3D Archive in Dental Practice – A Technology of New Generation

Miroslava Dinkova, DMD, PhD[1], Greta Yordanova, DMD, PhD[2], Arch. Ivan Dzhonev[3]

[1,2]Assistant Professor, Department of Orthodontics, Faculty of Dental Medicine, Medical University - Sofia, Bulgaria

[3]Guest Lecturer at the University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria

Abstract: *Over the years, teeth impressions and casts became necessary in the dental practice for adequate diagnosis and treatment planning. Despite of all the advantages and wide application of casts, the clinicians are required to maintain an archive for plaster models, which is space and time-consuming. With the development of dental practices, the number of patients, the plaster models and the space for storage is growing, respectively. Since the innovative technologies, 3D-scanners and printers found a wide application in the medicine, the gypseous archive maintenance became unnecessary. Current paper presents a 3D-technology for cast scanning, which can be used in the dental practice for digital cast storage. The technology is called 3D-scanning. The cast is scanned, recorded in a suitable file format and archived on a server or a digital media. As casts are already digital, they do not take up physical space. These files are not aging and do not change with time. Scanned models could be manipulated and further used in special software to motivate patients. 3D-technology successfully replace space-consuming archive, clinician can easily find a cast in a second, and if necessary, to reproduce it at any time with absolute precision via 3D printing.*

Keywords: 3D-scaning, plaster models, archive

1. Introduction

Over the years, teeth impressions and casts became necessary in the dental practice for adequate diagnosis and treatment planning. Casts are accurate, three-dimensional replicas of a patient's teeth which are made by pouring dental plaster or acrylic into impressions of the teeth, and allowing it to harden (fig.1) [1].
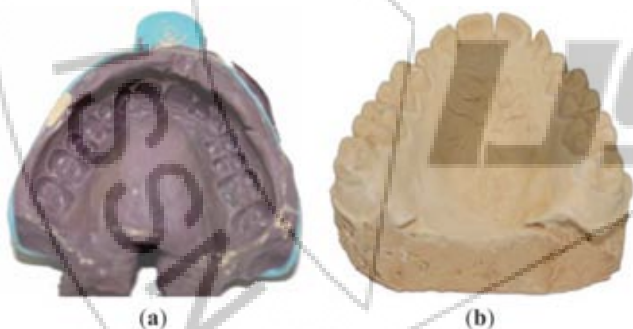

Figure 1: Teeth impression (a) and three-dimensional replica (b) of a patient's teeth

They can be created from many types of dental stone, metal or plastic, depending on the intended use and the durability requirements of the cast. Dentists use them to study the size and relationship between the teeth, gums and dental arches, patient's growth and development, or to plan a significant dental treatment. They are used for making of athletic mouthguards, fluoride/ tooth whitening trays, crowns, fixed bridges and dentures by dental technicians. These plaster models are a great choice for recording the treatment progress or for relapse control after orthodontic treatment. Dental casts are also a means of communication between the dentist and the laboratory.

The conventional technique for the preparation of a plaster model from elastomeric impression has been in use since 1937, when Sears introduced agar as an impression material for crown preparation [2]. The impression materials (e.g. silicone, polysiloxane or polyether) [3] provide highly accurate impressions of the teeth and the dental environment, and their accuracy have been described in the literature for several times e.g. [4]-[6].

Nowadays, casts are also used for simulation of treatment outcomes after orthodontic treatment, aesthetic restorations or even orthognathic surgery [7]. Despite of all the advantages and wide application of casts, the procedures of their making and keeping are time-consuming, laborious and require qualified dental technicians and proper laboratory equipment. Except those inconveniences, the maintenance of an archive for plaster models (fig.2), especially in the orthodontic practice, where the requirement of storage the casts is ten years, is very difficult and there is a need of appropriate storage conditions, enough space and additional organization.

Figure 2: An archive for plaster models

Also the plaster is easy fragile material and casts can easily be damaged during transportation and handling with them. With the development of dental practices, the number of patients, the plaster models and the space for storage is growing, respectively.

In the past two decades, biotechnologies and digital systems evolved significantly and innovative software, 3D scanners and printers found wide application in the dental medicine and especially in orthodontics. They made the indirect braces bonding, virtual set up preparation, treatment outcomes simulation, teeth and impression scanning possible as well as their materialization by 3D printers (fig.3).

The current paper presents a 3D technology for plaster model scanning, which can be used in the dental practice for improvement and facilitation of digital casts archive maintenance.
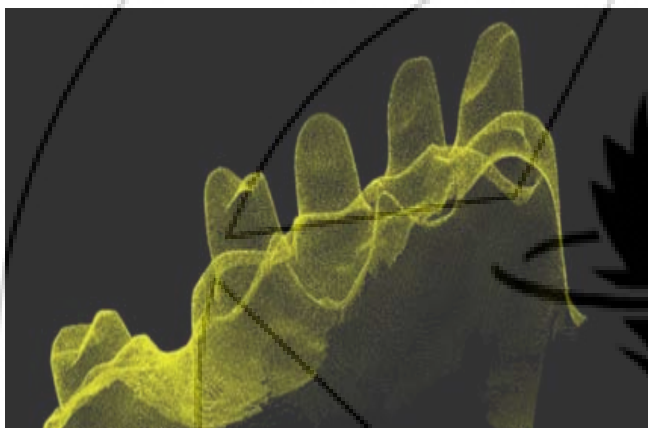

Figure 3: A scanned three-dimensional plaster model

2. Methodology

The process begins with taking the impressions of the patient's teeth. They could be taken with different type of materials (silicone, polysiloxane or polyether). The impressions then are sent to a dental laboratory, where the plaster models (casts) are made, scanned and digitalized.

