

Paradigm Shift in Orthodontics

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ABSTRACT

In the Time Magazine issued on May 22, 2000, orthodontics was listed as one of the 10 careers that would disappear in the “new millennium.” At that time, this prediction seemed ridiculous, not even worthy of consideration. Now, as we approach the end of this millennium’s first decade, there is evidence that might lead one to believe that this profession might be at risk after all. Orthodontics is going through a watershed moment in many ways. New technologies and emerging concepts of dental care are being rapidly developed and incorporated into clinical practice, and getting scientific interest around the world. In this world of innovative technologies, we realize that we have a shared clinical practice, where a segment of Dentistry is concerned uniquely with commercial aspects, performing dental alignments without major criteria for diagnosis and treatment planning and increasing its market share daily, while the real specialty desperately looks for a new path to follow. The use of these innovative technologies allied with the contemporary concepts of orthodontic treatment as clinical practice based on scientific evidence, minimally invasive procedures, tissue engineering and oral systemic medicine, to define an innovative approach to the specialty focuses on a systemic approach to promoting health and life quality, as opposed to the traditional “Angle’s paradigm”.

Keywords: 3-dimensional craniofacial imaging, Orthodontic diagnosis, Quality of life.

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1. Overview

Orthodontics is a specialty that is going through a watershed moment. A new generation of technologies providing multiple possibilities is being developed and quickly incorporated to the clinical practice. These technologies work as vehicles for conceptual changes to the Orthodontics field. On the other hand, the practitioner feels discouraged and depreciated in a very competitive market, in a moment when this practitioner should have taken as an opportunity to develop a new treatment philosophy. Questions related to the therapeutic decision-taken process (assessment of benefits, expenses, risks and responsibilities), need for new working tools, such as computers, peripherals and software, formation of a new knowledge foundation, greater importance for a practice based on scientific evidences and minimally invasive procedures, as well as understanding of an individual as whole will become even more important to the development of a new professional who wants to be competitive in the Orthodontics market. At the same time, this practitioner also starts offering a new variety of benefits and possibilities to its patients. The new Orthodontics understands the concept of a treatment that goes beyond morphology and physiology for health and wellness. Make the patients' quality of life better instead of simply "treat a disease" should be the treatments' main goal. Besides, a dentofacial problem is not a pathological condition in itself. Thus, the "Orthodontic health" can be better defined as a constellation of characteristics consistent with the physical, mental and social welfare of an individual in opposition to the traditional reactive concept, which does not see "the whole" situation, but just "part of it", values the morphology over the function and is extremely complex and disintegrated.

2. The Current Market and the New Trends

Orthodontics is the oldest specialty in Dentistry and, paradoxically, it is the most threatened area into a saturated and standing market. On the other hand, sadly the practitioners are becoming very indifferent on the search for new ways and alternatives. The *Time* magazine, on its issue from May 22, 2000, listed the Orthodontics as one of

the 10 careers that is most likely to disappear on the new millennium. According to Brett Blake¹, a Wall Street analyst graduated in the Harvard Business School, who has been working as a consultant in this area, the American Orthodontics is currently at risk due to the competition with the dentists who are indiscriminately using aligners, such as Invisalign[®], after attending to what they called as “weekend courses”. The Align Technology American Company has already trained over 31 thousand dentists and has almost 25 thousand practitioners treating patients currently in the USA. Thus, the general practitioners noticed a dramatic increase on their market share for the last ten years in the US. An analyst's report published on January, 2008 by the Piper Jaffrey estimated that, by the year of 2005, a higher number of procedures would be performed by dentists with aligners than by Orthodontics specialists. According to him, the lack of reaction from those specialists was the most shocking fact. Does the Dentistry community understand that this unresponsive reaction from the Orthodontists takes the public to assume that this specialty is not necessary and that the dentists are as qualified as the Orthodontists to perform the job? Blake wonders. Deborah Pereira², in her recent monograph published by the Universidade Federal do Paraná / Brazil, confirmed the reduction on the number of Orthodontists following the academic career in the United States, according to the American Dental Association (ADA), the American Association of Orthodontists (AAO) and the American Association of Dental Schools, which characterizes the lack of interest for this area of specialization.

In Brazil, the reality is even more complicated, as it shows a dramatic increase on the number of Orthodontics specialization courses and, consequently, of professionals available in the market. In 2001, there were 124 Orthodontics specialization courses; in 2007, this number raised to 315, and, in 2009, the number of specialization courses in Brazil reached 329, with almost 15 thousand Orthodontists working in the most competitive market of the world. Those numbers do not take into account the tens of thousands dentists without specialization who keep practicing the corrective Orthodontics within their offices. They inappropriately use some technology innovations, such as aligners, Orthodontics wires and preset systems. This Dentistry practice sounds to be legal, since the Orthodontics is part of the curriculum in the Dentistry graduation courses. Besides, the Law 5081/66, which regulates the Dentistry exercise and practice, says that the dentists can exercise all the actions concerning the Dentistry, due to the

knowledge acquired from graduation or post-graduation courses. Additionally, the Conselho Federal de Odontologia (CFO) does not prohibit the practice of Orthodontics acts by the non-specialized dentists; the CFO only prohibits the dentists to publish or advertise titles, qualifications and specializations they do not have or the CFO does not recognize. Consequently, the market is chaotic and represents losses for both sides: the population, who is confused and cannot find a quality treatment that suits their needs; and the specialized professionals, who invested years of study, hard work and material resources to see their area of specialization degraded and incorrectly interpreted. Within this fractious context, technological innovative appliances and new philosophy of treatment can be able to help recovering this area of expertise as a Science, for the best of the patients' and professionals' interest. Among these technological innovations, we could give as exemple, the temporary anchorage devices, self-ligating brackets and 3D reconstructions through cone-beam computed tomography (CT) and surface scanners, which allow diagnosing and virtual planning of all the cases, not to mention the production of therapeutic guidelines and results analysis. The use of these innovations, together with the contemporary concepts of care, such as the practice based in scientific evidences, minimally invasive procedures, tissue engineering and oral-systemic medicine, define an innovative approach to the Orthodontics specialty area. This approach focuses on systemic aspects to promote health and quality of life as opposed to the traditional "Angle paradigm". With this, there can be not only an improvement of the Orthodontics treatment quality, but also new ways of assess results.

