Rafi Romano (ed)

ORTHODONTIC MINDSET

The secrets behind successful orthodontic treatment

With contributions by: Javier Aznar Arraiz · Alberto Canabez Berthet · Luis Carriere · Asif Chatoo · Christian Coachman · Francesca Cremonini · Lihi Keren · Edward Y. Lin · Luca Lombardo · Miriam López Vila · Domingo Martín Salvador · Randall Moles · Nazariy Mykhaylyuk · Susana Palma · Daniel Souza Pinto Ramos · Jacqueline Schneider · Nuno Sousa Dias · Juan Carlos Perez Varela · Ventseslav Zhivkov Stankov

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Introduction

Over the past two decades, orthodontics has undergone a revolutionary transformation driven by rapid technological advancements and refined clinical protocols. While the underlying biologic principles remain constant, modern innovations have ushered in an era of unparalleled precision, predictability, and efficiency in treatment. This evolution has not only shortened treatment times but has also elevated patient care to new standards.

This book is a comprehensive guide to contemporary orthodontic practice, carefully curated to address the diverse challenges and opportunities encountered by today's clinicians. It is structured around six pivotal areas that represent the cutting edge of the field. The text begins by exploring modern applications of traditional orthodontics through advanced techniques in braces—whether buccal or lingual— to demonstrate how age-old methods have been reimagined for improved outcomes. Next, an in-depth exploration of clear aligners showcases innovative biomechanics and hybrid approaches designed to manage even the most complex cases.

For scenarios that require surgical precision, the discussion on ortho-surgery combined with temporary anchorage devices (TADs) offers insights into resolving skeletal and transverse discrepancies with confidence. The book also addresses the multifaceted challenges presented by temporomandibular joint (TMJ) management, providing strategies to diagnose and treat disorders that impact both function and overall oral health. Rounding out the content is an exploration of Digital Smile Design (DSD), in which state-of-the-art digital tools are employed to visualize and plan treatments, ensuring both esthetic and functional excellence.

The esteemed contributors, hailing from diverse corners of the globe—including the USA, Brazil, and various parts of Europe—are celebrated for their profound influence in shaping generations of orthodontists worldwide. With unparalleled expertise and a legacy of excellence, they have dedicated their careers to advancing the field. This book offers a rare opportunity to delve into their minds, guiding the reader through the intricate journey of diagnosis, treatment planning, and execution. By weaving together meticulously presented cases, it provides an insightful exploration of their thought processes and clinical decisions, and the mastery that defines their approach to orthodontic care.

Authors

Javier Aznar Arraiz, DDS

Dr. Aznar earned his DDS degree from Alfonso X El Sabio University in Madrid in 2010, and then received his master's in Orthodontics from San Rafael Hospital, Madrid in 2014. He completed his orthodontic training by taking the Functional and Cosmetic Excellence (FACE)/Roth-Williams postgraduate course in Multidisciplinary Advanced Orthodontics in San Sebastian. In 2016, he obtained his doctorate cum laude from Alfonso X El Sabio University with a thesis entitled "In vitro study of the expression of torque in different self-ligating orthodontic brackets". He then took a course in Dental and Craniofacial Clinical Research Methods at the University of Washington, Seattle, in 2019.

Dr. Aznar has published numerous articles on orthodontics and has taught at the University of Zaragoza and Alfonso X El Sabio University. Currently, he works exclusively as an orthodontist at the clinic run by Dr. Domingo Martín Salvador in San Sebastian, Spain.

Alberto Canabez Berthet, DMD

Dr. Canabez Berthet is a specialist in orthodontics and dentofacial orthopedics in the Dental Faculty at the University of the Republic, Montevideo, Uruguay.

He received a diploma from the Roth-Williams Foundation for Functional Occlusion after studying there from 2000 to 2002. From 2002 to 2005, he worked alongside Dr. Domingo Martín Salvador in his private practice, and since then has been linked to the teaching of the Functional and Cosmetic Excellence (FACE) philosophy worldwide. He is Visiting Professor of the FACE Roth-Williams postgraduate course at the Catholic University of Uruguay (Montevideo), the International University of Catalonia, and Complutense University of Madrid.

He runs a private orthodontic practice in Barcelona, Spain that focuses on functional occlusion, the temporomandibular joint, esthetic orthodontics, and interdisciplinary treatment.

He is a member of FACE and the Spanish Society of Orthodontics and Dentofacial Orthopedics (SEDO), and an honorary member of the Dawson Academy.

Luis Carriere, DDS, MSD, PhD PhD Hon.

Dr. Carriere earned his PhD cum laude from the University of Barcelona in 2006, his DDS degree from Complutense University of Madrid, and his MSD degree from the University of Barcelona. He was granted an honorary PhD from UNICIEO in Bogotá, Colombia.
In May 1995, he was the winner of the Joseph E. Johnson Award from the American Association of Orthodontists (AAO) San Francisco.
Dr. Carriere is a member of the editorial review board of the American Journal of Orthodontics and Dentofacial Orthopedics and contributing editor of the Journal of Clinical Orthodontics.
He is the inventor of the Carriere Motion Appliance, Carriere Distalizer, and Carriere Self-ligating Bracket, and is an invited professor at several orthodontic departments of universities in the USA, South America, Europe, and Asia.
He is an invited speaker around the world.

Asif Chatoo, BSc, BDS, FDS RCS (Eng), MSc, MOrth RCS (Eng)

Dr. Chatoo qualified as a dental practitioner from King's College London and gained his master's degree in Orthodontics from GKT Dental Institute, London. In 2005, he co-founded The London Lingual Orthodontic Clinic, the first clinic in the UK to be dedicated to lingual orthodontics. He has a keen interest in the multidisciplinary treatment of adult patients and the use of digital technology in orthodontics. He is the current Chairman of the European Society of Lingual Orthodontics (ESLO), and has been an accredited member and honorary secretary of the society since 2017. He was Co-chairman of the Scientific Committee of the World Society of Lingual Orthodontics 2019 and is an accredited member of the society. He held the position of Chairman of the Scientific Council ESLO 2018 and was a founding member and Secretary (2007 to 2012) of the British Lingual Orthodontic Society, and President of the London Dental Fellowship in 2014. He is a Fellow in Dental Surgery of the Royal College of Surgeons of England, of the World Federation of Orthodontics, and of Pierre Fauchard Academy, and also serves as Clinical Lecturer and Advisor for the IAS Academy.

Christian Coachman, DDS, CDT

Dr. Coachman graduated in Dental Technology in 1995 and in Dentistry in 2002 from the University of São Paulo, Brazil. He is the only dental practitioner to be a member of the Brazilian, European, and American Academy of Esthetic Dentistry, the three most important such academies in the world.

In 2004, he was invited by Goldstein, Garber, and Salama to become Head Ceramist at their laboratory in Atlanta, a position he held for over 4 years.

Dr. Coachman has worked with many leading dental practitioners and developed concepts that are renowned worldwide, such as Digital Smile Design (DSD), the pink hybrid restoration, the Digital Planning Center, emotional dentistry, interdisciplinary treatment simulation, and Digital Smile Donator. He is also Director of the DSD Residency program that offers continuing education courses for dental professionals from all over the world.

In 2017, Dr. Coachman became an adjunct professor in the restorative department at the University of Pennsylvania School of Dental Medicine and, in 2018, coordinator of the Digital Dentistry postgraduate program at the University Avantis in Balneario Camboriu, Brazil.

Founder and CEO of the DSD-Digital Smile Design company.

Dr. Coachman also works as a consultant for dental companies and offices, developing products and implementing concepts and marketing strategies, such as the facially driven digital orthodontic workflow developed in collaboration with Align Technology.

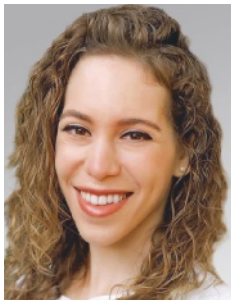
He has lectured and published internationally in the fields of esthetic and digital dentistry, dental photography, oral rehabilitation, dental ceramics, implants, and communication strategies and marketing in dentistry.

Francesca Cremonini, DDS

Dr. Cremonini graduated cum laude in Dentistry in 2017 from at the University of Ferrara, Italy, with an experimental thesis in orthodontics. She completed her postgraduate degree with honors in orthodontics at the same university in 2020.

She currently works as a researcher with a scholarship at the Postgraduate School of Orthodontics in Ferrara and in a private orthodontic practice in Modena.

She has written national and international publications.



Lihi Keren, DMD

Dr. Keren graduated from the Faculty of Dentistry at Tel Aviv University, Israel, in 2020, and now plays an active role in guiding students in dental studies and delivers lectures as part of the training program for dental studies at the university. In addition, she is involved in several studies related to the frequency of the appearance of temporomandibular disorders, among others in patients with severe occlusal defects who require orthogenetic surgery.

