The Digital Decade in Interdisciplinary Orthodontics

ALEXANDRU OGODESCU, COSMIN SINESCU, EMILIA OGODESCU, MEDA NEGRUTIU, ELISABETA BRATU
Department of Paedodontics - Orthodontics and Dental Materials and Dental Technologies
University of Medicine and Pharmacy “Victor Babes” Timisoara
Bd. Revolutiei din 1989 nr.9 et.I, Timisoara
ROMANIA
ogodescu@yahoo.com  http://www.umft.ro

Abstract: - Modern treatment of adult patients with complex dental problems often requires an interdisciplinary collaboration between different specialties of dental medicine among them frequently orthodontics: interdisciplinary orthodontics. Good diagnostic tools and easy communication are essential in such complicated cases. Computer technology has an increasing impact in the practice of orthodontics; everything is now digitized from photographs to radiographs or even models. The paper will discuss and evaluate the major applications of computers in interdisciplinary orthodontics like three-dimensional craniofacial imaging, digital models or cone-beam computed tomography. In conclusion orthodontics is undergoing a gradual transition from plaster decade to digital decade, mainly due to advancements in computer technology, changing the dental specialists to a new way of imaging, diagnosing, documenting and communicating between them and with the patients.

Key-Words: - interdisciplinary adult orthodontics, three-dimensional craniofacial imaging, digital models, cone-beam computed tomography, diagnosis and treatment planning, bioinformatics, databases, image processing

1 Introduction
Orthodontics was performed mainly to children and adolescents, generally in solo practice in relative isolation. Now, the orthodontist has emerged as a member, and frequently the leader, of an interdisciplinary team seeking to improve the overall results for adult patients with complex dental problems [1].

Orthodontic treatment of adults because of the association of primary and secondary dento-maxillary malocclusions with various diseases of the stomatognathic system often requires an interdisciplinary collaboration between Orthodontics, Periodontics, Implantology, Maxillofacial Surgery and Prosthodontics [2].

In the past the application of computer science to orthodontics was limited to creation of databases with some data from patients obtained with classic diagnostic methods on photographs, radiographs or plaster models.

By respecting protocols and interdisciplinary collaboration rigors many cases that initially seem to be compromised could reach a functional and aesthetic balance (Fig.1, Fig.2)

Fig.1 Adult patient with advanced periodontal disease and dento-maxillary malocclusion before (left) and after (right) the interdisciplinary therapy

Fig.2 Periodontally compromised adult patient with secondary dento-maxillary malocclusions before (left) and after (right) the interdisciplinary orthodontic treatment

This new concept of interdisciplinary collaboration between orthodontics and other specialties of dental medicine is best synthesized by the word TEAM (Fig.3).

T.E.A.M. = TOGETHER EVERYONE ACHIEVES MORE
To have good results in such complicated cases it is very important to have those diagnostic tools that facilitate an easy communication between the different specialists and with the patients for weighing the risks and benefits of all treatment options.

Today the evolution of the digital technology has changed computers from having a limited, supporting role mainly in managing databases to one being indispensable in orthodontic treatment.

2 Problem Formulation

Computer technology is having an increasing impact on the practice of orthodontics, with digital imaging and radiography, three-dimensional virtual models and various CAD-CAM technologies affecting everyday practice. Virtual reality will be used in telemedicine, education, patient care, treatment planning and a host of other areas. The applications are only limited by our imagination [4].

The objective of this study was to evaluate the different applications of computers in orthodontics and to compare the accuracy of measurements carried out using dedicated software on digital models and cone-beam computed tomography (CBCT) with measurements made by hand on conventional plaster models.

3 Problem Solution

For each case treated with interdisciplinary orthodontics we applied the following steps: 1. Acquisition of images and enhancement: digital photographs, optimal scanning of radiographs, photographs and dental casts. 2. Digitization: to reduce the common sources of error in cephalometric or cast measurements we use computer-aided methods like multiple digitization or computer aided point identification. 3. Measurements and analysis with dedicated software.

We used also digital facilities like image histograms to correct image problems or morphing and warping for photorealistic treatment predictions.

Today smile analysis and smile design is a key factor in orthodontic diagnosis and treatment. Using digital videography and computer technology the clinician can evaluate the patients dynamic anterior tooth display and incorporate smile analysis into routine treatment planning. Esthetic smile design is a multifactorial decision-making process that allows the clinician to treat patients with an individualized, interdisciplinary approach [5].

3.1 Digital models

The introduction of digital models has provided the orthodontist with a viable alternative to plaster models with the added advantages of electronic storage of data, minimal storage space required, simple and accurate cataloguing and a rapid transmission of records for consultation [6].

