70% overbite. The maxillary dental midline was deviated 3 mm to the right and the mandibular was on.

Both maxillary and mandibular arches were U-shaped. A 4mm dental crowding was measured in the maxillary anterior region and 1 mm on the mandibular arch (Fig. 11).

Panoramic radiograph revealed the presence of a full complement of teeth, with unerupted maxillary and mandibular third molars. The maxillary left first molar was heavily restored with amalgam (Fig. 12).

Analysis of the lateral cephalometric radiograph demonstrated a skeletal Class II anteroposterior relationship (AOBO= 5 mm) combined with a low mandibular plane angle (FMA= 23°). The maxillary and mandibular incisors were protruded (IFPA= 109°, IMPA= 105°) and the soft tissue analysis disclosed an everted lower lip (Fig. 13, Table 2).

### TREATMENT ALTERNATIVES

Three treatment options were considered:
1- Extraction of maxillary right second premolar and left first premolar and mandibular second premolars.
2- Extraction of maxillary left first premolar.
3- Extraction of maxillary left first molar.

The advantages and disadvantages of the three options are the following:

- **First option**
  - Advantages:
    - Correction of the Class II molar and canine relationships on the left side.
    - Resolving crowding on both arches.
    - Uprighting mandibular incisors.
  - Disadvantages:
    - Flattening of the subnasal profile.
    - Extraction of four sound premolars.

- **Second option**
  - Advantages:
    - Correction of the Class II canine while keeping the Class II molar relationship on the left side
    - Resolving crowding on the maxillary arch.
  - Disadvantages:
    - Creating an asymmetrical maxillary arch form.
    - Extraction of a healthy left maxillary premolar.
    - Possible extraction of the four third molars in the future.
    - Leaving the patient with a heavily restored maxillary left first molar.

- **Third option**
  - Advantages:
    - Correction of the Class II molar and canine relationship on the left side.
    - Symmetrical maxillary arch form.
    - Resolving crowding on both arches.
    - Avoiding flaring and even slightly uprighting mandibular incisors.
    - Freeing the patient from a compromised molar.
    - No cooperation needed from the patient.25

---

**Table 2.** Cephalometric measurements summary.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Norm</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
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<td>25°</td>
<td>23°</td>
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<tr>
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<td>105°</td>
<td>97°</td>
</tr>
<tr>
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<td>107°</td>
<td>109°</td>
<td>108°</td>
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<tr>
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<td>82°</td>
<td>80°</td>
<td>80°</td>
</tr>
<tr>
<td>SNB</td>
<td>90°</td>
<td>74°</td>
<td>76°</td>
</tr>
<tr>
<td>ANB</td>
<td>2°</td>
<td>6°</td>
<td>4°</td>
</tr>
<tr>
<td>AoBo</td>
<td>0 mm</td>
<td>5 mm</td>
<td>1 mm</td>
</tr>
<tr>
<td>11</td>
<td>133°</td>
<td>119°</td>
<td>130°</td>
</tr>
<tr>
<td>Occ. Plane</td>
<td>10°</td>
<td>6°</td>
<td>10°</td>
</tr>
<tr>
<td>Z Angle</td>
<td>75°</td>
<td>60°</td>
<td>65°</td>
</tr>
<tr>
<td>Upper Lip</td>
<td>mm</td>
<td>12 mm</td>
<td>15 mm</td>
</tr>
<tr>
<td>Total Chin</td>
<td>mm</td>
<td>12 mm</td>
<td>14 mm</td>
</tr>
</tbody>
</table>

- Possible extraction of the four third molars in the future.
- Leaving the patient with a heavily restored maxillary left first molar.
Figure 10. Pre-treatment facial photographs.

Figure 11. Pre-treatment intraoral photographs.

Figure 12. Pre-treatment panoramic radiograph.

Figure 13. Pre-treatment lateral cephalometric radiograph.
• Disadvantages:
  – Surgical procedure for microimplant placement.
  – Additional fees.

After explaining the advantages and disadvantages of each option, the first and second options were rejected by the patient and his parents while the third was adopted and considered as optimal treatment.