Edward Y. Lin, DDS, MS

Dr. Lin received his degrees in both Dentistry (DDS) and Orthodontics (MS) from Northwestern University Dental School. He is one of two partners at Orthodontic Specialists of Green Bay and a former partner at Apple Creek Orthodontics of Appleton, both completely digital practices that have been utilizing intraoral scanning and SureSmile since February 2004 at three different locations for labial, lingual, and aligner treatment, and that have been involved with CBCT with the i-CAT since 2005. In-house aligner therapy is an important part of all practices, with more than 2,000 cases having been treated in 2021.

Dr. Lin is an internationally recognized speaker, and has written several articles that have been published in a wide variety of dental journals and lectured at several orthodontic residency programs across the world. He is a Clinical Advisory Board Member for SureSmile and a Key Opinion Leader for American Orthodontics, Imaging Sciences International, Envision TEC, uLab, Desktop Health, and Hu-Friedy. He is a former member of the American Association of Orthodontists' Committee on Technology and is on the editorial board for the journals OrthoTown and Orthodontic Practice. Dr. Lin's passion for orthodontics and technology has enabled him to integrate them both into his clinical practice in his pursuit of clinical excellence to be able to provide the highest quality of care for patients.

Luca Lombardo, DDS

After earning his degree in Dentistry and Dental Prosthetics from the University of Palermo in 2004, Luca Lombardo specialized in Orthodontics at the University of Ferrara in 2007. He remained there as a research fellow until 2011, before becoming a researcher in 2012, and has been an Adjunct Professor at the university since 2010. In 2012, he also became a member of the European Board of Orthodontics. He is an Associate Professor at Ferrara University and has been Chairman of the Postgraduate School of Orthodontics since 2019.

Prof. Lombardo has written several journal publications and has spoken at national and international conferences. He is an associate editor of the journal Progress in Orthodontics. He served as President of the Italian Association of Specialists in Orthodontics and the Italian Association of Lingual Orthodontics from 2013 to 2016, and of the Italian Academy of Orthodontics in 2018. He is a member of the Italian Society of Orthodontics (SIDO), the Italian Academy of Orthodontics (AIDOR), and the World Society of Lingual Orthodontics (WSLO), and is also an Active Member of the Angle Society of Europe.

Miriam López Vila

Dr. López Vila graduated in Dentistry from the University of Santiago de Compostela, Spain, in 2017 and earned her master's degree in Exclusive Orthodontics with Dr. Juan Carlos Pérez Varela in 2019.

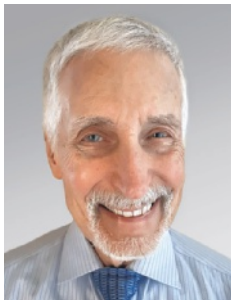
Dr. López Vila has been an Active Member of the Spanish Society of Orthodontics since 2021 and is a co-tutor of several end-of-degree projects at the University of Santiago de Compostela. and scientific publications in journals/books with a high scientific impact.

Domingo Martín Salvador, MD, DDS

Dr. Martín Salvador specializes in orthodontics and dentofacial orthopedics (University of Valencia, Valencia Spain), Diploma for Functional Occlusion (San Francisco, California 1991 to 1993), Diploma Foundation for Bioesthetic Dentistry (Portland, Oregon 2004 to 2006). He is an Active Member of the Angle Society of Europe, Spanish Society of Orthodontics (SEDO), European Orthodontic Society (EOS), American Association of Orthodontists (AAO), and World Federation of Orthodontists (WFO). He was President of the Angle Society from 2014 to 2016 and Diplomate of the European Society of Orthodontics (EBO) in 2008.

Dr. Martín Salvador is a visiting professor in the Department of Orthodontics at the International University of Catalunya-Barcelona and Complutense University of Madrid.

He is a reviewer for the European Journal of Orthodontics, the Journal of the Polish Orthodontic Society, the Turkish Orthodontic Society, and the International Journal of Oral & Maxillofacial Surgery. He has published more than 25 articles and written several chapters for orthodontic and periodontic textbooks, and has lectured extensively in more than 50 countries worldwide. He also runs an interdisciplinary practice in San Sebastian, Spain.



Randall Moles, DDS

Dr. Moles graduated from Marquette University and practices in Milwaukee and Racine, Wisconsin, USA. He served in the US Coast Guard Division of the United States Public Health Service and worked as an Associate Professor of Orthodontics at Marquette University. Dr. Moles is board certified, and for many years has been actively involved in carrying out research for several orthodontic companies, having three US patents to his credit. He is an original member of the Ormco Insiders group, who developed the lingual appliance, and also of the Invisalign Alpha Group. Dr. Moles has written a book on temporomandibular disorder (TMD) as well as numerous orthodontic articles, and lectures both nationally and internationally on digital orthodontics, TMD treatment, airway, and practice management.

Nazariy Mykhaylyuk

Dr. Mykhaylyuk specializes in microscopic and digital dentistry, focusing on smile makeovers and full mouth reconstruction. He works at the M.Vision clinic in Kyiv, Ukraine, and is the founder of M.Vision Academy, M.Vision Clinics and Lab, M.Vision Las Vegas, and the M.Vision Asia training centers. Dr. Mykhaylyuk has organized and delivered numerous courses and presentations worldwide, sharing his knowledge and expertise with his fellow dental practitioners. He also serves as an international Key Opinion Leader for leading companies in the field such as Ivoclar Vivadent, 3Shape, Deppeler, Asiga, DGShape, Modjaw, and DMG.

Susana Palma, DDS, PhD

Dr. Palma received her degree in Dentistry from the University of Granada, Spain, in 1998, and her postgraduate degree and PhD in Orthodontics and Orthopedics from Complutense University of Madrid in 2002. She has been working in private practice in Ciudad Real, Spain, since 2005. She has written multiple articles that have been published in international journals and several white papers published by Align Technology. She was an Invisalign Apex provider (TOP #1 in Europe, the Middle East, and Africa [EMEA]) after becoming a Diamond II doctor in 2015, having treated more than 2,000 cases using Invisalign.

She is a professor of the postgraduate degree program in Orthodontics at Salamanca University in Spain, an active member of the Spanish Society of Orthodontics (SEDO), and a member of the World Federation of Orthodontists (WFO), SEDA, and the Spanish Association of Orthodontic Specialists (AESOR). guest lecturer at the Egaz Mouniz School of Health and Science in Lisbon, the University of Tor Vergata in Rome and Seville University. She has been co-director of the Aligners International Advanced Program and an international speaker since 2016.

In 2021, she was co-author of the book Aligners Technique in Orthodontics, which was translated into four languages.

Daniel Souza Pinto Ramos, DMD, MSc

Dr. Ramos received his master's degree in Orthodontics in 2002. Dividing his time between academia and his private clinic in Brazil, he always stays up to date with the latest techniques, innovations, and technologies that arise in orthodontics. With a focused approach to providing a better patient experience, Dr. Ramos has gradually increased the use of aligners in his office. He is also Adjunct Faculty in two universities in Brazil (IMED-POA and Rede IOA) and Guest Faculty at the Institute of Houston Dental Synergy (iHDS) in the USA. Dr. Ramos is the Clinical Director of Propel Orthodontics in Brazil and is responsible for spreading the concept of accelerated and digital orthodontics in his country, using Propel technology in almost all of his aligner treatments delivered since 2016. He also trains new users of the Propel method in Brazil. As an international speaker, Dr. Ramos has delivered lectures in countries such as the USA, Mexico, Portugal, and Spain. Since 2018, he has been working as the orthodontist at Well Clinic (the private practice run by the Coachman family, founders of the Digital Smile Design [DSD] concept), one of the most important interdisciplinary dental clinics in the world, where DSD was created. Since late 2019, Dr. Ramos has been Clinical Manager at the DSD Planning Center Orthodontics, where he provides DSD and Invisalign treatment planning services for doctors all over the world.

Rafi Romano, DMD, BSc

Dr. Romano specializes in orthodontics and dentofacial orthopedics (Hebrew University, Hadassah Jerusalem, Israel) and runs a private orthodontic practice in Tel Aviv that focuses on adult and esthetic orthodontics.

Dr. Romano is an American Association of Orthodontics (AAO) Ambassador representing the Israel Orthodontic Society, and an Active Member of the European Academy of Esthetic Dentistry (EAED). He has edited five books: Lingual Orthodontics (Decker, 1998), The Art of the Smile (Quintessence, 2005), The Art of Treatment Planning (Quintessence, 2009), Lingual & Esthetic Orthodontics (Quintessence, 2011), and The Art of Detailing (Quintessence, 2013).

Dr. Romano is a member of the editorial board of the International Journal of Esthetic Dentistry (IJED), a former editor-in-chief of Orthodontics: The Art and Practice of Dentofacial Enhancement, and a former editor of the Journal of the Israeli Orthodontic Society.

He is an Invisalign Diamond Provider and an Advisory Board Member for Align Technology, and lectures worldwide on esthetic orthodontics and adult multidisciplinary orthodontic treatment.