3. The Angle Paradigm *versus* the Quality of Life Paradigm

In 1899, Angle³ proposed a malocclusion classification that has been used until nowadays. Orthodontists have always been influenced by his ideas that the ideal occlusion is reached by aligning all the teeth from the arch, which also establishes good harmony of facial lines. Tweed⁴, Angle's learner, re-evaluated the cases he treated at that time and concluded that the balance between the ideal occlusion and the facial harmony was not always obtained through the alignment of all the teeth. After getting to

this conclusion, he started to indicate the teeth extraction whenever there were discrepancy between the dental volume and the basal bone. Despite of the geniality and brilliance of those precursors, such as Angle and Tweed, for so long the diagnosis and Orthodontics treatment philosophy had been mainly based on the cephalometric standards of the relationship between the teeth and the bone structure. This philosophy looked for a way to fit the patient's face within those relationships considered to be "ideal", i.e., arbitrary standards whose focus was not on the face and on the individual as whole; rules that did not take into consideration any aspects related to the individual need of each patient regarding the aesthetics perception of the smile, the facial harmony and balance and the maintenance of the facial results over time. Not to mention the masticatory and speech functions and the presence of any parafunctional habit (stress) and its repercussion on the TMJ and on the muscles. Besides, issues related to the airways and their inter-relationships with the spatial positioning of the skeletal base and the presence of comorbidities, such as obstructive sleep apnea (OSA) and central sensitization, had almost no importance in the Orthodontics diagnose process, mainly on adult patients. Challenging this common sense, Marc Ackerman⁵ provides a new point of view to the Orthodontics treatment by using a paradigm focused on the patient to improve aesthetics, function and health issues of the dentofacial complex and of the individual as whole, consequently. The importance of this decision-taken process based on information obtained from a new diagnosis philosophy provides a rational way of planning the cases, a way that goes beyond intraoral anatomical entities, for both the face and the individual as a whole. Consequently, the Dentistry is evolving in order to fit to the changes, to become more sophisticated and specialized and to be integrated with the Medicine. The current paradigm stands for an approach that can be better defined as the search for a constellation of dentofacial characteristics, which are consistent to the physical, mental and social welfare of the individual.

4. New Concepts in the Contemporary Orthodontics

The new concepts of health care in Orthodontics provide a more comprehensive understanding of the Oral and Medical Biology; this understanding together with a more extensive range and the diagnosis details that come with the new technologies, mainly

the cone-beam computed tomography (CBCT) have completely changed the philosophical context of “Angle's paradigm”. The fundamental change comes from the reductionist context and goes to the systemic context. This means that the Orthodontics treatment diagnosing and planning have gone through the analysis of occlusion, function, aesthetics and periodontal health, as coexisting entities, moving to the dental health consideration within a system that is much more comprehensive and integrated. Actually, this is related to the change from the 2D to the 3D visual analysis through the CBCT, which makes it easier to take an isolated component and include it into the systemic context, as we can see on Figure 01.

While the “Angle paradigm” focuses on obtaining the ideal shape as we can found in the nature, with a small rate of individual variation, one of the current treatments' philosophies relies on the attention to each individual problem due to the new technologies available and the details that the computed tomography provides. The individualization/customization concept on the diagnosis and on the treatments is an important and highly accepted element of the minimally invasive treatments. The integrated system concept of the minimally invasive Orthodontics (WSMIO – Whole System Minimally Invasive Orthodontics), which was developed by the American Orthodontist, Daniel Meyers, represents an attempt to establish the conceptual frame towards an Orthodontics philosophy, which also comprises health care, in the new technology era. This conceptual frame has the makings of being the foundation for the rationalization and guiding the clinical application of the new technology available to the contemporary Orthodontics. With this purpose, the integrated system of the minimally invasive Orthodontics tries to comprise a substantial number of modern concepts cohesively, which influences the treatments philosophy either direct or indirectly, including:

- Evidence-Based Dentistry (EBD);
- CBCT and customization of the treatments based on the integrated 3D images technologies;
- Minimally Invasive Dentistry (MID).

4.1. Evidence-Based Dentistry (EBD)

The concept of clinical practice based on evidences appeared for the first time on Medical literature on the Journal of American Medical Association, in 1992, in an article written by Guyatt et al⁶. Although the adoption of evidence-based Dentistry practices has been considered to be a slow process by some professionals, there is room for a higher influence of this philosophy over the clinical practice in the future, partially due to the great emphasis that the American Dental Association (ADA) has been given to this philosophy. Essentially, the Evidence-Based Dentistry (EBD) is a scientific approach regarding the dental health care, which is based on the “conscious, explicit and judicious use of the best evidences currently available” on the daily practice. The ADA defines the “Evidence-Based Dentistry” term as:

“Evidence-based dentistry (EBD) is an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences.”

The ADA's policy states that the Evidence-Based Dentistry consists of four steps:

1. Define a clinically relevant question;
2. Systematically conduct searches for all studies and databases, that may help to answer a “clinically relevant question”;
3. Transfer the findings from systematic reviews for use by practitioners;
4. Assessment of the health care outcomes following the findings of the previously described steps.

The EBD represents an important change on the approach regarding the relationship between the scientific knowledge and the clinical practice in at least two different aspects: the approach that requires an assimilation of information resources that focus on evidences originated on randomized clinical trials, other controlled studies

and systematic reviews; and the approach that requires a change of the probabilistic thought.

The identification of information resources is essential to the entire process. Currently, two journals are dedicated to the EBD theme: The Journal of Evidence Based Dental Practice (Elsevier) and Evidence-Based Dentistry (Nature Publishing Group). Thus, the introduction of these technological innovative appliances and the necessity of professional improvement must pass through the formation of a solid base of knowledge, which should probably happen within the next years. However, there are certain clear limitations to those approaches:

- The available evidence can reflect a preconceived idea;
- The available evidence is usually weak or insufficient;
- The available evidence may not confirm the clinical efficiency or may not have clinical significance.

As the EBD approach can favor the construction of a scientifically base of the clinical diagnosis, the treatment planning and/or the treatment itself, the EBD process must be incorporated into a modern health care philosophy.

4.2. CBCT and customization of the treatments based on the integrated 3D images technologies

The acquisition of accurate images is a key part of the diagnosis and planning of the treatment, as well as an important item on the follow-up and documentation of its progress and final results. The image diagnosis has been part of the Orthodontics patient records for decades. This diagnose has usually included 2D image records such as lateral and frontal teleradiographs with their cephalometric tracings, panoramic and periapical radiographs, and photographs.

Traditionally, the only 3D data available are restricted to the dental plaster models study. This is the current paradigm on the image diagnosis in Orthodontics. However, these data sets unfortunately do not represent the patients' anatomy accurately. The accurate diagnosis is the key to the treatment planning; and for this

accuracy, the analysis of image data that represents precisely the true patients' anatomy is essential.