**TREATMENT PROGRESS**

Orthodontic treatment was initiated after extraction of the maxillary left first molar. A preadjusted (Roth prescription) fixed orthodontic appliance (.022 x .028-inch) was placed on both arches bypassing maxillary and mandibular incisors. Initial leveling was started with a progression of continuous archwires beginning with .014-inch Nitinol and building up to .020-inch. Maxillary and mandibular archwires were progressively increased to .019 x .025-inch stainless steel. At that stage, two microimplants were placed distal to maxillary second premolars (Fig. 14).

Microimplants were planned to be used as:
1. Direct anchorage for the distal driving of the left lateral maxillary dentition in order to achieve a Class I canine and molar relationship.
2. Mandibular anchorage preparation using Class III mechanics in order to upright the mandibular incisors.

Once a Class I canine and molar was reached on the left side, the incisors were bonded and leveled on both arches.

Finishing and detailing of the occlusion were accomplished as the last phase of active treatment.

The fixed appliance was removed after 20 months of active treatment. It was replaced by a maxillary Hawley retainer for full-time wear the first 6 months and at night time only after this period. A .0215-inch twist wire was also bonded on the palatal aspect of the maxillary incisors.

On the mandibular arch, a .032-inch round stainless steel wire was bonded on the lingual aspect of canines.

The patient was asked to have the maxillary right third molar and mandibular third molars extracted.

**TREATMENT RESULTS**

A Class I molar and canine was achieved, with proper overbite and overjet resulting in a normal function in protrusion and laterality. Dental midlines were on, coinciding with the facial midline and crowding was relieved (Fig. 15).

Post-treatment records showed that facial esthetics improved. The smile has improved and became consonant, displaying an ideal amount of tooth structure (Fig. 16).

Panoramic radiograph showed a good root parallelism with no sign of root resorption (Fig. 17).

The superimposition of the pre and post-treatment lateral cephalometric tracings revealed the changes obtained with treatment (Figs. 18, 19).

**FINAL EVALUATION**

In this report, both patients benefited from treatment results that satisfied their aesthetic and functional needs and most importantly their chief complaints.

The first patient was treated several years ago before the use of microimplants had begun. If he was treated more recently with microimplants, he could have probably benefited from a shorter treatment with less compliance, although the results would have been the same.

The second patient has benefited from recent advances in orthodontics which microimplants have presented, shortening treatment duration, with no cooperation needed.

The possible complications that may arise from the use of microimplants are the following:
- Injury to the root surface
- Microimplant breakage or loosening

Those complications could be easily overcome if the clinician is experienced enough and has the proper manual dexterity.

A thorough assessment must be undertaken before treatment to ensure that benefits of treatment will outweigh any potential disadvantages of this treatment.26

Whenever first molar extractions are carefully considered and planned, ideal results can be achieved with a final result resembling a non-extraction case.
Figure 15. Post-treatment intraoral photographs

Figure 16. Post-treatment facial photographs.

Figure 17. Post-treatment panoramic radiograph.

Figure 18. Post-treatment lateral cephalometric radiograph.

Figure 19. Superimpositions: Pre-treatment (——) and Post-treatment (——)
REFERENCES


Correspond with:
Zouhair Skaf
zskaf@cyberia.net.lb
Do functional appliances work in the final stages of growth?  
A case report.

Mada Jeshi\textsuperscript{1}, DDS, DU Oral Biol., DES Ortho., Samar Bou Assi\textsuperscript{2}, Dr. Chir. Dent., MS

Abstract

A case is presented below following the American Board of Orthodontics norms. In this patient, a functional appliance was used to enhance differential growth although the records showed that most of the growth was over and only little was left.

SUMMARY OF TREATMENT

CASE REPORT CATEGORY: Class II division 1.
PATIENT’S NAME: N.B.
DATE OF BIRTH: August 13, 1996.
CHRONOLOGICAL AGE: 11 years 8 months, 6 months post menstruation.
SKELETAL AGE: 13 YEARS, based on hand-wrist radiograph and according to the bone age atlas of Greulich & Pyle, limited residual growth (Fig. 1).