Jacqueline Schneider, DSD

Dr. Schneider has specialized in dental oral rehabilitation since 2012, and from the beginning of her career, she has dedicated herself to digital dentistry and its clinical applications.
For the last 5 years, she has focused on developing her skills while working as a general clinician in a digital interdisciplinary practice.
In 2018, she became a Digital Smile Design Key Opinion Leader (DSD KOL) after being able to implement all DSD concepts on digital interdisciplinary planning in everyday clinical practice, and also clinical performance digitally guided.
She is now a partner and responsible for the digital clinical planning and execution of all interdisciplinary cases at WellClinic in Sao Paulo, Brazil, in partnership with the DSD Planning Center in Madrid.

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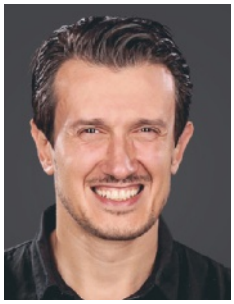
Dr. Sousa Dias received his degree in Dentistry (DDS) in Portugal in 2007.
He completed a full-time Orthodontic Postgraduate Program (MOrth) at Tel Aviv University, Israel, from 2008 to 2012. His main clinical interest concerns interdisciplinary treatment planning in cases involving orthodontic tooth movement.
Dr. Sousa Dias is an Active Member of the European Academy of Esthetic Dentistry (EAED) and a member of several national and international dental and orthodontic scientific organizations. As a speaker, he has lectured worldwide in more than 20 countries, at some of the most important events in dentistry (such as the CIDAE, EAO, EAED, EFP, and AARD).
He cooperates with different dental and orthodontic companies as a Key Opinion Leader.
He is section editor for the “Orthodontics” section of the International Journal of Esthetic Dentistry (IJED).
In addition to his clinical work, he completed an MBA in Healthcare Innovation at Arison School of Business at IDC Herzliya, Israel, from 2018 to 2019. He is the CEO of XPECTEC, a company that focuses on innovative health care solutions.
Dr. Sousa Dias practices orthodontics at his own private dental clinic, IDENTIFY, in Portugal.



Ventseslav Zhivkov Stankov

Dr. Stankov graduated in Dental Medicine from the Faculty of Dental Medicine at the Medical University of Plovdiv in 2007. His clinical work is focused on end-to-end esthetic treatment in dental medicine, implantology, periodontal plastic microsurgery, periodontal regeneration, and complex cases of prosthetic treatment on natural teeth and implants. He completed a 1-year master's program at the Global Institute for Dental Education (GIDE) at the University of California, a 2-year master's program at the Hurzeler/Zuhr Dental Education Institute, a 1-year master's program at the Urban Regeneration Institute, and the master's program run by Prof. Zucchelli at the University of Bologna. He is a certified Zimmer instructor and demonstrator for Zimmer Biomet.

Juan Carlos Pérez Varela, MD, DDS, MS, PhD

Dr. Varela received his degree in Medicine and Dentistry from the University of Santiago de Compostela and his postgraduate degree in Orthodontics from the University of Valencia, Spain. He also holds a PhD in Medicine and Surgery from the University of Santiago de Compostela and has a Research Fellowship at the University of Ohio. He is a member of the Spanish, European, and Ibero-American Boards of Orthodontics, and an active member of the Angle Society of Europe.

He is currently Professor of Orthodontics at the School of Dentistry of the University of Santiago de Compostela, and Visiting Professor at the University of Valencia, the University of Oviedo, Complutense University of Madrid, the International University of Catalonia, Teknon Clinic, and the University of Barcelona in Spain, and the University of Ferrara in Italy.

Dr. Varela has received the Houston Award from the European Orthodontic Society, the Renato Africa APOS Trend Award from the Asian Pacific Orthodontic Society, and the Moriyon and Jose Antonio Canut Awards from the Spanish Society of Orthodontics (SEDO). He is President of the SEDO, an Ambassador for the American Association of Orthodontists (AAO) 2016, and former President of the Spanish Association of Specialists in Orthodontics (AESOR).

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1 Comprehensive Phase I and Phase II 3D Digital Orthodontic Diagnosis and Treatment for a Patient with Significant Mouth Breathing and Snoring Habits, Severe Crowding, and Transposed Maxillary Lateral Incisors and Canines

Edward Y. Lin

1.1 Introduction

Sleep-disordered breathing in children can manifest in a wide range of respiratory symptoms. In its mildest form, it can present as mouth breathing and snoring, and in its most severe form, as obstructive sleep apnea (OSA) resulting in hypoxic episodes during sleep. The consequences of sleep-disordered breathing are believed to impact metabolic and neurocognitive development, possibly leading to learning disabilities. There is also scientific evidence indicating a direct association with airway and craniofacial development resulting in significant malocclusions.[1] Traditionally, the recommended treatment for pediatric OSA patients is tonsillectomy and adenoidectomy. However, many other factors are involved such as reduced airway volume (upper, middle, and lower), retrognathia, constricted maxillary and mandibular arches, maxillary sinus obstruction with pathology, and nasal cavity obstruction with hypertrophied nasal turbinates, deviated nasal septum, and macroglossia. As a result, the orthodontist plays a significant role in the early diagnosis and treatment planning for patients who attend the practice with sleep-disordered breathing issues, or craniofacial development concerns, as well as correcting the resulting malocclusions.

In order for the orthodontist to properly diagnose and plan treatment of sleep-disordered breathing issues in any patient, there are three critical steps that must be performed:

1. Thorough medical history including a sleep questionnaire (mouth breathing, snoring, bedwetting, behavioral issues, and sleep pattern).
2. Thorough clinical orthodontic evaluation including evaluation of tonsils and tongue size.
3. Low-dose CBCT scan to evaluate the patient's maxillary sinuses, airway volume, and dental eruption paths.

1.2 Case Presentation

A girl aged 11 years and 5 months presented with her mother for her examination as a new patient. The chief complaint was severity of crowding and dental alignment, with a desire to achieve a more esthetic smile, and resolve significant mouth breathing and snoring habits.

Frontal facial evaluation revealed a dolichocephalic facial growth pattern. Profile evaluation revealed a retrognathic profile with a recessive chin. Her nasolabial angle was 130 degrees. Both upper and lower lips appeared normal and competent at repose. A frontal smile evaluation revealed a significantly high upper smile line and gummy smile with 8 mm excessive gingival tissue display when smiling. There was also an anterior maxillary cant present 7 mm up to her left when smiling. Buccal corridors were also evident when smiling due to her constricted maxillary and mandibular arches.

Intraoral examination revealed a Class I malocclusion with delayed eruption of her teeth 12, 33, and 43. She presented with a vertical overlap (overbite; OB) of 50% and a horizontal overlap (overjet; OJ) of 6 mm, and an increased mandibular curve of Spee (COS). Arch length deficiencies were present in both the maxilla (7 mm) and mandible (12 mm). The maxillary and mandibular arches were asymmetric and tapered in arch forms with a bilateral posterior edge-to-edge relationship. Periodontal evaluation revealed healthy oral mucosal and gingival tissue. However, her gingival tissue was hypertrophied in appearance due to her mouth breathing and snoring habits. Her tonsils were within normal limits in size and were not enlarged upon clinical examination **(Fig 1-1a to i)**.

For the radiographic examination, a panoramic radiograph was taken using i-CAT NextGen QuickScan dental CBCT unit (Imaging Sciences, Hatfield, PA, USA) (4.8 seconds scan time and 0.3 mm voxel size) and low-dose CBCT scan at a field of view (FOV) of 8 × 16 cm. The panoramic radiograph revealed only tooth 27 to be present and under development at this time. Her alveolar bone height appeared healthy and within normal limits for both maxillary and mandibular arches. However, teeth 12, 33 and 43 were impacted due to the severity of crowding, with root development complete for tooth 12 and nearly complete for teeth 13 and 23 with little active eruption remaining. Teeth 12, 13, 22, and 23 were transposed with definite potential for teeth 13 and 23 to be impacted or to cause root resorption for teeth 11, 12, 21, and 22. There were no third molars present at this stage **(Fig 1-2)**.

The 2D digital cephalometric radiograph revealed a Class II skeletal relationship with ANB = 5.2 degrees. She had an open bite skeletal growth pattern with SN-MP = 44.4 degrees. Her mandibular incisors were also retroclined with IMPA = 82.7 degrees **(Fig 1-3)**.

A low-dose CBCT scan was taken with an i-CAT NextGen.[2,3] QuickScan (4.8 seconds scan time and 0.3 mm voxel size with an FOV of 8 x 16 cm).[5] Essentially, this is a panoramic field-view setting, therefore no lateral cephalometric radiograph was created after the CBCT scan. The eruption of the maxillary lateral incisors and canines was of greater concern as they were transposed with a significant risk of root resorption in teeth 11, 21, and 12, 22 as a result. In addition, an airway evaluation for this patient was scheduled as the oropharyngeal space, the nasopharyngeal space, and the nasopharyngeal area of the upper airway were severely constricted, which was evident from the excessive gingival display and hyperplastic maxillary gingival tissue **(Fig 1-4a to d)**.