The CBCT advent substantially magnifies the details and the range of information regarding the Orthodontics diagnosis, the planning and the treatment itself due to the amount of available information; the CBCT also substantially improves the communication with the patient, in a interactively way, which also represents a gain related to the Orthodontics clinical communication aspects. The usage of CTBC in Orthodontics is substantially increasing, and both the enthusiasm and the caution on its application are under discussion in the literature. The questions that allow us to determine the balance between the caution and the enthusiasm and to establish the guidelines to the CBCT clinical application are closely related to the *Orthodontics treatment philosophy* concept, which is a very broad subject and it must include valid patterns of health care and Orthodontics practice. The Figure 02 illustrates in a simplified way the cost-benefit relationship of using the CBCT. However, the practitioner that starts using this technology incorporates value to the clinical practice, which makes it usage essential to the daily practice.

Regarding the large amount of interest areas, the CBCT has been recognized and accepted as a means of getting much more complete and accurate information that the details we can get through conventional 2D images or though any other means. The CBCT overcomes the substantial and known failures of the conventional techniques of getting images, such as the superposition, the distortion and the magnification inherent to the X-rays usage on the conventional radiograph techniques. The CBCT offers a visualization without any distortions and the perspectives of the anatomical areas of interest which otherwise would be impossible to get. Besides, the CBCT provides a volumetric representation in 3D that overcomes the capacity of any other means of obtaining 2D images. These advantages show that the CBCT is able to provide a much more complete and accurate visualization of the patients' actual anatomy, which can (potentially) improve the diagnosis, the treatment planning and the treatment itself. To the Orthodontics evaluation, the visualization of the actual anatomy through the cone beam computed tomography provides a large amount of information concerning the teeth, the TMJ, the skeletal morphology, the alveolar morphology, the airways and the oral cavity morphology as a whole, regarding the pathologies and

traumas (Figures 03 and 05). Cephalometric analysis in 3D are under development in a variety of research centers all over the world, and they should be part of the dental offices routine; additionally, they are about to become a priority matter of scientific interest, since the information about craniofacial growth and development and cephalometric standards have been got through the use of 2D cephalograms. The information in 3D enables the merging of digital files, such as CBCT files, 3D photographs and dentoalveolar 3D models, which allows getting highly important information that was impossible to be obtained through the conventional techniques (Figure 06). Among the data available to the practitioners and researchers, we can mention the evaluation of the 3D axial positioning of all the dental roots, the inter-relationships among hard and soft tissues, the volumetric assessment of the airways and the definition of reference plans towards the 3D cartesian orthogonal analysis. The software tools currently available in the market offer an extended range of possibilities regarding the virtual simulations of Orthodontics and Orthognatic treatments (Figures from 07 to 09), as well as the surgical wafers and indirect brackets bonding. Even brackets and wires can be customized for each patient, which individualizes the treatment based on the specific needs of each case. This individualization allows for a much more objective and predictable treatment. The treatment results can also be better evaluated through the new technologies of 3D images, as shown by the Figures from 10 to 12.

4.3. Minimally Invasive Dentistry

The Minimally Invasive Dentistry⁷ (MID) can be defined as: the maintenance and supervision of the dental health through the continuous care, which comprise a preventive handling, a longitudinal approach for risks assessment and chronical disease diagnosis, and a minimally invasive approach required for any surgical intervention.

The Minimally Invasive Orthodontics is a summary of all existing concepts, with the addition of a new approach, since these concepts were ignored in the past. In so many places around the world, these concepts are changing the health care from a reactive perspective to a more proactive approach based on Systems and Processes. The MDI philosophy can be split into four main components: a) prevention; b) early

detection; c) disease control and early intervention; and d) minimally invasive treatment. Regarding prevention and early disease diagnosis, we have:

- Use of Magnification Loupes;
- Cone Beam or Digital Radiography
- Caries Risk Assessment (CaMBRA)
- Assessment of all the items compounding the face and the smile aesthetics;
- Periodontal Risk Assessment
- Esthetic Risk Assessment
- Sleep-Related Disorders Assessment
- Oral Cancer Screening.

Regarding the early intervention and the minimally invasive procedures, we have:

- Microscope + Endoscopy
- MID Restorative Procedures (Lasers, Inlays/Onlays)
- MID Periodontal Procedures (Perioceutics, LANAP/ Lasers, GTR)
- Low level Laser Therapy
- Integrative TMD Therapy
- Impacted 3RD Molar Removal when Biologically Most Opportune (Usually Age 16 – 19)
- Whole System Minimally Invasive Orthodontics - Tissue engineering / TADs + *Wilkodontics®* - Periodontally accelerated osteogenic orthodontics + virtual setups and customized appliances); (Figures 13 and 14);
- Self-ligating brackets and super elastic wires (term-activated);

The MDI philosophy and practice are very broad and sophisticated. They include risk assessment, preventive strategies, use of new technologies and strategies of early detection, early intervention and disease control, as well as a variety of individualized procedures looking for an improved efficacy. The MDI philosophy and practice are also sophisticated on the diagnosis and treatment planning processes, and on the treatment itself. In a minimally invasive approach in Orthodontics, we apply the probabilistic thought to translate the patients' history, signals, symptoms, clinical findings and risk determination, priorities and probabilities regarding each component of the oral health system. The therapeutic invasiveness level is calibrated to reach the treatment goals, which are defined through the integrated assessment and the improvement of the entire system prognosis (oral health on the systemic context). The scope of the treatment application is affected by the predefined treatment goals, and the invasion level can be superior to the therapeutic option less invasive if the cost-benefit relationship justifies certain therapeutic decisions. A good example is choosing the orthognathic surgery in a patient with mandibular deficiency, poor airways volume and compatibility with obstructive sleep apnea, instead of removing upper premolars in order to fix the occlusion only. Thus, this availability predispose to the consistency between the Orthodontics treatment and the “quality of life paradigm”.

5. Discussion

The Medical Schools teach to their students how the “therapeutic decision” process works in details, but the Orthodontics post-graduation courses are much more concerned in teaching “Orthodontics mechanics”, focusing their program on this issue. Currently, the diagnosis and planning process is taught with focus on the occlusion, instead of on the patient as a whole. An approach based on an interdisciplinary team of professionals is similar to the “therapeutic decision” process, which is focused on a systematic approach of the entire diagnosis and planning process and goes beyond the dentoalveolar morphology. The Minimally Invasive Orthodontics philosophy integrates new concepts of attention to the health care that can improve the Orthodontics practice in two different ways. In the first place, through a systemic approach applied to the entire diagnosis and planning processes comparable to the interdisciplinary approach to

all the cases (early treatments, adults, surgical cases, and others), and also sets the Orthodontics as an specialty of the health area itself and, consequently, more integrated to the Medicine. Taking into consideration the current knowledge base and the new technologies, this systematic and contemporary approach can bring a variety of substantial advantages, such as the reduction of the number of surgical cases, whenever it is possible. Substantial reduction of extractions and of rapid maxilla expansions due to the range of possibilities that the self-ligating brackets, together with the TADs, allow concerning what we can call dentoalveolar modeling and a patient-centered treatment approach, which values their individual need, as well as the stability, the aesthetics (smile and face), the functional occlusion and the appropriate support to the airways. These concepts must be associated to preventive health care, early disease diagnosis, early intervention and individualized therapeutic (customized appliances). Additionally, considerations about risks and risks handling, time and quality of treatment, long term perspectives e clinical record focused on the therapeutic decision are extremely important, and all these items must be taken into consideration within a biopsychosocial context.