PRETREATMENT RECORDS

Date of records: March 27, 2008.

HISTORY AND ETIOLOGY

Medical: Patient was in good health.
Dental: Teeth were in good dental health with no history of trauma. No TMJ signs or symptoms were evident. No CR/CO discrepancy. Fair oral hygiene.
Etiology: Primarily hereditary factors. Lips incompetence probably accentuated by flaring of the maxillary incisors.
Chief Complaint: “My front upper teeth are far out.”

DIAGNOSIS

- Skeletal: Class II skeletal pattern (ANB 5°) with retrognathic mandible (SNB = 77°, AOBO + 5 mm) (Fig. 5).
- Dental: Class II division 1 malocclusion. Bilateral full Class II molars and cuspids. Overjet of 11mm and impinging overbite. Proclined maxillary incisors without crowding (Fig. 3).
- No TMJ signs or symptoms. CR coincides with CO.

\textsuperscript{1} Orthodontist, Beirut, Lebanon
2 Assistant Professor, Department of Orthodontics, Lebanese University School of Dentistry, Beirut, Lebanon, and Clinical Associate, Division of Orthodontics and Dentofacial Orthopedics, Department of Otolaryngology/ Head and Neck Surgery, American University of Beirut Medical Center

Figure 1. Hand wrist radiograph shows developmental stage of ossification that corresponds to 13 years according to Greulich and Pyle.

Figure 2. A. functional appliance, B. when trimmed, C. with vertical elastics

- Slightly hypodivergent pattern (FMA 22°) (Fig. 5).
- No TMJ signs or symptoms. CR coincides with CO.

Upon smile: Acceptable smile line. Flared maxillary incisors. Lower lip interposed between maxillary and mandibular incisors.

**TREATMENT PLAN**

1. Consult with patient and parents. Discuss the necessity of patient’s compliance to succeed with functional treatment.
2. Deliver functional appliance to enhance differential growth, improve the profile and correct the Class II malocclusion.
3. Trim the acrylic gradually facing mandibular premolars to allow their eruption in order to level the deep mandibular curve of Spee and to open the bite.
4. Bond maxillary and mandibular premolars and deliver vertical elastics to enhance mandibular premolars eruption.
5. Band maxillary and mandibular molars; bond the remaining maxillary and mandibular teeth.
6. Level and align both arches.
7. Consolidate maxillary spaces anteriorly.
8. Retract maxillary incisors using closing loops.
9. Detail and finish the occlusion.
10. Debond, deband and retain.

**TREATMENT**

A functional appliance was delivered initially. After achieving a Class I occlusion and before stopping the functional appliance, maxillary and mandibular premolars were bonded and vertical elastics (4oz, 1/8”) were delivered to premolars to aid their eruption.

Brackets were bonded on the remaining teeth and bands cemented on maxillary and mandibular first and second molars.

Arches were leveled and aligned progressively until reaching 0.018” stepped down on mandibular incisors and 0.016x0.022” TMA closing archwire was used to retract maxillary incisors. Class II elastics were used to support anchorage.

Occlusion was detailed using 0.018” SS wires. Appliances were then removed and maxillary and mandibular fixed retainers were bonded from maxillary lateral to contralateral and mandibular canine to canine and a wraparound retainer was delivered to the maxillary arch.

- Initiated treatment date: July 24, 2008.
- Appliance removal date: April 15, 2010.
- Active treatment duration: 1 year 9 months.

**POST-TREATMENT RECORDS**

- Date of Records: April 29, 2010.
- Retention:
  - Maxillary wraparound retainer with fixed retainer on maxillary incisors.
  - Mandibular fixed retainer on the six anterior teeth.
- Retention completed date: ongoing.
- Retention duration: indefinite.

**SPECIFIC OBJECTIVES OF TREATMENT**

**Maxilla**


**Mandible**

  - Vertical: allow slight clockwise rotation of the mandible and slight increase in lower facial height (ANS-Me) during Class II and overbite correction.