Evaluation of her maxillary sinuses on the CBCT scan showed them to be radiolucent and clear with


1-1a


1-1b


1-1c


1-1d


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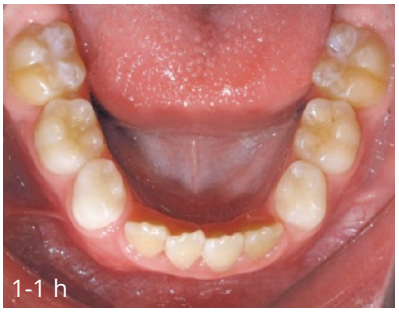
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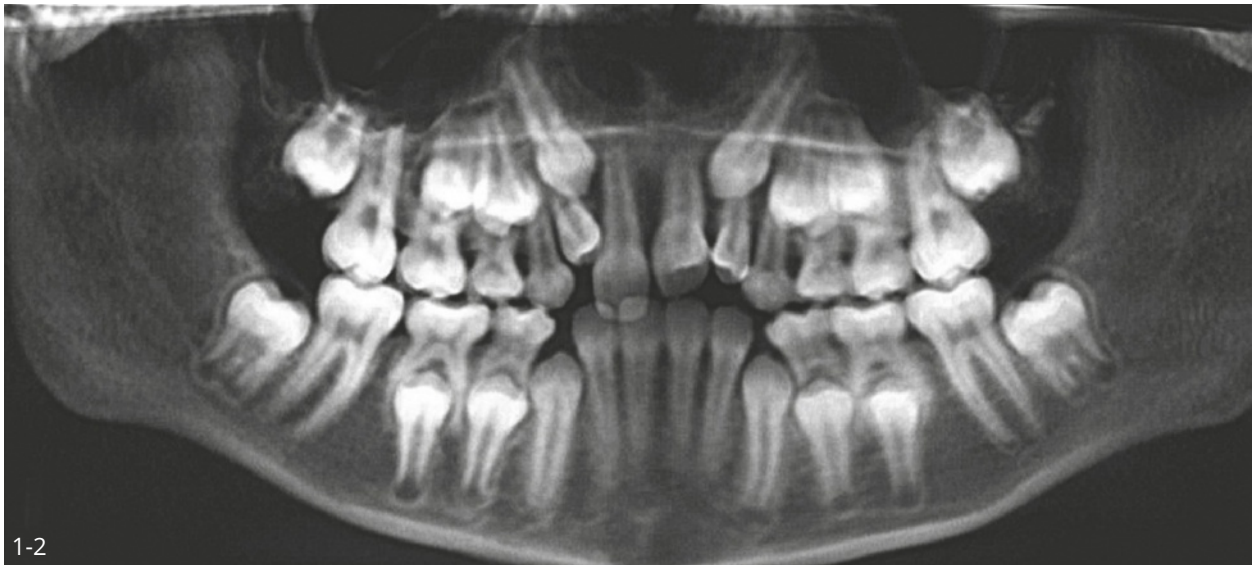
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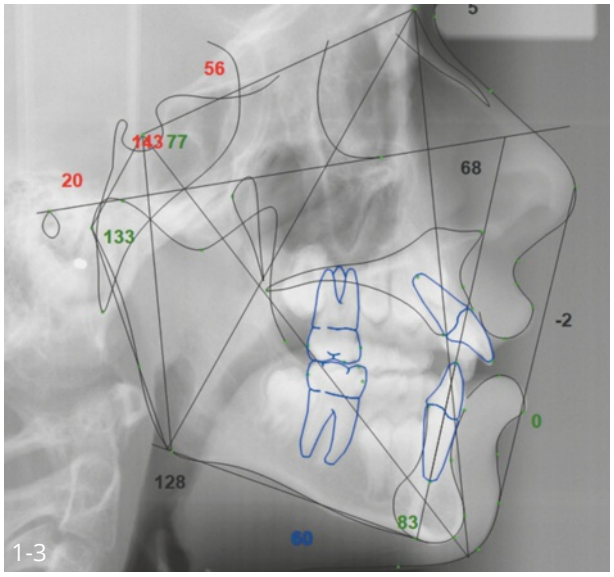

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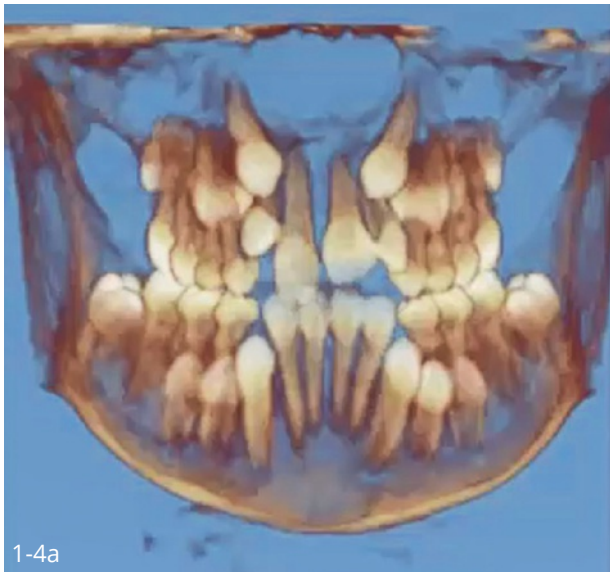
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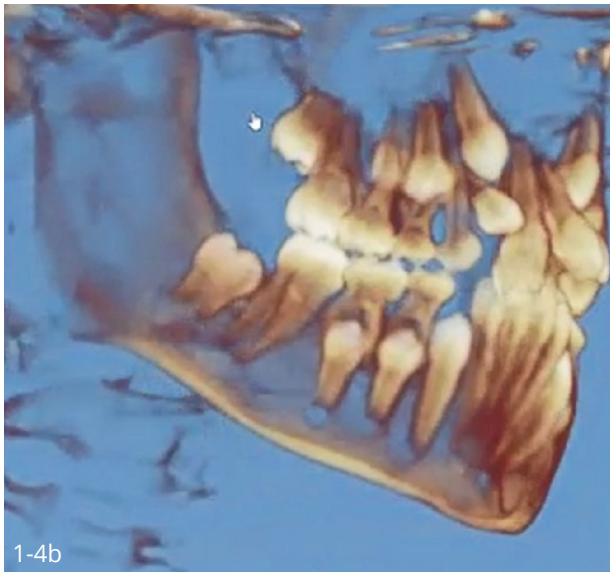
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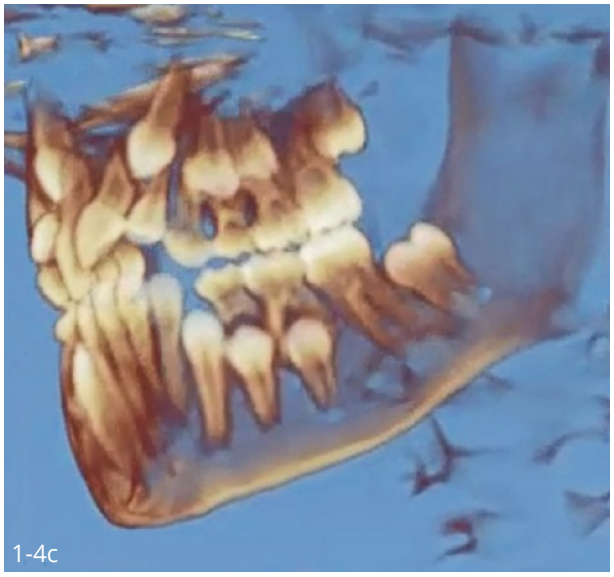
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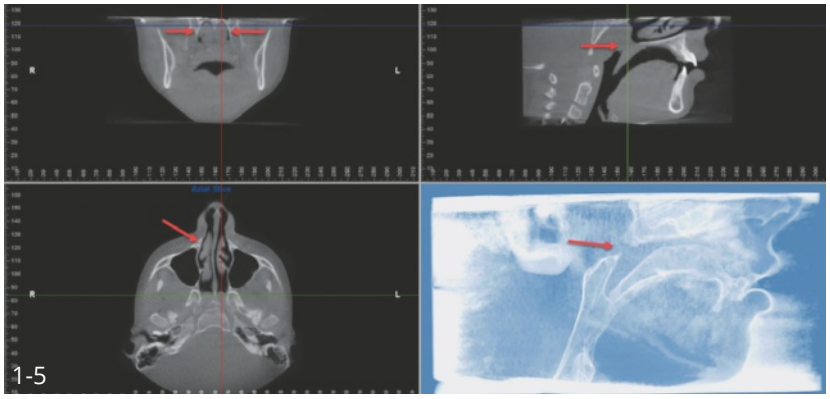
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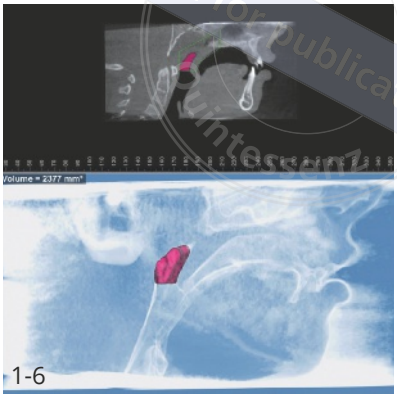
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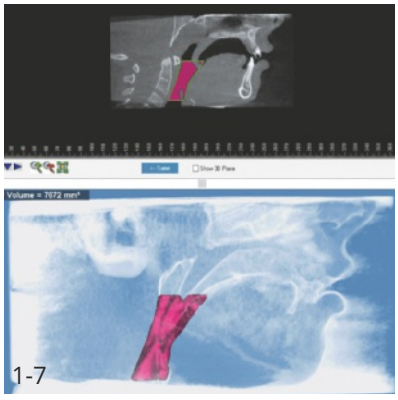
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1-8

no pathology present. However, there was a mild nasal septal deviation to her right with hypertrophied inferior right and left nasal turbinates present.[4] Evaluation of her upper airway indicated an obstruction in her nasopharynx due to hypertrophied adenoid tissues. Red arrows on the left cross-sections indicate a deviated nasal septum to her right with hypertrophied right and left inferior nasal turbinates. Red arrows on the right cross-sections indicate a constricted upper airway with hypertrophied adenoids **(Fig 1-5)**.

