Abstract—Orthodontic treatment of adult patients is done in interdisciplinary teams that have to manage a vast quantity of data. Computer science gives a big help in almost every aspect of the orthodontic practice, research and education. Some of the most important applications of computers in this orthodontic field like digital photographs, virtual study models, cone beam computed tomography, communication, virtual reality, software for prediction and treatment planning, video imaging, manufacture of orthodontic appliance, web-based digital orthodontic records and proper backup protocols will be presented.

Keywords—Computerized diagnostic tools, digital patient records, virtual reality, simulation and manufacture in orthodontics.

I. INTRODUCTION

The evolution of dental specialties allowed for an enhancement in the quality of treatment performed to adult patients.

In the last years an increasing number of adults have been referred to orthodontists not only to correct their primary malocclusions but also for adjunctive orthodontic treatment to correct problems brought on by periodontal disease, edentulous areas or hopeless teeth. The number of adult patients is continuously growing and today represents more than 40% of new patients in most orthodontic offices [1].

Unlike orthodontics for children and adolescents, for adults that often have mutilated dentition, the therapeutically targets and rules are not the same as in the growing patients.

In the management of compromised adult malocclusions the orthodontist must interact interdisciplinary with the periodontist, oral and maxillofacial surgeon and the restorative dentist to perform excellence [2].

Adult orthodontic treatment often involves compromise and compromise solutions can be performed only through continuous communication between the various specialists involved in the treatment.

The Internet, the actual CAD/CAM (computer – aided design and computer – aided manufacturing) technologies and the development of high speed communication modalities have enabled group practices, with multiple locations, to access records in outlying locations electronically. We speak today about digital orthodontic office [3]. But are we able to use and apply all the developments of the computer science in the everyday orthodontic practice or research?

Orthodontics is in a large manner similar to computer science because we have to spend most of our time to solve problems and to think logic and straightforward for solutions.

II. PROBLEM FORMULATION

The orthodontic records like study models, panoramic and cephalometric radiographs or the patient’s intraoral and facial photographs are used to collect data in order to establish a diagnosis, to develop a problem list and a therapeutic concept.

These records, however, can be damaged or lost and need to be stored and maintained many years (Fig.1).

Fig.1 Veiled cephalometric radiograph, 6 month after exposure, become blurry and unusable. This would not happen if we would scan the radiograph or use a digital x-ray machine.
When you initiate an orthodontic treatment and damage some records you cannot have the initial clinical situation that changed during the treatment.

Also in our didactic work with students these records can be destroyed accidentally and need to be replaced every year. All this problems belong to the past in the digital decade [4].

Because adult orthodontics is a complex science with many data from different dental specialties you must integrate this amount of information in order to elaborate a diagnosis and a treatment and also to observe the evolution of all this parameters during the treatment.

All this models, radiographs, photographs and files occupy a huge space that grows over the years and requires new storage spaces while the digital format is more easily archived and accessed.

The analyses of the records are done manually using different measuring tools. This is a time consuming process, not always very exact (depending on the ability of the clinician) and also the amount of information that you can obtain is limited. To correlate all this information is not always easy. Today we have a lot of computerized diagnostic tools but before using them we should ask a question: are those accurate?

Also in research you must process a lot of information and it is very difficult to manage this data without using the latest developments in computer science.

III. PROBLEM SOLUTION

Today all the orthodontic records of adult patients can be in digital format and also they are some software solutions in order to analyze them (Fig.2, 3, 4).

**Fig.2** The intraoral digital photographs of a patient with a partial transposition between the upper canine and first premolar, with the persistence of the temporary canine.

**Digital photography** is today widely used to document orthodontic adult patients. The digital single lens reflex (SLR) cameras were tested for use in intra- and extra-oral photography and proved to generate perfect images when used with the recommended macro-lens and macro-flash.

The large possibilities offered by the recent image processing software allow a better diagnosis of the adult patient malocclusions. Because the digital images are so precise often in front of the computer screen you can see more details than during the clinical examination. The analyze of digital photographs and tools like image magnification or contrast enhancement holds promise for the detection of white spot lesions (W.S.L.) or better management of the dental surfaces after the debonding of fixed orthodontic appliances [5].

For scanning of the models we use an optical three-dimensional scanner (Activity 101, Firma Smart Optics Sensortechnik GmbH, Germany).