**Maxillary dentition**

- A-P: Reduce the incisor axial inclination. Minimize molar anterior movement as needed to achieve a Class I molar relationship.
  - Vertical: allow slight incisors extrusion to improve smile line. Control molar extrusion while improving deep bite.
  - Intermolar width: expand slightly with wires coordination.

**Mandibular dentition**

- A-P: Maintain incisor axial inclination and molars position.
  - Vertical: Allow more premolars than molars extrusion to aid in bite opening. Maintain or intrude incisors while leveling the curve of Spee.
  - Intermolar / intercanine widths: Maintain both intermolar and intercanine widths.
Facial esthetics
- Improve facial balance.
- Eliminate lips incompetency.
- Increase naso-labial angle.
- Improve mental sulcus.
- Improve the smile line slightly.

APPLIANCES
- Functional appliance (Fig. 2).
- Maxillary and mandibular .022X.028” Roth prescription edgewise appliances bonded and banded.
- Limited usage of inter-arch light Class II elastics just to maintain anchorage and vertical seating elastics (4oz. 1/4”; 4 oz. 1/8” respectively).

TREATMENT PROGRESS
When the functional appliance was delivered, the patient was instructed to wear it at least 20 hours/day. Occlusion was monitored throughout 4 months without any interfering. The overjet was reduced to 4 mm after 4 months. Trimming of the acrylic facing the mandibular premolars was then performed, but minimal spontaneous eruption occurred during the preceding 2 months. Maxillary and mandibular premolars were bonded and vertical elastics were delivered to help extrude the mandibular premolars. After 7 months, a Class I molars and canines occlusion was achieved and the overjet was reduced to 3mm and the overbite to 40%. At that point, the functional appliance was removed and teeth in both arches were bonded and banded, including the second molars.

Both arches were progressively aligned with 0.014” NiTi, 0.016” SS archwires stepped down on mandibular incisors to open the bite and level the lower curve of Spec. 0.018” SS with a power chain between the maxillary incisors to gather the spaces anteriorly, followed by upper 0.06x0.022” TMA with closing loops (the loops were activated 1mm /month) were used. Class II and vertical elastics were used to support anchorage.

After detailing and finishing, using triangular elastics to seat the occlusion, appliances were removed, and maxillary and mandibular fixed retainers (Hilgers’ type) were bonded from maxillary lateral to lateral and from lower canine to canine, and a wraparound retainer was delivered to the maxillary arch.

RESULTS ACHIEVED
Maxilla
- A-P: Maintained anteriorly.
- Vertical: Maintained.

Mandible
- A-P: Significant anterior mandibular growth (Fig. 11).
- Vertical: Downward growth of the mandible with no increase in FMA (Fig. 11).

Maxillary dentition
- A-P: Slight distal movement of the molars. Uprighting of the incisors to a more favorable position.
- Vertical: Maintained the vertical position of both molars and incisors.
- Intermolar Width: 2.5 mm increase in intermolar width.

Mandibular dentition
- Intermolar/Intercanine Width: Intermolar width maintained. Intercanine width decreased by 0.5 mm.

Facial esthetics
- Improvement of the facial profile. Smile line improved. Lips became competent. Improved naso-labial angle. Improved mental sulcus.

RETENTION
An upper wraparound retainer was delivered upon appliances removal. The patient was instructed to wear it full time for the first 6 months, and later, only while sleeping.

Upper and lower fixed retainers were bonded to the anterior teeth. The patient was instructed to seek check-up on fixed retainers in case of breakage suspicion.

Third molars were evaluated and the patient was informed that they might need to be extracted in the future if any problem occurred during eruption.

FINAL EVALUATION OF TREATMENT
The overall treatment result was good. The facial balance and smile esthetics improved.

A Class I dental relationship was achieved and the deep anterior overbite improved.

The overjet is optimal.

The patient temporo-mandibular joints were asymptomatic after treatment.

The panoramic radiograph showed no significant root resorption.

It could be argued that the skeletal age and post
menstrual status of the patient does not initiate a high growth potential that can be considered efficient to correct the skeletal Class II and the severe overjet, and therefore the patient would not be considered as a good candidate for functional therapy.