Her upper airway cross-sectional area was right at the minimum normal threshold at 104 mm^2 and below the normal threshold airway volume at 2,222 mm^3 **(Fig 1-6).** However, more research is needed to truly define and obtain a general consensus for normative 2D and 3D airway values.[4] The middle and upper portions of her lower airway were within normal limits with a cross-sectional area of 399 mm^2 and volume of 7,672 mm^3 **(Fig 1-7).** It is generally considered that there should be a minimum cross-sectional area of 100 mm^2 with a minimum airway volume of 3,000 mm^3, which is mainly the baseline for airway evaluations undertaken by this author.

The anterior nasal cavity width from a frontal view was measured at 19.4 mm. There are many different facial types (dolichocephalic, mesocephalic, and brachiocephalic) that impact the shape of the nasal cavity. This measurement was taken to establish a baseline prior to the initiation of any orthodontic treatment as the size of the nasal cavity should be taken into consideration with airway evaluation **(Fig 1-8)**.


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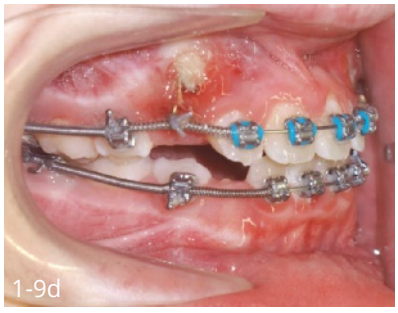
1-9c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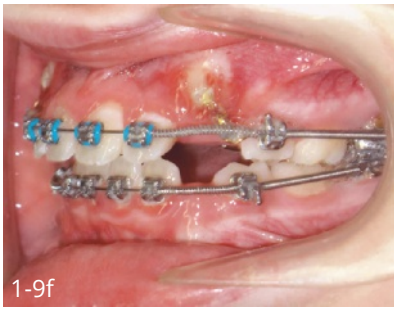

1-9f

1.3 Treatment plan considerations

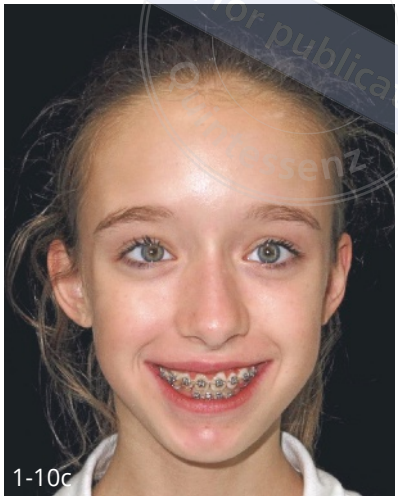
The debate of extraction versus non-extraction orthodontic treatment remains contentious in orthodontics. However, the author's treatment philosophy has always been more non-extraction orientated. For this case, with significant concerns about airway obstruction, the severity of her maxillary and mandibular arch constriction and her constricted and gummy smile. The author's personal belief was that the combination of RPE with a fixed appliance would create an optimal occlusion with enlargement of the airways and provide sufficient space for the function of the tongue **(Fig 1-9)**.

1.4 Treatment progress

A Phase I, non-extraction treatment plan beginning with an RPE appliance was recommended to the parents of the patient due to concerns with her reduced upper airway volume, gummy and tapered smile, severity of crowding, and transposed teeth. For her transposed teeth 12, 13, 22, and 23, extraction of both maxillary canines was recommended by her dental practitioner prior to the start of orthodontic treatment. Following primary teeth extractions, orthodontic treatment was initiated with the RPE. Instructions were given to turn the RPE key one turn every other day. There were a total of 30 turns resulting in 7.5 mm of expansion (mandibular fixed appliances for arch form development and open coil springs for teeth 33 and 43. Approximately 2 months after the treatment began with the RPE, American 0.018" Empower self-ligating brackets (American Orthodontics) were directly bonded for her 54, teeth 12 and 22, and 64 and a 0.016" CuNiTi wire was placed as her initial archwire. Active open coil springs were placed for teeth 13 and 23 to create more space than necessary due to her transposed teeth. Approximately 2.5 months after her brackets were bonded in her maxillary arch, American 0.018" Empower self-ligating brackets were directly bonded in her mandible for tooth 46, 84, teeth 42 and 32, 74, and tooth 36, and a 0.016" CuNiTi straight wire was placed as her initial archwire.


1-10a


1-10b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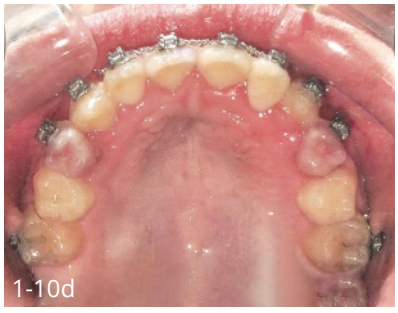

1-10d


1-10e

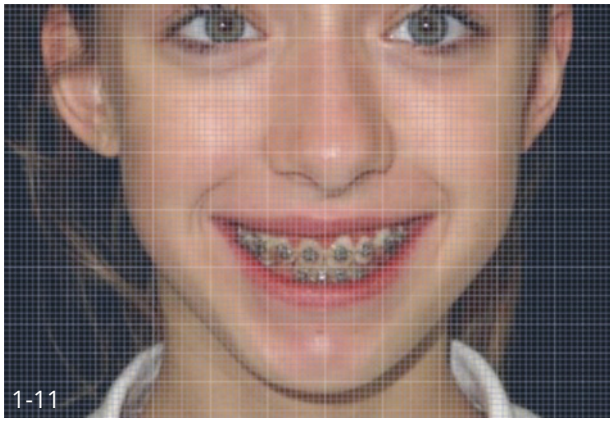

1-10f


1-10g


1-10 h


1-10i

Active open coil springs were placed for teeth 43 and 33 to create space and allow for eruption of these teeth. A new 0.016" CuNiTi straight wire was placed in her maxilla with new, active open coil springs to create additional space due to her transposed teeth. Approximately 2 months later, after additional space had been created for teeth 13 and 23, a soft tissue diode laser was utilized to surgically expose these teeth, and a gold button and chain were bonded to them. The RPE was kept in place for a total of 12.2 months for anchorage in her cortical bone and to maintain transverse width of her maxillary arch while bringing her teeth 13 and 23 into their correct positions. Round CuNiTi straight wires (0.014", and 0.016") were utilized in her maxillary arch during the entire process of Phase I treatment while bringing her teeth 13 and 23 into their correct positions to protect the roots of her teeth 12 and 22, and to minimize the potential for root resorption **(Fig 1-10)**.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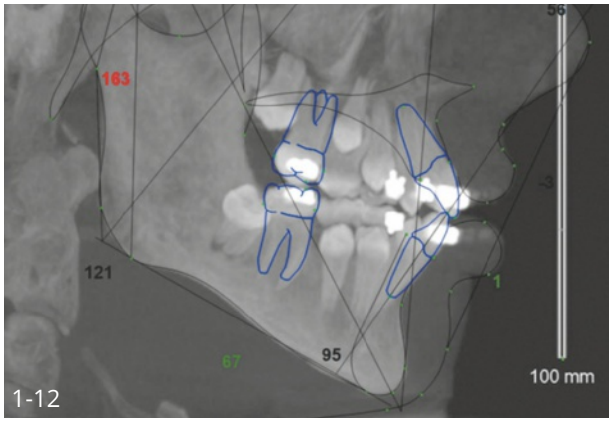


1-12


1-13

1.5 Phase II evaluation

After approximately 17 months of Phase I treatment, Phase II records were taken with updated photographs and CBCT scans after consultation with her parents for Phase II treatment recommendations. The patient was now 13 years and 2 months old. Significant positive changes had been achieved with her Phase I treatment by creating an arch length for non-extraction treatment, correcting transposition of teeth 12, 22 and 13, 23, preventing impactions of teeth 12, 33, and 43, broadening her maxillary and mandibular arches, and reducing her excessive gingival display. In addition, her father reported that her snoring had decreased significantly to approximately 75% to 80% of what it was prior to the start of her orthodontic treatment. Intraoral examination revealed a Class I malocclusion with retained 55, 65, 75 and 85 and delayed eruption of teeth 15, 25, and 35, 45. She presented with a vertical overlap of 20% and a horizontal overlap of 1 mm. No arch length deficiency was observed in her maxilla and now the spacing in her mandible was 2 mm. Both the maxillary and mandibular arches were symmetric and ovoid in arch forms. Periodontal evaluation revealed healthy oral mucosal and hyperplastic gingival tissue with generalized plaque and gingivitis present in both the maxillary and mandibular gingival tissues.