The concepts presented in this article represent only the tip of a very large and full of positive opportunities iceberg to those who want to embrace these new tendencies. A lot of effort, study and training is required, as well as the search for solid scientific evidences that points to the correct direction to follow regarding so many issues, mainly the ones which are more polemic and sensitive, such as the inter-relationships between the temporomandibular disorders and the dental occlusion. According to Kulbersh⁸, the Orthodontics is a specialty that deals with total reconstructions (rehabilitations) of the “dental enamel”. Thus, the Centric Relation (CR) must be the focus area to all the practitioners. During the past decades, Ronald Roth⁹ reiterated that the movement towards establishing that the occlusion is not an etiologic factor on the TMDs has negatively influenced all the dentists and given to the orthodontists a new zeal to minimize the importance of functional occlusion concepts on the Orthodontics treatments’ goals. On the other hand, authors such as Sadowsky¹⁰, McNamara¹¹ and Rinchuse¹² published papers which demonstrated the lack of evidences between the TMDs and the Orthodontics treatment. According to Rinchuse, the TMDs are multifactorial conditions and their treatment must pass through a

biopsychosocial Medicine approach that comprises Orthopedic, Neuroscience (chronical pain), Sleep Neurophysiology, Genetics and the psycosocial factors, leaving the gnathological issues in the background. The new technologies can be powerful tools to the clarification of these and other polemic issues, and they are also important to the Orthodontics as a specialty of the health area.

Charles Darwin's statement that says that the survivor species are neither the strongest, nor the smarter, but the ones that adapt themselves to the changes appropriately fits to illustrate the historical moment we are current experiencing in our profession. The Dentistry is “on top of the wave” when it comes to changing, and when it is inevitable, we should let us go or we can be left behind. The Orthodontics is a very important specialty to be demoted to technical aspects and to be associated only to aesthetics issues. Certainly, there must be a balance between the enthusiasm and the cautiousness whenever using those new technologies because the entire diagnosis, planning and treatment protocol are done in light of new paradigms, being the orthodontist the major responsible for the therapeutic decision-taken process. Are people who makes innovation happen. They do not occur from new technologies, that are the vehicles. It's always the people who create new ideas and always will be then who will implement it or block it.

6. Conclusion

The Orthodontics finds itself in the same crossroad as Ronald Roth recognized 30 years ago, i.e. Are we only “cosmetology technicians” or can the Orthodontics fit into the health area specialties scope? Nowadays, the Orthodontics counts on a vast range of advanced technological resources, as well as new devices and an expanded base of knowledge compared to the Roth's time. The direction we will decide to take depends on how the Orthodontists redefine the specialty, what can change the entire process of diagnosis, planning and Orthodontics treatment approach, with benefits for both the specialty and mainly the patients.

7. References

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8. Captions

Figure 01. The change from 2D to 3D allowed by the CBCT, which facilitates the displacement of an isolated component to a global context (MEYERS, 2011).

Figure 02. The cost-benefit relationship of using the CBCT routinely in the Orthodontics practice must take into consideration the radiation dosage, where the ALARA (*as low as reasonable achievable*) principle can be applied, as well as the need for a new learning process and software tools. The legal and ethical responsibilities over the images assessment represents another aspect to be taken into consideration. However, the large amount of advantages that the CBCT can provide to the clinical practice suggests its daily utilization in the future, as the access to this examination becomes simpler.

Figure 03. 3D reconstruction demonstrating the dentoalveolar morphology of an adult patient with periodontal bone support loss.

Figure 04. Cone-beam CT taken in maximum intercuspation, demonstrating the morphology and the temporomandibular articulations, in which we can observe the inappropriate positioning of the mandibular heads relatively to the articular fossa.

Figure 05. Sagittal plane segmentation of soft tissues, in which we can observe the airways path and the inappropriate lingual positioning.

Figure 06. Virtual patient obtained through Anatomodel virtual lab (Anatomage, San Jose, EUA), in which we observe the inter-relationships among the occlusion, the dentoalveolar morphology, the mandibular nerve path and the soft tissues.

Figure 07. Virtual setup in 3D models provided by OrthoCad[®] (Cadent, Inc. EUA) company. A) Pre-treatment of a Class III malocclusion with anterior crossbite; B) self-ligating brackets selection; and C) case finalized.

Figure 08. Surgical guide placement after the virtual surgical planning, in which the skeletal bases have been repositioned through the software tools.

Figure 09. Integrated 3D technology for individualized treatment – 3D acquisition (SureSmile[®] + OraScanner[®]) and surgical simulation (MEYERS, 2011).

Figure 10. 3D superposition of superior models in case of expansion by using the Geomagic Studio 10 (Research Triangle Park, EUA) software, in which the area in blue represents the post-treatment maxilla (ACCORSI, 2011).

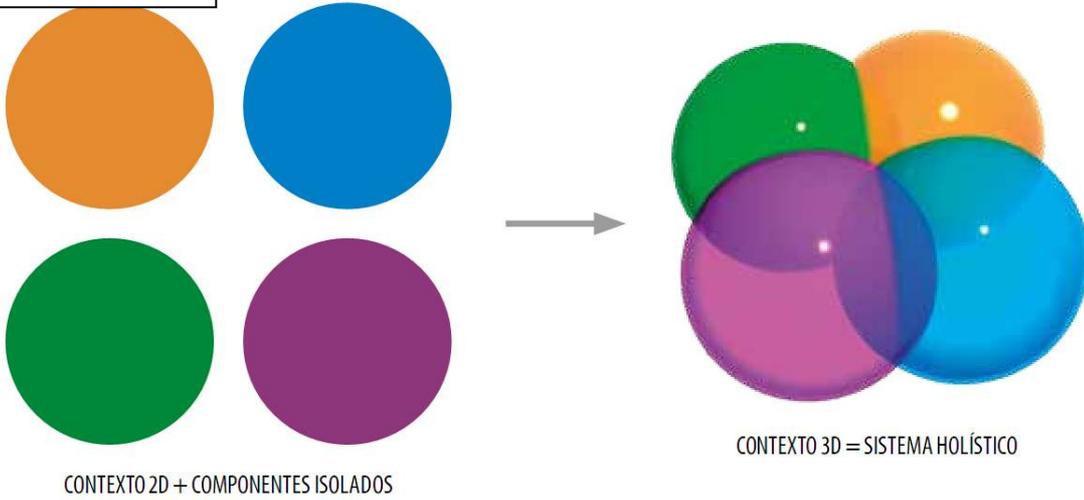
Figure 11. Superposition after orthognathic surgery of bimaxillary advancement – in blue, post-surgical stage (ACCORSI, 2011).