The result attained is quite satisfying as most of the treatment objectives were met by avoiding orthognathic surgery or unnecessary extractions.

**Figure 3.** Pre-treatment extra-oral and intra-oral photographs.

**Figure 4.** Pre-treatment dental casts.
Figure 5. Pre-treatment cephalometric tracing and measurements.

Figure 6. Pre-treatment panoramic radiograph.
Figure 7. Post-treatment extra-oral and intra-oral photographs.

Figure 8. Post-treatment dental casts.
Figure 9. Post-treatment cephalometric tracing and measurements.

Figure 10. Post-treatment panoramic radiograph.
Figure 11. General and local cephalometric superimpositions.
Table 1. Cephalometric measurements summary.

<table>
<thead>
<tr>
<th>Area</th>
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<th>A2 (progress)</th>
<th>B</th>
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Soft tissue

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<td>Holdaway line</td>
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<tr>
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<td>Point B</td>
<td>-8</td>
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<td>0</td>
</tr>
</tbody>
</table>


* NOTE: Difference between A1 and B is the absolute value without negative or positive signs.

Correspond with:
Mada Jeshi
dr_madajeshi78@hotmail.com
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Dearborn, MI 48126
Tel: 313-5821919
Fax: 313-5820300
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www.berrydistribution.net
Evaluation of hearing in children treated with palatal expansion.

Anthony Macari¹, Dr. Chir. Dent., DES Ortho., MS (Human Morphol.), Residency Ortho. (AUB), Ammar Kassab², BDS, Hala Aoun³, BDS, DES Ortho., Kim Smith Abouchacra⁴, Ph.D., CCC-A, FAAA

Abstract

The aim of this presentation is to explore the potential association between rapid palatal expansion (RPE) and decrease in conductive hearing loss. RPE is a common orthopedic treatment for maxillary constriction and/or lateral crossbite(s). This procedure may result in unexpected improvement of nasal breathing and improvement in hearing sensitivity. The underlying mechanism for the latter would consist of the extension of the tensor-veli palatine muscle following the palatal distraction, which opens the Eustachian tube orifice and facilitates air passage, allowing normal function of the middle ear system. Clear-cut conclusions are not yet formulated on whether the improvement in hearing is transient or permanent. A thorough review of the literature with methodological shortcomings and design of future studies are reported.

Usage of RPE

RPE has been routinely used for the treatment of transverse maxillary deficiency, posterior crossbites, crowding, abnormal breathing pattern and conductive hearing loss (CHL), in growing children having maxillary constriction.

<table>
<thead>
<tr>
<th>Dental and/or skeletal</th>
<th>Medical</th>
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<tr>
<td>Unilateral or bilateral crossbite</td>
<td>Poor nasal airway</td>
</tr>
<tr>
<td>Borderline Antero-posterior discrepancies</td>
<td>Septal deformity</td>
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<tr>
<td>Face mask therapy</td>
<td>Recurrent Ear or Nasal infection</td>
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<td>Cleft lip and palate</td>
<td>Allergic rhinitis and asthma</td>
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<tr>
<td>Narrow smile</td>
<td>Prior to Septoplasty</td>
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<td>Arch length discrepancy</td>
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</tbody>
</table>

Eustachian Tube

Anatomy and functions:
- Connects tympanic cavity (middle ear space) to nasal part of pharynx.
- Orifice lies on lateral nasal pharyngeal wall.
- Peristalini muscles (levators and tensors) open and close pharyngeal ostia of Eustachian tube and clear its internal parts from mucus, secreted to humidify and lubricate the inner tube. Action of these muscles allows:
  * Middle ear ventilation to equilibrate its air pressure with atmospheric pressure
  * Drainage and clearance of any secretions from the middle ear space
  * Protection from nasopharyngeal secretions

Conductive hearing loss in otitis media

Audiogram testing is important to diagnose the presence of conductive hearing loss. Air and bone conductions are measured separately (Fig. 1a). In cases of otitis media resulting from Eustachian tube dysfunction, conductive hearing loss is characterized
by poorer air-conduction hearing and normal bone-conduction hearing sensitivity (Fig. 1b). Upon resolution of Eustachian tube dysfunction and clearance of fluid from the middle ear, hearing by air-conduction returns to normal (Fig. 1c).