Frontal facial evaluation revealed a similar dolichocephalic facial growth pattern in comparison to pre-treatment records. Profile evaluation also revealed a very similar retrognathic profile with a recessive chin. Her nasolabial angle was still 130 degrees. Both the upper and lower lips were normal and competent at repose. A frontal smile evaluation revealed a slightly higher upper smile line and a gummy smile with 4 mm of excess gingival tissue showing on smiling, which was a reduction of 4 mm prior to the start of her Phase I treatment. An anterior and posterior maxillary cant was present 2 mm down to her right when smiling. This cant evaluation was performed with superimposition of her smile photograph with a grid where each square in the grid was equivalent to 1 mm. No buccal corridors were evident anymore when smiling due to broadening of her maxillary and mandibular arches **(Fig 1-11)**.

From the cephalometric radiograph generated off an i-CAT FLX QuickScan with a low-dose CBCT scan at 13 × 16 cm FOV, the cephalometric analysis revealed a Class I skeletal relationship with ANB = 3.2 degrees. She still had an open bite skeletal growth pattern and her SN-MP increased slightly up to 44.4 degrees. Her retroclined mandibular incisors (42-32) were now more centered in


1-14a


1-14b


1-14c


1-14d

her alveolar trough with IMPA = 95.2 degrees **(Fig 1-12)**. Assessing the panoramic radiograph from an i-CAT FLX QuickScan with a low-dose CBCT scan at 13 × 16 cm FOV, the panoramic and 3D evaluation revealed healthy and normal alveolar bone height for both the maxillary and mandibular arches. The roots of teeth 12 and 22 had a good root form and length, and their root morphology was protected during Phase I treatment while correcting the transpositions of teeth 12, 22 and 13 and 23. Her teeth 17, 27 and 37, 47 were all present and in development but unerupted. Only teeth 18 and 28 were immature and still in development. However, her 55, 65, 75, and 85 were retained with little root resorption and her teeth 15, 25, and 35, 45 were all ectopically erupting lingually with root development nearly complete and little active eruption remaining with definite potential for impactions **(Fig 1-13)**.

After correcting the transposition of teeth 12, 22, and 13, 23, the roots of teeth 11, 21, and 12, 22 had been protected. Any remaining root resorption was very minimal. Space was created for teeth 31, 41, 32, 42 and 33, 43 as well to prevent impactions. The process also involved dental arch expansion as well as mid-palatal sutural expansion. Though some constriction was still felt in the nasopharyngeal area, according to her father, her mouth breathing and snoring had improved significantly. As with the airway, not only the oropharyngeal and nasopharyngeal areas are important but also the involvement of the maxillary sinuses, so CBCT scan was required for linear measurements of the anterior nasal cavity **(Fig 1-14a to d)**.

4 Guidelines for Successful Treatment of an Interdisciplinary Ortho-Perio-Prostho Case

Nuno Sousa Dias, Nazariy Mykhaylyuk, Ventseslav Zhivkov Stankov

4.1 Introduction

Interdisciplinary cases are a great challenge since the patient is often confused about who is managing the case. The orthodontist is generally the first clinician to see the patient with the complaint of crooked teeth. The patient is, however, unaware of many other aspects related to the case such as abraded incisal edges, uneven gingival height, old unesthetic restorations, tooth color, and periodontal condition.[1] In addition, it is essential to diagnose the musculature behavior of the lips during rest and in different smiling positions. Therefore, it is necessary to integrate all these parameters since most patients develop an exaggerated dental awareness when they start treatment and, even if not all the imperfections are eventually addressed or corrected, a thorough discussion must take place to build the workflow in a very clear manner and set the timing at which each interdisciplinary team takes on the role. Today, digital tools such as intraoral scanners enable sharing of not only the earlier records but also the ongoing ones. Virtual meetings are constantly scheduled to ensure adequate follow-up.

A 24-year-old woman presented with a complaint related to her smile esthetics. She was aware of some disharmony in teeth positioning for which she decided to first consult the orthodontist. After the clinical examination, the patient was informed about her clinical condition and the need to reestablish oral health before addressing any other treatment objectives. She was informed about the complexity of the condition and the need for a multidisciplinary approach to address the necessary corrections to achieve the best esthetic and functional outcome. It was anticipated that she would need restorative and periodontal intervention, therefore these were included in the consultation and workflow of this case. From the anamneses, it was concluded that fortunately, she did not present any medical condition that could impact the treatment. From the frontal view, her face presented balanced proportions, with just a minor deviation of the tip of the nose to the right side but without clinical significance. From the lateral view, she had an esthetically pleasing profile with no noticeable disharmony between the forehead, nose, lips, chin, and neck **(Fig 4-1a and b)**.

4-1a

4-1b

The patient's smile appeared well-located on the facial frame, with the lips in balance with respect to size and equilibrium, but a small amount of asymmetry could be noticed on the upper lip, with the right side having less volume. When smiling, her lips stretched nicely from a closed to rest position, from medium to maximum, and gradually displayed the incisors as expected from a normal lip support. Yet, her upper lip was thinner than the lower lip, and due care was taken not to retract the teeth and risk collapse of the upper lip **(Fig 4-2)**.

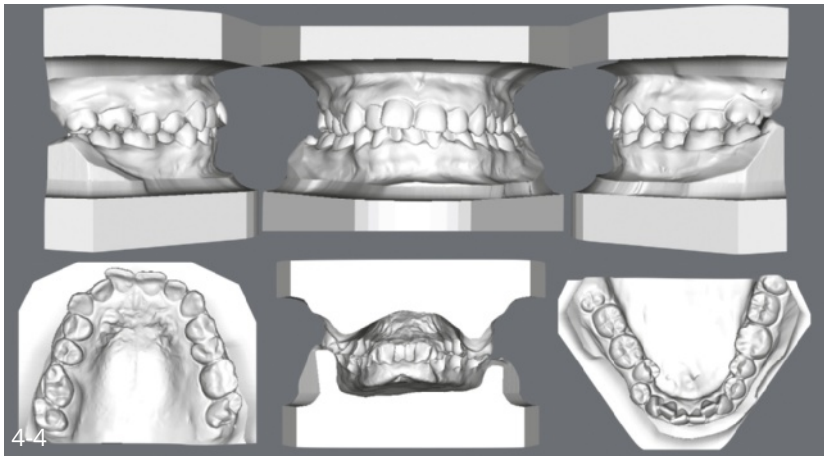
Her oral health was generally compromised. Generalized gingivitis with plaque accumulation was apparent, with most of the teeth having already been restored. Many of the restorations were in a compromised condition: the maxillary dental midline matched the facial midline and presented a small inclination, and the mandibular midline deviated approximately 3 mm to the left compared to the maxillary midline. At this stage, it was essential to determine which restoration must be added before orthodontic treatment due to active caries or restorative breakage during treatment. A discussion

4-2

4-3

was carried out with the patient and the team about which irregularities should not be included in the plan, not only as a matter of compromise, but as some of these were in harmony with the face, and did not require any special attention **(Fig 4-3)**.

Intraoral scanning makes it possible to examine, enlarge, and explore the teeth in a far broader way than just portable visual search (PVS) models, enabling the practitioner to check tooth size, occlusal contacts, arch width, and more. In the maxilla, mild crowding was present mainly on the right-hand side; the crown of tooth 22 was smaller mesiodistally compared with tooth 12; tooth 16 had been lost a long time ago, and the space was closed with mesial drift of tooth 17 followed by tooth 18. In the second quadrant, tooth 28 did not erupt to the arch. In the mandible, all the teeth were apparent—the anterior teeth were severely crowded. In the third quadrant, tooth 36 had a porcelain crown and in the fourth quadrant, tooth 45 was lingually positioned. Mandibular third molars 38 and 48 were partially erupted. Regarding the Angle classification, she presented molars in Class III malocclusion on the right-hand side, and in a mild Class II relationship on the left-hand side **(Fig 4-4)**.