The technology, which makes this possible, is called 3D-scanning. Nowadays, many companies working on innovative technologies offer scanners with different resolution. Good results are achieved by scanners with laser beam and optical camera. Such scanners circle the cast on all the sides with laser beam and a camera with high resolution shoots its position. Thus a cloud of points with precise geometric coordinates is created. The precision of the measurements is about +/- 10μm. Then the cloud of points is processed by special software, like 123D Design of AUTODESK, Blender, Sketch-Up for creation of exactly the same virtual copy of the scanned model. Once digitized, the plaster model can be further manipulated for future dental appliance modeling, for simulation of different treatment outcomes in relation to the treatment plan objectives, for virtual set-up preparation, prosthodontic surgery measurements and etc.

The scanned casts are recorded in a suitable file format and archived on servers and/or on a suitable digital media (DVD disc and etc.). These files are not aging and do not change with time. Thus, each time the file is opened, it gives the same information that we have stored in the time of its creation. As casts are already digital, they do not take up physical space, but only virtual. Therefore, the organization and the maintenance of virtual archive do not require additional efforts of the dental practice or laboratory and the required space is only about 300 KB.

The facilitated storage of plaster models is a significant advantage for every practice not only for the clinicians, but also for the patients. Once, the cast is scanned and converted into a suitable format, this 3D information can be further processed in special 3D software for treatment progress simulation. This is used for motivation of the patients, who became more cooperative - an essential requirement in the long orthodontic treatments (fig.4).
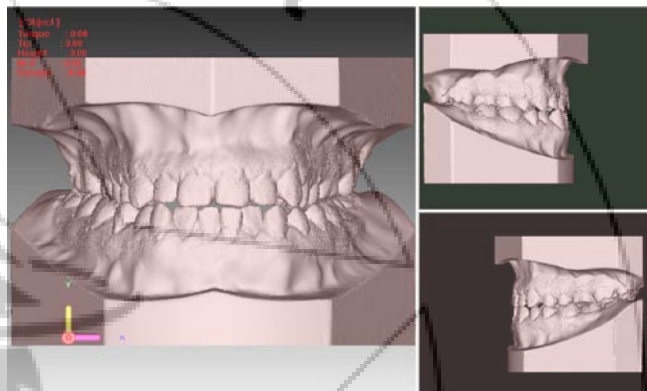

Figure 4: CAD/CAM software which uses a scanned plaster models for motivation of the patients.

3D scanning technology is also used in other areas of dentistry - a more precise modeling of bridges, crowns and even dentures. Materialization of virtual objects is performed using machines with numerical control that exactly match the set of program parameters.

The scanned models can be reproduced at any time with absolute precision and form indistinguishable from the original. They are made of ecological plant-based bio-polymers, which have a high resistance to chemicals, heat or mechanical stress as opposed to plaster models. The printed models are with excellent surface finish, do not absorb moisture or wrap over the time, which make them unchanged for a longer period [8].

3. Benefits

Archiving study casts in 3D images are a reliable way to archive study models, producing durable images without any fear of loss or damage to the original casts. [9] 3D modeling reduces costs, eliminates human errors and allows people without engineering to make 3D models [10]. Once the 3D model has been produced, the operator can save it in the hard disc of a computer (3D archive) in a specific 3D file format and the size of this file is dependent on the original resolution of the 3D mesh [9].

4. Conclusion

The digitalization of plaster models is a step towards for increasing the efficiency and precision in the field of dentistry. Development and perfection of 3D printing technology allows a production of the 3D information with an accuracy of 0.1mm. 3D technology successfully replace archives for plaster models and so the clinician can easily find a model in a second, and if necessary, to reproduce it.

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Author Profile

Miroslava Mileti Dinkova, DMD, PhD entered the field of dentistry in 1978 and specialized in Orthodontics, Pediatric Dentistry, Health Management and General Dentistry in 1987, 1993 and 2005, respectively at Faculty of Dental Medicine, Medical University of Sofia, Bulgaria. In 2014 she received her PhD degree in Orthodontics. Since 1992 she is Assistant Professor at the Department of Orthodontics - Medical University of Sofia, Bulgaria. Her main interests are in adult orthodontics, interdisciplinary treatment approaches, lingual orthodontics and digital technologies in orthodontics. Dr. Dinkova is a member of WFO, EOS, SIDO, BaSS, BOS and President of BSCLO.

Dr. Greta Yordanova has completed a master's degree in dentistry in 1991. She has post-graduated in Orthodontics and developed dissertation entitled "Clinical results in treatments with Pendulum" and obtained PhD degree. Since 1995 she is Assistant Professor at the Department of Orthodontics at the Medical University of Sofia. Her research interests are in the area of Non-extraction treatment and problems of ectopic and impacted teeth and working with 3D technology.

Arch. Ivan E. Dzhonev graduated the University of Architecture, Civil Engineering and Geodesy (Sofia) in 2007 as a magister of architecture. Since 2010 he leads "3D Modeling" CAD/CAM courses in the Department of Construction at the Faculty of Architecture, Sofia, Bulgaria.

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