Impaired Eustachian tube function can lead to inadequate aeration of the middle ear space, leading to inflammation of the mucoperiosteal lining of the middle ear cleft and secretion of fluid from the lining (otitis media). An accumulation of fluid in the middle ear space, in turn, can lead to a conductive hearing loss or other complications of otitis media. Otitis media is more common in young children because their Eustachian tubes are shorter, narrower and more horizontal than in adults, making movement of air and fluid difficult.

**Background and significance**

Recent literature has shown that rapid palatal expansion (RPE) may alleviate conductive hearing loss in patients with a history of mouth breathing and chronic otitis media that is unresponsive to pharmacological treatment\(^1\text{-}^4\). Specifically, the findings revealed clearance of fluid from the middle ear space (as measured by tympanometry) and a 10-20 dB HL improvement in hearing sensitivity [measured as size of gap between air and bone-conduction hearing levels (i.e., Air-Bone Gap) on the audiogram] after active RPE. Improvements in hearing remaining relatively stable after retention.

We hypothesize that improvements in auditory function found in patients who have conductive hearing loss and underwent RPE are the result of correction of the palatal anatomy during the procedure. That is, RPE influences the muscular function of the Eustachian tube ostia, via extension of the tensor-veli palatine muscles, thereby allowing drainage of middle ear fluid, normal aeration of the middle ear space and subsequent resolution of conductive hearing loss. The purpose of this study is to determine whether RPE can be used as a non-invasive method for resolving Eustachian tube dysfunction and concomitant hearing loss in children with a history of mouth breathing and chronic otitis media. Positive findings may provide parents with a less expensive, non-invasive alternative to surgical placement of pressure-equalizing tube to resolve middle ear dysfunction.

**RESEARCH DESIGN**

**Pilot study**
- **Design:** prospective
- **Sample:**
  - Patients with a history of chronic otitis media, conductive hearing loss, Eustachian tube dysfunction, history of mouth breathing and eligibility for RPE and surgical placement of pressure-equalizing tubes.
  - Patients undergoing RPE for orthodontic reasons.
- **Procedure:** Patients will undergo a baseline audiological evaluation (Tympanogram and Audiogram). RPE will be performed (Experimental Group). Audiological evaluation will be repeated (after one week of expansion) and compared with baseline results to determine whether improvements in hearing have occurred.

**Findings**

Audiometry and tympanometry tests were performed on a male growing patient undergoing orthodontic treatment where PRE was indicated and validated in his orthodontic treatment plan. The patient’s clinical history revealed a previous recurrent middle ear infection. The hearing tests were performed before and after expansion (Figures 2a and 2b). The pre-expansion audiometric tests results show a mild conductive hearing loss and a type C tympanometry, denoting negative middle ear pressure bilaterally. Post-expansion audiometric tests results shown by audiometry and tympanometry are within normal limits.
CONCLUSION
Resolution of conductive hearing loss is considered as a possible additional benefit of RPE treatment. However, it does not indicate that people with conductive hearing loss should consider this as treatment approach without the presence of dentofacial indications for RPE.

REFERENCES:
4- Villanoa A, Grampia B, Fiorentini R, Gandi P. Correlations between rapid maxillary expansion (RME) and the auditory apparatus. Angle Orthod 2006;76:752-58.

Correspond with:
Anthony Macari
am43@aub.edu.lb
# Forthcoming Dental Meetings, Exhibitions and Conventions

Reported by Maria Saadeh

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<td>67th Malaysian Dental Association Annual General Meeting and World Dental Federation, International Scientific Convention and Trade Exhibition</td>
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<td>July 14-17, 2010</td>
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2. Fiber 200 μm
3. Fiber 400 μm
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5. Non contact handpiece
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7. Battery Charger
8. Remote Interlock
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