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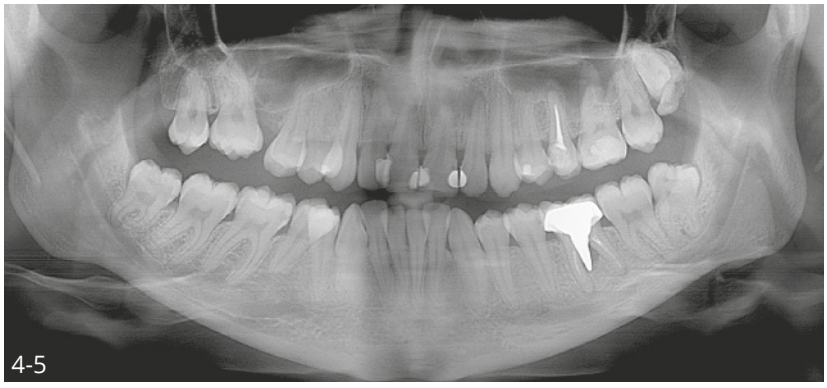


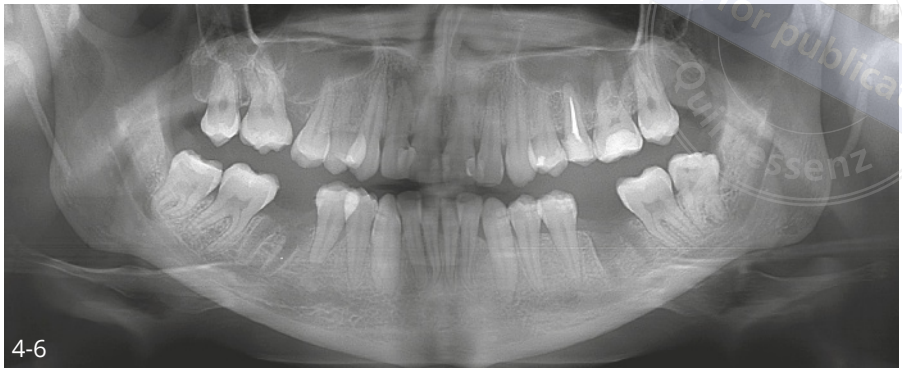
4-5

A panoramic radiograph taken before treatment revealed the most relevant radiographic findings such as an acceptable generalized bone level; a low position of the maxillary sinus in the first quadrant; an abnormal shape of tooth 28 in the second quadrant; a bad prognosis for tooth 36 in the third quadrant, and an apparent reduced crown/root ratio for tooth 45. The evaluation of caries and periodontal and endodontic conditions was done using periapical radiographs by the dental practitioner, who determined that tooth 36 should be extracted and all other final restorations could be delayed until after orthodontic treatment **(Fig 4-5)**.

4.2 Treatment goals

The following treatment goals were set and discussed with the patient:

- reestablish oral health;
- improve masticatory function;
- improve smile esthetics;
- resolve dental crowding in both arches;
- achieve an Angle Class I canine relationship;
- coordinate the dental arches;
- match the facial and dental midlines;
- improve the level of the gingival margins;
- open space to increase the mesiodistal size for correct dimensions of tooth 22;
- extract tooth 36 for dental reasons and consequently extract tooth 46;



4-6

4-7

- mesialize the second and third molars to close part of the space left by the extracted teeth;
- use a portion of the space left by the extracted teeth to resolve mandibular crowding;
- undertake interdisciplinary treatment involving the dental practitioner, orthodontist, prosthodontist, periodontist, and endodontist.

Oral health was reestablished starting with prophylaxis, oral hygiene instructions, and provisional restorations on several maxillary teeth, therefore teeth 28, 36, and 46 were extracted **(Fig 4-6)**.

A fully fixed appliance with ceramic brackets was chosen. The intention was to start the treatment of the mandibular arch first due to the expected longer treatment time compared to the maxillary arch. Owing to severe anterior mandibular crowding, brackets were not placed on teeth 32 and 42. For this reason, the increased interbracket distance made it possible to place a 0.016" NiTi (nickel-titanium) initial wire tied with metallic ligatures. It was expected that the anterior crowding would be reduced by using a portion of the space created by the extraction of teeth 36 and 46 **(Fig 4-7)**.[2–6]

Approximately 5 weeks later, it was already possible to bond the ceramic brackets on teeth 32 and 42. During this visit, metallic single tubes were bonded on teeth 37 and 47. Importantly, these tubes were for teeth 36 and 46 since the goal was to position the second molars in place of the extracted first molars **(Fig 4-8)**.

The patient came back 5 weeks later and showed good progress in terms of leveling, alignment, and

6 Not Just Aligners: A Hybrid Approach for Complex Cases

Luca Lombardo, Francesca Cremonini

6.1 Introduction

The treatment of adult patients is often complex, and therapeutic options must be examined from many perspectives. Hence, it is necessary for a team of specialists to collaborate in formulating a thorough diagnosis and effective treatment plan for the resolution of all dental and orthodontic issues if an optimal overall result is to be achieved. The ability to study each case individually, leveraging all the tools available in this digital age, has improved the quality of the dialogue between professionals and consequently increased the benefit to patients as the case report presented in this chapter illustrates.

6.2 Case presentation

The aim of this case is to shed light on:

- multidisciplinary collaboration;
- hybrid treatment;
- skeletal expansion in an adult patient;
- opening space biomechanics in lateral incisor agenesis;
- finishing with clear aligners.

A 25-year-old man presented with transverse maxillary deficiency, left lateral crossbite, and agenesis of the maxillary lateral incisors. Even though he was highly motivated to resolve his malocclusion and obtain a pleasant, well-aligned smile, he refused any kind of surgery and demanded an esthetic, non-invasive treatment. Nowadays, it has been widely demonstrated that even patients aged older than 25 years can achieve the same increase of skeletal transverse maxillary diameters with miniscrew-supported expansion as with surgically-assisted rapid palatal expansion (SARPE).

In the frontal view, the patient's face appeared harmonic, with a well-proportioned lower third with respect to the middle and the upper thirds. Nevertheless, there was a deviation of the mandibular symphysis to the left. The profile could be defined as straight, with a correct nasolabial angle and a good relationship between the arches **(Fig 6-1a to c)**.

Except for maxillary lateral incisor agenesis, all the teeth were present in the arches, including the third molars, which had erupted normally. The patient had a Class I first molar relationship on both sides, but a Class I canine relationship on the right side and Class II on the left **(Fig 6-2a to c)**.


6-1a

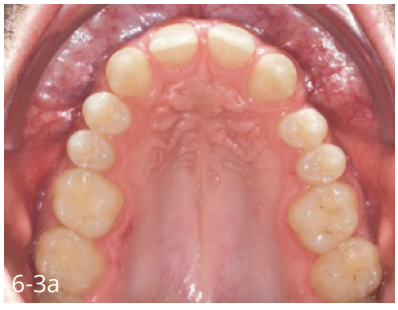

6-1b

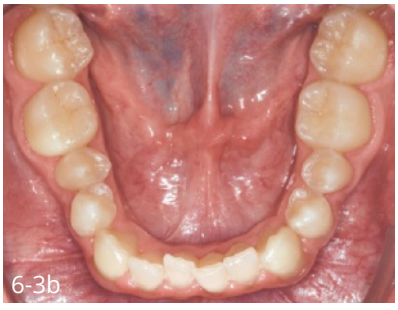

6-1c


6-2a


6-2b


6-2c


6-3a

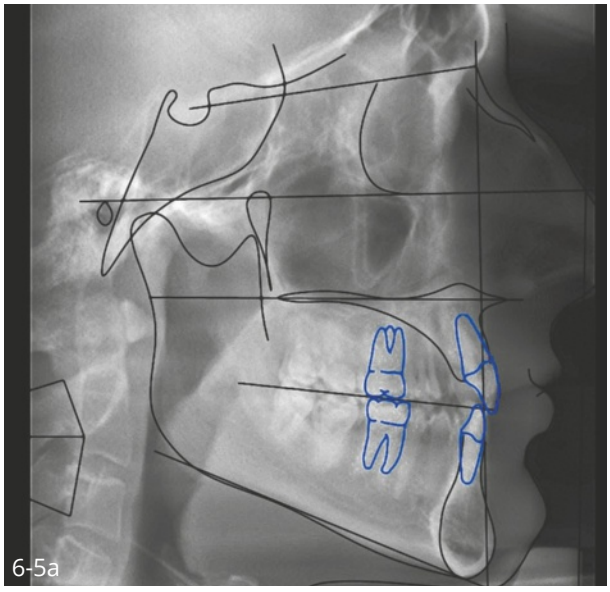

6-3b

There was slight crowding in the mandible and midline deviation to the left. The maxilla presented a central diastema and dental asymmetry due to the more distal position of the teeth in quadrant two. The teeth adjacent to the missing lateral incisors had not entirely filled their places, leaving wide black corridors especially on the left. Transversely, a maxillary deficiency was evident, with a lateral left crossbite as a direct clinical consequence.

If the initial size of the teeth was analyzed, a mesiodistal diameter of 6 mm for the missing lateral incisors was needed for normalization of the Bolton index. Because the mandibular anterior width (diameter = 3-3) was 31.3 mm, the maxillary anterior width had to be increased by 12 mm, from 28.5 to 40.5 mm. The diagnostic dental analysis could be performed digitally, which made it possible to plan the final dimensions of the lateral incisors **(Fig 6-3a and b)**.