Figure 12. The images show the dentoalveolar remodeling in an adult patient subjected to a treatment with self-ligating brackets, in which we can observe the better accommodation of the superior central incisive on the bone envelope. A) Parasagittal plane cut before treatment; and B) intermediary assessment.

Figure 13. A) Dentoalveolar morphology of a patient with convex profile and anterior open-bite. B) Virtual positioning of mini-implants to enable the superior molars intrusion and the open-bite correction without the necessity of an orthognathic and/or teeth extraction.

Figure 14. Tissue engineering – demo of a bone grafting procedure after a corticotomy to accelerate the orthodontics movement (MEYERS, 2011).

Figure 01



- Custo financeiro
- Ferramentas de software
- Aprendizado das novas técnicas
- Dose de radiação/ALARA
- Responsabilidades de interpretação

- Visualização da anatomia real
- Visualização ampliada e integrada
- Possibilidade de simulações (setups)
- Confecção de guias terapêuticos
- Melhora na comunicação com os pacientes
- Telerradiologia (laboratórios virtuais)

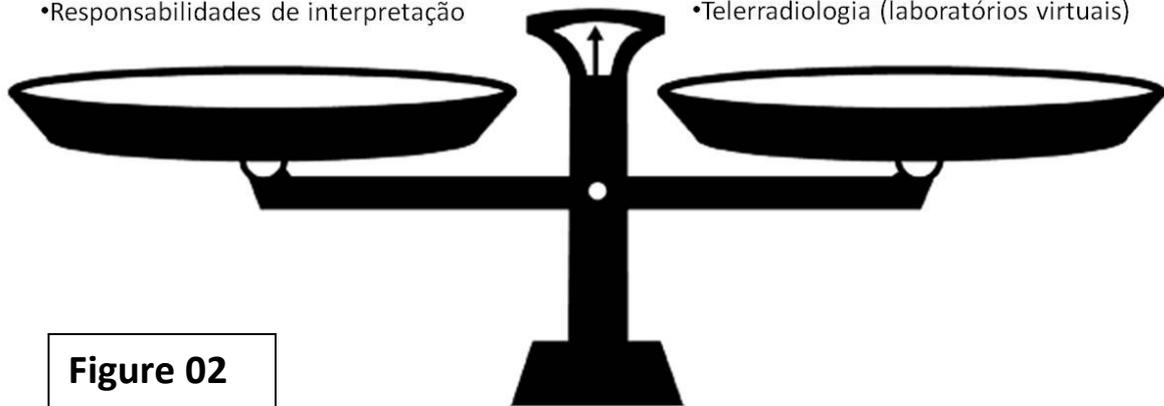


Figure 03



Figure 04

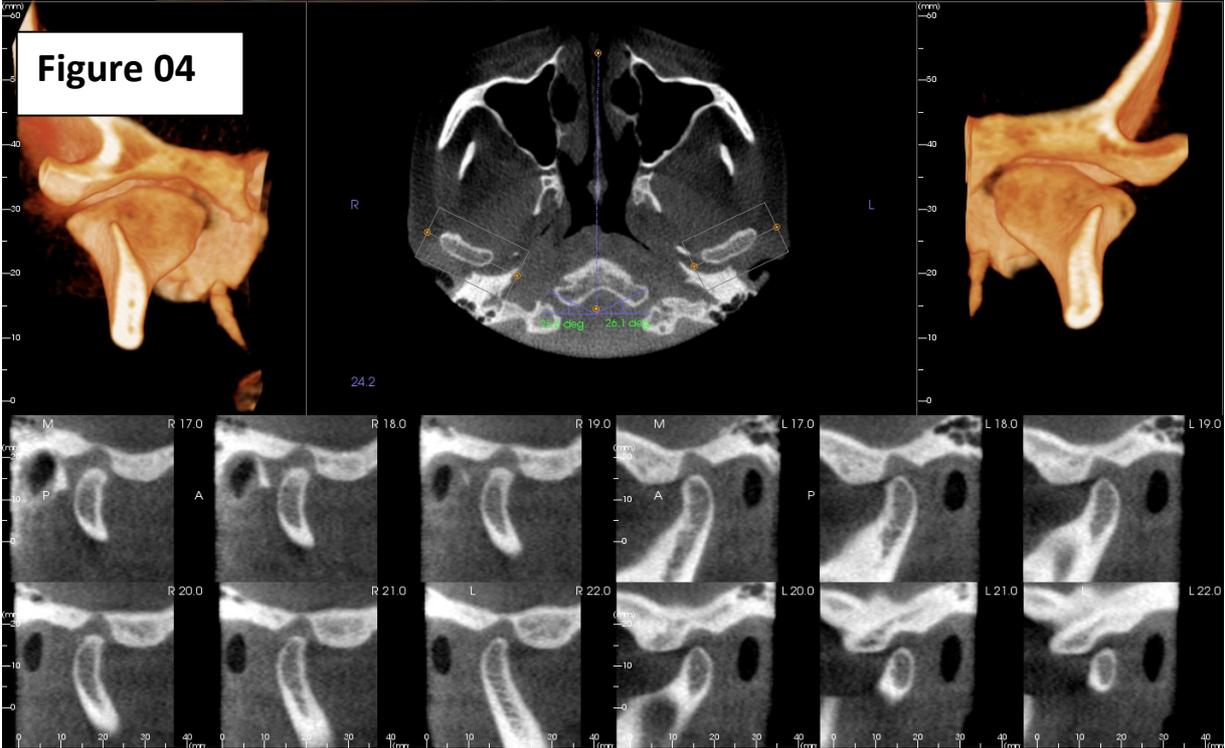


Figure 05

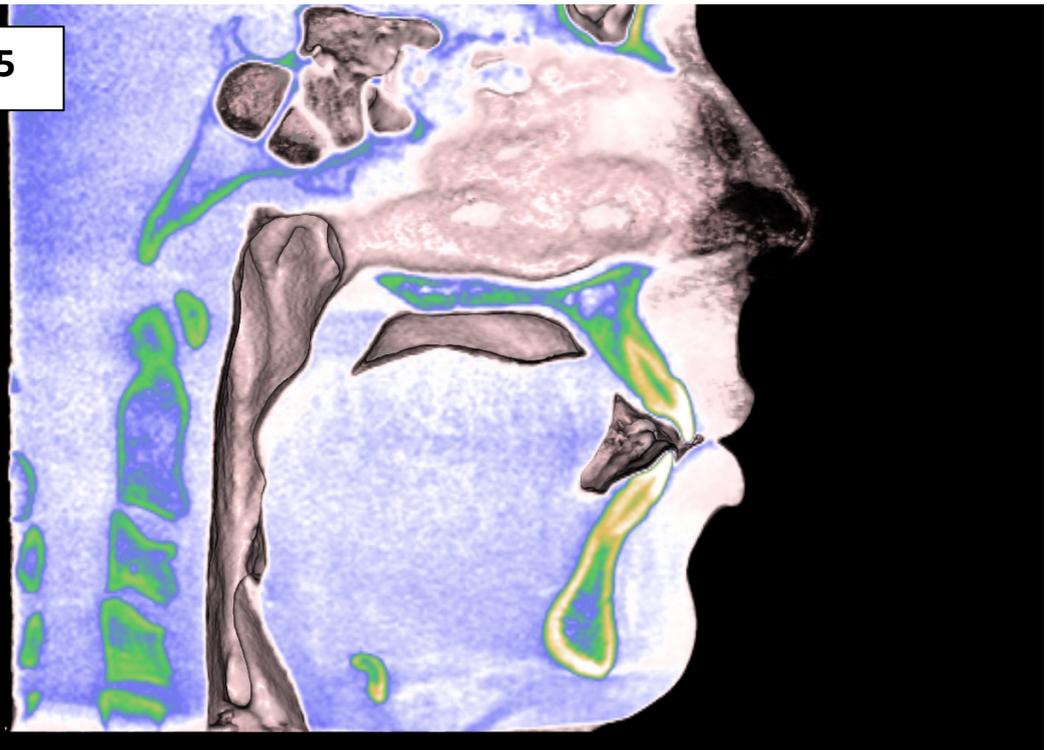


Figure 06

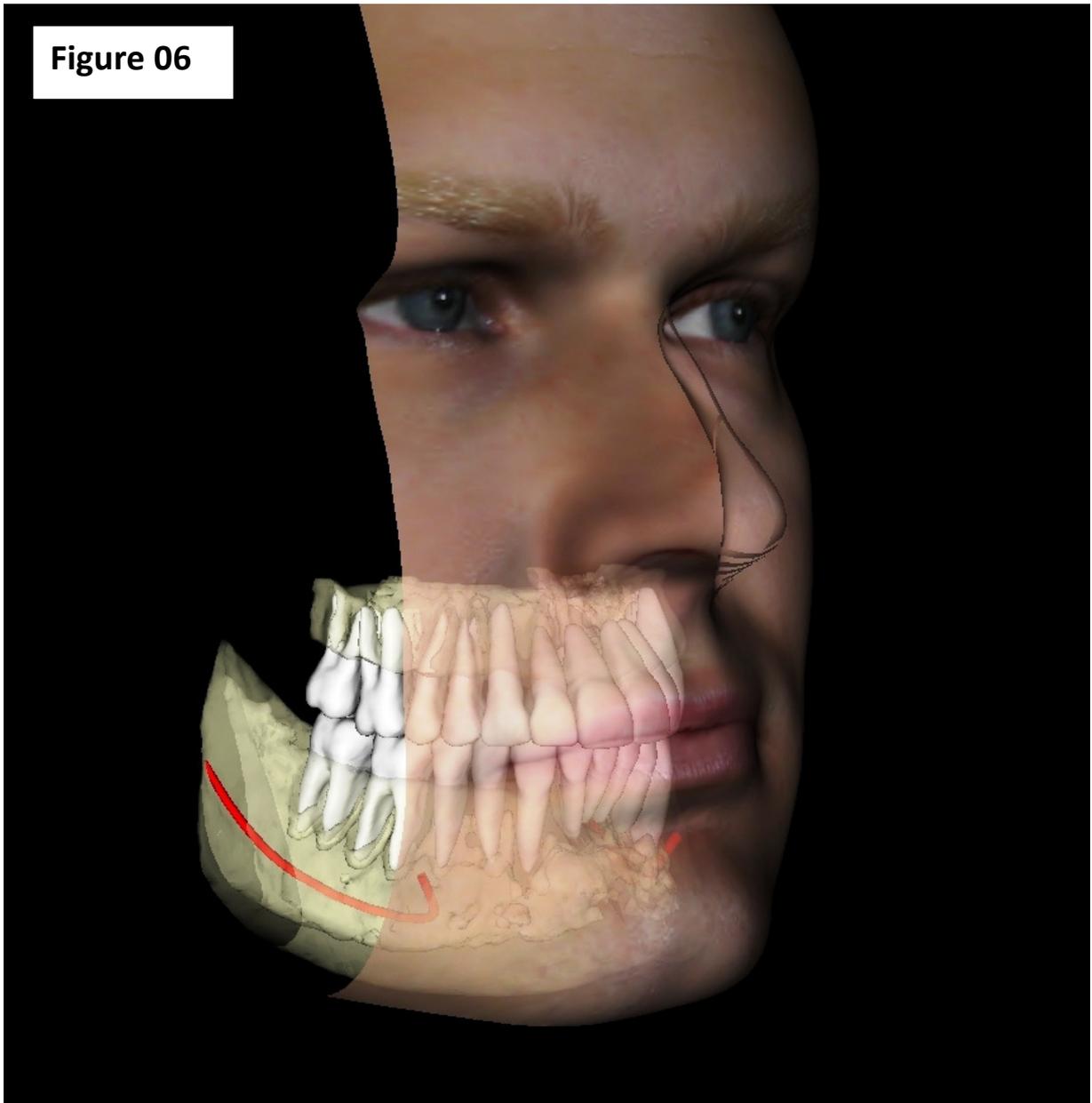


Figure 07A

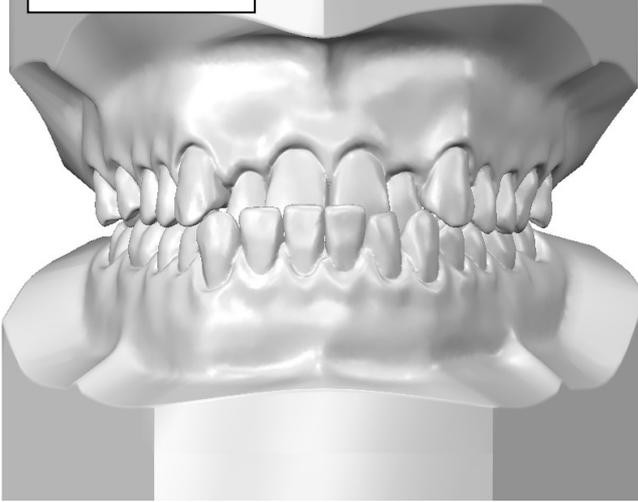


Figure 07B

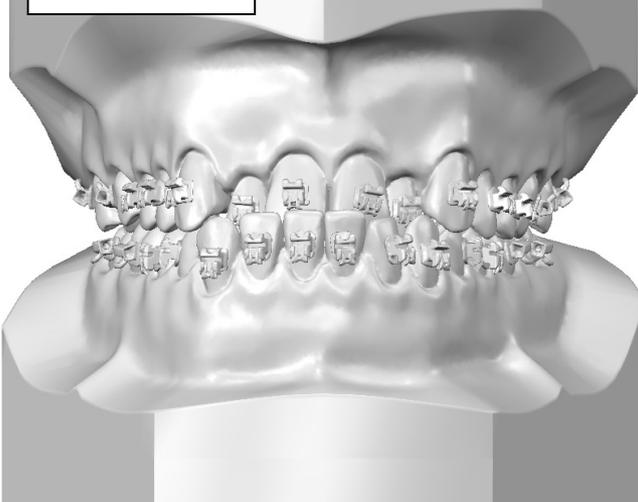


Figure 07C

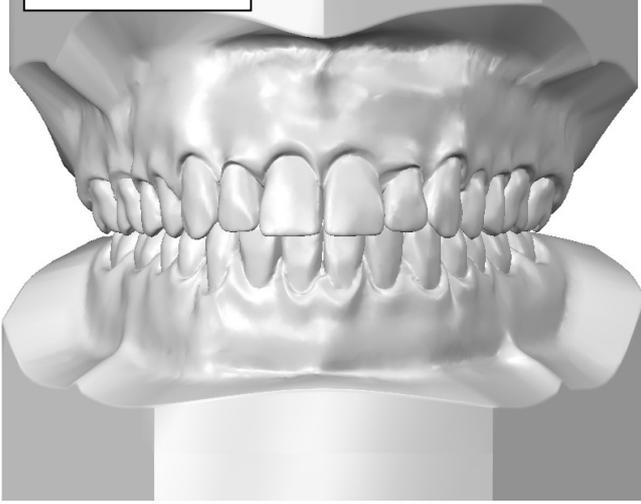


Figure 08

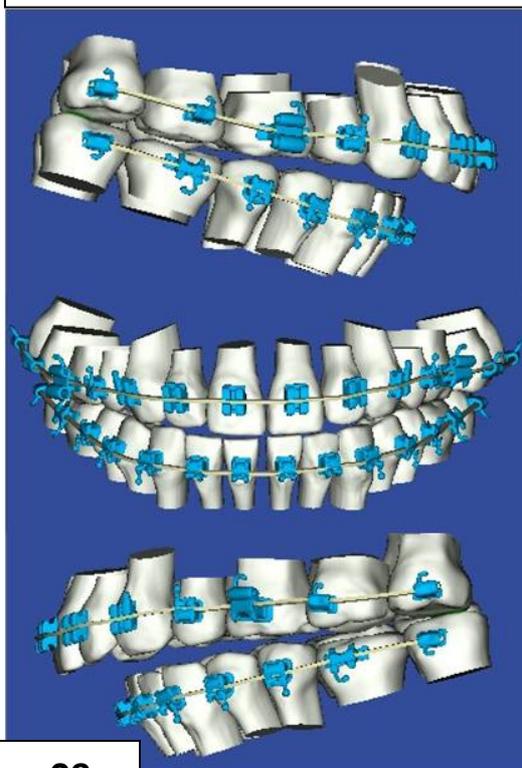
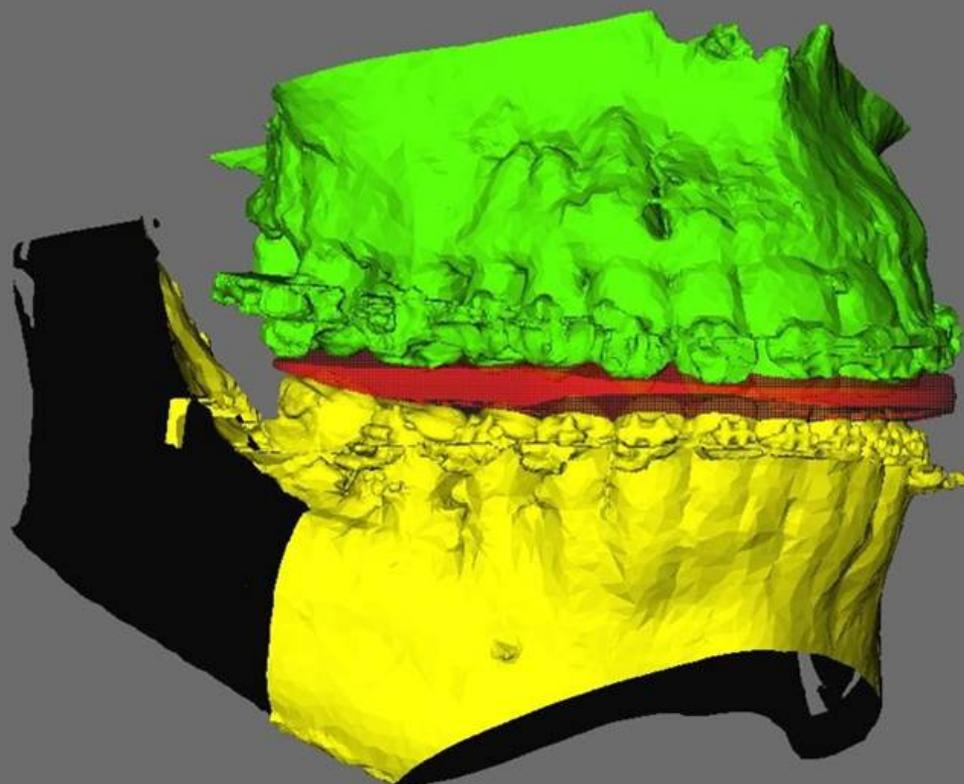