**Fig.3** Digital model scanned with the Activity 101 scanner and viewed through the OnyxCeph™ software.

The measurements on the 3D models were performed using the OnyxCeph™ software developed by the firma Image Instruments GmbH, Germany.

Are those measurements precise? Generally computers are very accurate in measuring things. Actually this is exactly what they do the best since they are infinitely precise, mathematically based beings.

In our studies, like in many others from the recent orthodontic literature about digital models, we found that the measurements of dental dimensions by the software package were very precise, and this is probably the truth at almost all quantitative orthodontic software [6, 7].

Cone Beam Computed Tomography (CBCT) is ideally suited for dento-maxillofacial scanning and offers a lot of useful information for the interdisciplinary orthodontic diagnoses.

The new GALILEOS cone beam technology (Sirona Dental Systems, Inc.) has a perfect combination of software (GALAXIS 3D imaging software), 3D volume reconstruction and 3D diagnostics [8].

Computer science has an impact in almost every aspect of the orthodontic practice: diagnosis and treatment planning, communication at consultations and with other specialists, data base maintenance or practice management. Computer-assisted cephalometric analysis is today a point of interest for more and more orthodontists.

Orthodontic treatment for adult patients is often done for esthetic reasons. Using computer science we can create a computerized craniofacial model based on a large number of soft-tissue measurements, facial profile and proportionality, all for evaluation of the facial esthetics. The uses of computers in the management of this large amount of information provide...
relevant standards that are useful in the diagnosis and treatment of the actual adult population with dentofacial deformities.

![Image of 3D CBCT imaging](image)

**Fig.4** The 3D CBCT imaging allows a good view of all anatomic elements, particularly the alveolar bone around the teeth in transposition and the relative position of the tooth.

Three-dimensional (3D) computer models of the human craniofacial structure have been constructed with computed tomography (CT). However, the high cost of CT and the radiation exposure are drawbacks to this method. Today, using a technique, proven to be accurate, it is possible to produce a 3D head model on a personal computer based on cephalograms, facial photographs and dental cast models. This three-dimensional computer-generated head model will provide easy-to-understand information for patients and establish a diagnostic or therapeutic method for communication with other health care providers [9].

**Virtual reality in orthodontics** modifies a lot of the traditional techniques. We must not cut the plaster models to generate set-up models; we can create them virtually. There is a great interest in develop specific software for prediction and treatment planning to correct the malocclusion, or for simulation of tooth movements. It allows the clinician to simulate the effect of the orthodontic treatments, and is also useful in engineering design of new brackets that fit better with the biomechanical conditions when treating periodontally compromised adult patients [10].

**Video imaging** is an important emerging technology in orthodontics, in planning orthognathic surgery, in educating patients about the esthetic effects of treatments and also in the education. There is a great interest in this technology and how to apply it to the orthodontic treatment of adults and for computer generated video image predictions.

Today with the use of computerized imaging techniques and the CAD/CAM technologies the orthodontists can integrate the computer in the manufacture process of orthodontic appliance. The best example is the Invisalign system where the series of trays are made using a computer-assisted simulation of the needed movements.

In education the introduction of computer science has a tremendous effect. Virtual reality in orthodontics by creation of diagnosis web sites provides the undergraduate and postgraduate students in orthodontics an accessible source of complete, good-quality study materials. Web-based digital orthodontic records were as effective in teaching clinical orthodontic diagnosis as were conventional records [11].

In the orthodontic research we cannot imagine any important result without the use of computer science even for epidemiological studies, for biomechanical or material studies.

Respecting the TEAM (together everyone achieves more) principle from interdisciplinary orthodontics we can say that today the computer and the computer science is the first partner in every team that tends to optimize the treatment effects for their patients [12].

**IV. CONCLUSION**

In the orthodontic treatment of adult patients computer science is very present. The introduction of digital photographs, the virtual study models and CBCT may allow the use of a fully electronic patient record. This is particularly useful because these patients are treated in interdisciplinary teams, with many dental specialists that need a facile access to the whole documentation. With good management of this digital data, proper backup protocols, patients records will never again be lost or misplaced and can be used in a large variety of domains. This new digital paradigm will propel well the orthodontic treatment of adult patients in the future.

**REFERENCES**