The panoramic radiograph showed good root parallelism, with some missing space for the lateral incisors due to anterior crowding. Although a slight difference in the right and left condyle size was evident on the radiograph, no temporomandibular disorders or functional alterations were reported. For this reason, no further evaluation or radiological investigation was needed **(Fig 6-4)**.

6-4



6-5a

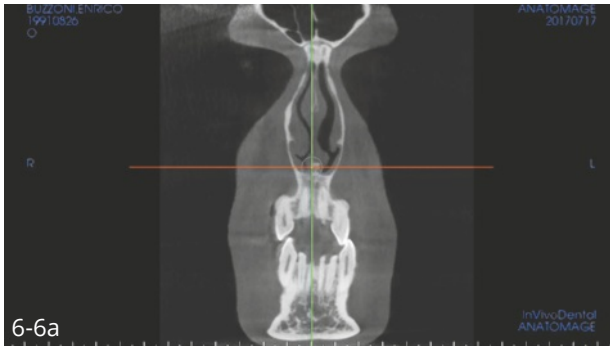
* HORIZONTAL SKELETAL *		
SNA (°)	83.0	82.0
SNB (°)	82.9	80.0
ANB (°)	0.1	2.0
Maxillary Skeletal (A-Na Perp) (mm)	-3.7	0.0
Mand. Skeletal (Pg-Na Perp) (mm)	-3.8	-4.0
Wits Appraisal (mm)	-3.2	0.0
* VERTICAL SKELETAL *		
FMA (MP-FH) (°)	23.7	26
MP - SN (°)	27.4	33.0
Palatal-Mand Angle (°)	19.6	28
Palatal-Occ Plane (PP-OP) (°)	4.4	10.0
Mand Plane to Occ Plane (°)	15.2	11.4
* ANTERIOR DENTAL *		
U-Incisor Protrusion (U1-APo) (mm)	0.8	6.0
L1 Protrusion (L1-APo) (mm)	-1.5	2.0
U1 - Palatal Plane (°)	103.6	110.0
U1 - Occ Plane (°)	72.1	54.0
L1 - Occ Plane (°)	84.9	72.0
IMPA (°)	79.9	95.0

6-5b

Cephalometric analysis showed a tendency toward a sagittal Class III relationship. Even though the ANB angle was positive (0.1 degrees), the Wits appraisal had a negative value (–3.2 mm). No dental compensation could be evaluated at this stage, because both the maxillary and mandibular incisors were retroclined with respect to the palatal plane (U1-Apo 103.6 degrees) and the mandibular plane (IMPA 79.9 degrees). The skeletal growth pattern was normodivergent (FMA 23.7 degrees), indicating that treatment with a slight mandibular post-rotation was accepted **(Fig 6-5a and b)**.

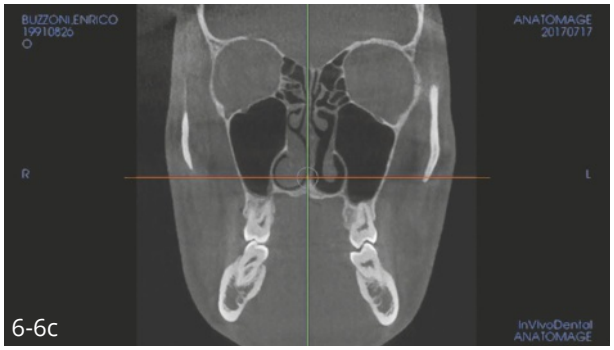
When a skeletal discrepancy is recognized in an adult patient, it is always important to include a CBCT scan in the initial records. Analyzing the slices in the 3D radiograph, it is possible to study the bone thickness and the lingual root torque to understand if dental compensation of the transverse discrepancy is still possible. In this particular case, the CBCT scan was also prescribed for surgical and implantology reasons.

Axial CBCT slices at the maxillary canine and premolars and at the furcation of the first molars confirmed a severe transverse maxillary deficit, left lateral crossbite, and accentuated curve of Wilson, that is also shown from the 3D skull model. It is evident that the maxillary teeth were straight with respect to the alveolar bone, with no cortical bone



6-6a

6-6b



6-6c


6-6d

available for any dental compensation for the transverse discrepancy **(Fig 6-6a to d)**.

6.3 Treatment plan considerations

6.3.1 Maxillary skeletal expansion

As the patient was an adult, traditional rapid maxillary expansion (RME) was not recommended for the treatment of the malocclusion because of the various side effects that would arise, namely dentoalveolar tipping and bony dehiscence, with no opening of the mid-palatal suture. Orthopedic surgical expansion of the basal bone would have been capable of overcoming the increased resistance of the midpalatal suture and establishing proper posterior occlusion. Nevertheless, this procedure is associated with a large amount of relapse and discomfort for patients, and the present patient demanded a less invasive approach. Hence, to avoid surgery but still achieve successful expansion of the midpalatal suture, with minimal dental buccal tipping and unfavorable periodontal effects, miniscrew-assisted bone-borne RME was proposed.

6.3.2 Maxillary lateral incisor agenesis

The demand for orthodontic treatment in patients with congenitally absent maxillary lateral incisors is high because the condition has an obvious impact on facial esthetics, adversely affecting the individual's self-esteem. The two major treatment alternatives, namely orthodontic space closure and space opening for prosthetic replacements or implants, could both be acceptable compromises in terms of esthetics, periodontal health, and function. However, correct diagnosis, careful treatment planning, and interdisciplinary collaboration are crucial to achieving a satisfactory result. In this case, the stable dental Class I relationship, reduced incisor inclination with respect to the maxilla, generalized spacing of the teeth, and the tendency toward a Class III malocclusion indicated that space opening would be the more appropriate solution. Implant rehabilitation was particularly favorable because the

patient had no history of periodontitis and had good oral hygiene and optimal periodontal health. As the patient was already 25 years old, implant placement could be done directly at the end of orthodontic treatment because passive tooth eruption is limited at this age. To determine the amount of space necessary for restoration of the missing lateral incisors, esthetics represent the most important factor, together with the evaluation of the size of implant fixtures. In general, to ensure sufficient space for implant placement, 6.3 mm intercoronal space and 5.7 mm interradicular space between the adjacent central incisors and the canine are recommended. The initial position of canines that are very close to the central incisors is another factor that works in favor of the space opening solution. The orthodontic movement in distalization would determine a new bone apposition, even though a final bone graft would probably be necessary.

6.4 Treatment plan selected

A two-phase treatment was planned. The first phase consisted of orthopedic treatment with the objective of obtaining correction of the transverse deficiency, conducted with a four-miniscrew pure skeletal anchorage expander. This first phase was considered completed after the maxillary deficiency had been resolved. The amount of time needed was uncertain, depending on the patient's response.

The second phase consisted of orthodontic treatment with the objective of obtaining a correct intercoronal and interradicular space for the subsequent rehabilitation of the lateral incisors. The estimated treatment time was less than 12 to 18 months. As the patient requested high esthetic appliances, lingual fixed braces were planned in the maxilla in the first phase to have good root control during space opening. Finally, clear aligners were used for refinement of alignment, leveling, and coordination of the maxilla and mandible.

At the end of orthodontic treatment, two implants and integrated ceramic crowns were placed in order to substitute the missing maxillary lateral incisors, preceded by bone grafting. Each phase was characterized by accurate digital planning to maximize the precision and efficiency of every system used.

6.4.1 First phase of treatment

To achieve true skeletal expansion, a four-miniscrew pure skeletal anchorage expander was designed and the use of the Miniscrew-assisted Palatal Application (MAPA) system was planned[1,2] to avoid any possibility of damage to the anatomic structures. Thanks to accurate preoperative planning on volumetric tomographs and in purpose-designed software, the MAPA system enabled safer insertion of the miniscrew (11 mm length, 2 mm diameter; Spider Screw Regular Plus, HdC, Thiene, Italy), and ensured bicortical engagement. This in turn guaranteed greater resistance for supporting the expansion device. After scanning, a digital model (stereolithography file) of the maxilla was superimposed onto the CBCT scan using eXamVision (KaVo Dental, Biberach, Germany) and Rhinoceros software (Robert McNeel & Associates, Seattle, WA, USA) to identify the best anteroposterior miniscrew placement sites based on the width and thickness of the palatal vault **(Fig 6-7a and b)**. Two cylindrical guides were designed to replicate the angle of insertion and prevent the screws from penetrating beyond the required depth in the central position of the palate.

The same software was then used to design a virtual surgical guide that would fit the morphology of the palate and the teeth in the buccal and posterior segments of the maxilla. Maintaining accurate control of the placement and direction of insertion, four miniscrews with a length of 11 mm and a diameter of 2 mm were inserted into the palate. The expander was then designed with the same purpose-designed software in order to have optimal correspondence with the position of the miniscrews **(Fig 6-8a to d)**.

A tandem skeletal expander (TSE) was employed, characterized by simultaneous use of two expansion screws, one in the front and one in the rear.[3] The virtual position of the two expander screws was checked on occlusal and sagittal views. This enabled the biomechanical difficulties to be overcome