Figure 09

Figure 10

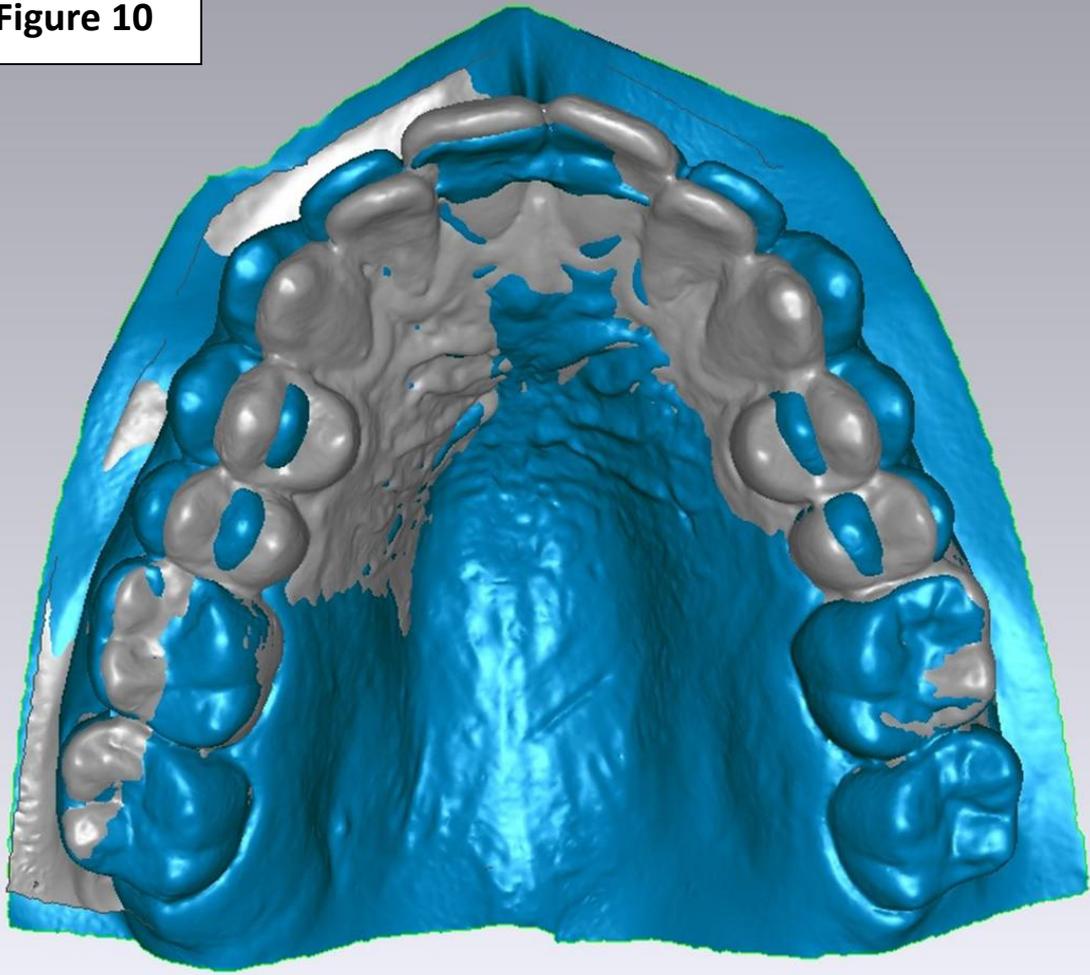


Figure 11

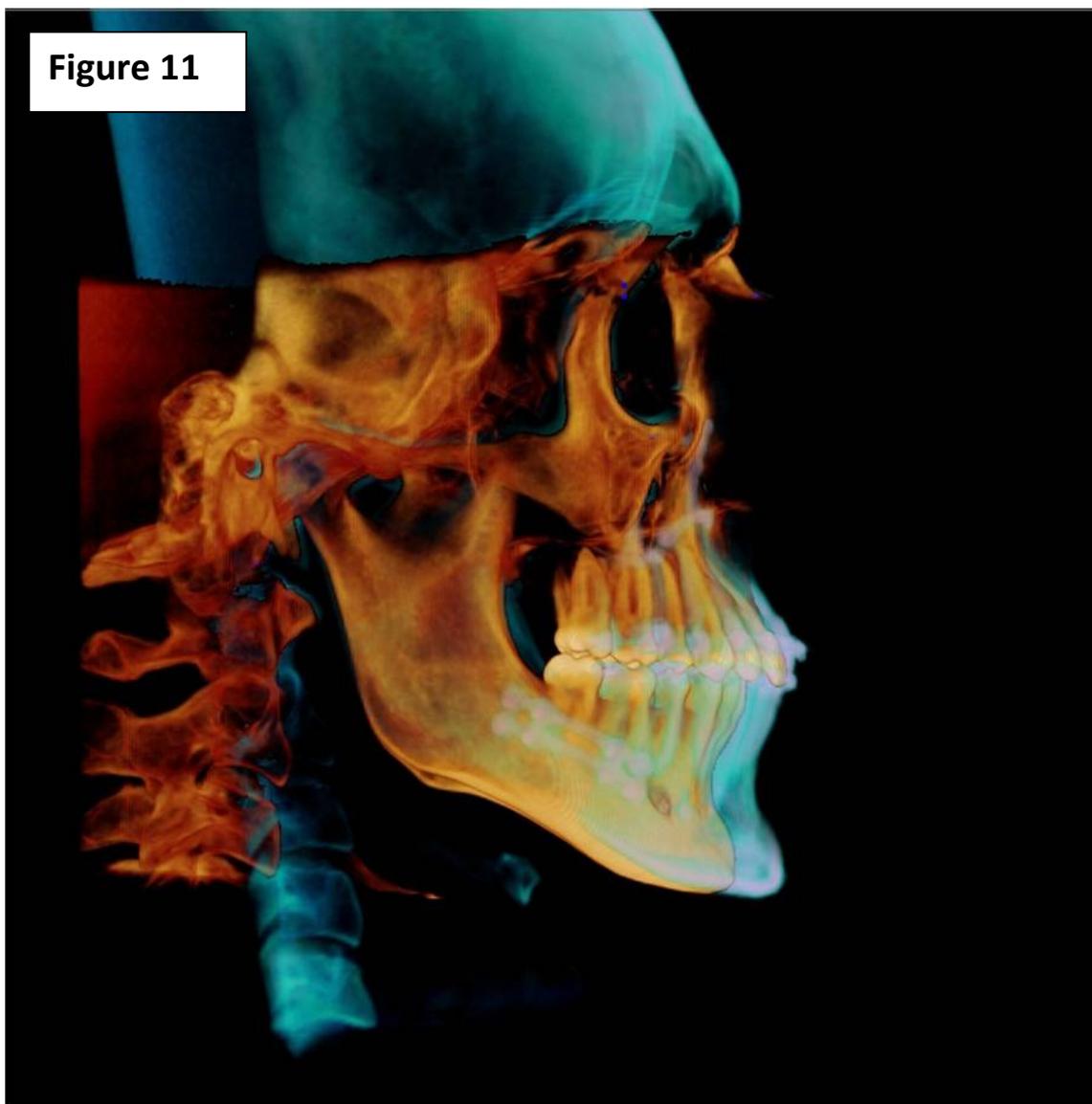


Figure 12



Figure 13