For this study we scanned a total number of 227 teeth using an optical three-dimensional scanner (Activity 101, Firma Smart Optics Sensortechnik GmbH, Germany).

The measurements on the 3D models where performed using the OnyxCeph™ software developed by the Firma Image Instruments GmbH, Germany. All of the teeth have no interproximal caries, restorations or stripping and no evident tooth wear. The same teeth were measured on the scanned plaster models with a digital caliper by the same investigator. The teeth were measured from occlusal and facial view (Fig.4).

Fig.4 Digital model scanned with the Activity 101 scanner and viewed through the OnyxCeph™ software

After performing statistical analysis (Student’s t test for paired data) they are no major differences between the measurements carried on digital and plaster models (Fig.5).

Fig.5 Measurements of the digital models where taken with the software OnyxCeph™ developed by the Firma Image Instruments GmbH, Germany
Digital models can be used in conjunction with CAD-CAM technologies to individualize the brackets to the adult patients crown morphology. So we will obtain a more stable tooth/bracket interface and a better biomechanical control on the specific tooth movements in interdisciplinary orthodontics [7].

3D databases from digital models and virtual model analysis are useful tools for diagnosis and treatment planning but also for education and research, facilitating statistical analysis.

3.2 Cone-beam computed tomography (CBCT)

The new GALILEOS cone beam technology (Sirona Dental Systems, Inc.) has a perfect combination of hardware and software (GALAXIS 3D imaging software), 3D volume reconstruction and 3D diagnostics (Fig. 6).

Fig.6 The 3D imaging allows a good view of the position of the supernumerary teeth, the relationship with the surrounding structures and even linear measurements can be done with the dedicated software proven to have a good accuracy.

The Cone-Beam Computed Tomography is ideally suited for orthodontic and dento-maxillofacial diagnosis and offers a lot of useful information for the interdisciplinary orthodontic diagnose of impacted teeth.

For example the case of an 11 years old girl with a delayed eruption of the two permanent central upper incisors. Clinically there is only a tumefied alveolar process. What is inside? What produced the disturbance in the normal eruption? On the panoramic radiograph we observe 4 supernumerary teeth and 2 incisors but it was very difficult to decide the teeth that should be extracted mainly because the supernumeraries have completely developed roots. So we decide to recommend a CBCT (fig. 7, 8.)

Fig. 7 Initial clinical situation with 4 supernumeraries
Fig. 8 Due to the advancements in computer technology the CBCT comes with exceptional anatomical details of the investigated region.

Always when we recommend a CBCT we must take into consideration the risk from ionizing radiation that result from this examination especially because we often work on growing children.

In a recent study the authors concluded: depending on the size of the scanned field, the effective doses with CBCT vary significantly. A scan of 13 cm height, which is sufficient in most growing patients, with a fast scanning mode results in a dose approximately two times than a conventional set of orthodontic radiographs. Whole head scanning without a neck shield to allow the study of the cervical vertebrae was found to produce an almost 4-fold increase in the radiation compared with three routine orthodontic radiographs [8].

The CBCT is very useful for the three-dimensional quantification of the alveolar bone for Orthodontics, Periodontics or Implantology. The Galileo software for virtual implant planning enables the precise positioning of the implant (fig. 9).
Fig.9 After the orthodontic treatment the implant site was evaluated by CBCT and the software for three-dimensional pre-surgical dental implant treatment planning

3.3 Three Dimensional Face Scanner

To explore the human face the science goes from classic photography to digital two-dimensional (2D) and even to three-dimensional (3D). Based on the triangulation and fringe projection method the 3D facial scan is used to measure aesthetic facial parameters, to orthodontic diagnosis and to evaluate the craniofacial growth and development [9]. More studies and advances in manufacturing engineering and in the development of specific software for image processing must be done to make this method more suitable for everyday clinical use.

4 Conclusion

The era of plaster models seems to come to an end. Today’s orthodontic hardware and software facilitates rapid measurements on digital models without any distortion on the real morphology of the teeth.

When we recommend a CBCT examination we have to compare between the increased amount of information obtained and the increased radiation dose for each person.

Orthodontics is undergoing a gradual transition from plaster decade to digital decade, mainly due to advancements in computer technology, changing the dental specialists to a new way of imaging, diagnosing, documenting and communicating between them and with the patients.

Each specialist in orthodontics and in other specialties from dental medicine should have good knowledge in bioinformatics and should be trained to use these new digital devices in order to provide better medical care for the complex cases.

All this digital technologies when applied correctly and in an interdisciplinary approach they fertilize each other, resulting in more precise diagnosis, improved treatment results and better communication.

References: