DIGITAL ORTHODONTICS - A REVIEW

Type of manuscript: A Review

Reshmi B
Saveetha Dental College,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University,
Chennai, India

Naveen Kumar
Senior lecturer
Department of Orthodontics
Saveetha Dental College,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University,
Chennai, India

CORRESPONDING AUTHOR:
Naveen Kumar,
Senior Lecturer,
Department of Orthodontics
Saveetha Dental College,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University,
162, poonamallee high road.
Chennai, India

***Abstract*: Orthodontics is a complex treatment which involves an interdisciplinary team which consists of different specialists to manage a vast data especially in adult orthodontics. In such complicated cases, good diagnostic tools and proper communication are essential. Computer science has taken a role in almost every aspect of orthodontic practice and other dental practice. This review will discuss into the said aspects in the practice of orthodontics as well as evaluate the applications of computer technology in orthodontics like digital photographs, cone beam computed tomography, virtual study models, communication, and treatment planning, video imaging, manufacture of orthodontic appliance, web-based digital orthodontic records and network-attached storage devices.**

***Keywords*: Computerized; digital; radiographs**

1. Introduction:

Orthodontics and Dentofacial Orthopaedics, is one of the most complex branches of dentistry, requires a careful interpretation of a large amount of information to attain a correct diagnosis and treatment planning. Imaging technology in dental field has emerged as one of the most important aspects of diagnosing and treating oral disorders, especially since the advent of three-dimensional (3D) techniques, which have found various applications in orthodontics as well as in oral and maxillofacial surgery

The digital revolution that has occurred in recent decades has also impacted orthodontics significantly. The orthodontist now has an arsenal of digital documentation at his disposal that facilitates orthodontic diagnosis, treatment planning, and treatment follow-up. Digital radiographs and digital photographs have replaced conventional methods of physical imaging, and concomitant cone beam computed tomography (CBCT) is being increasingly employed.

Following this development, plaster models are now rapidly replaced by digital models. The 3D technology provides numerous advantages for both the patient and the orthodontist. The patients will be more comfortable and while chair time is decreased, accuracy is greatly increased. With the help of digital imaging, patients' scans are transferred to interactive treatment planning software. This means the tooth movement can be digitally adjusted and guided right on the screen, in real-time. Another main benefit of digital orthodontics is the computer-generation of unique appliances. With custom appliances, orthodontists can increase accuracy and precision. For patients, that means better results and faster treatments.
A fortunate orthodontic treatment is based on a comprehensive diagnosis and treatment planning. A few of the fundamental factors in the diagnosis are the spacing condition, tooth size, arch form and the tooth-arch discrepancies. The model analysis is a time-consuming procedure. Nevertheless, it is a vital part in the diagnosis and subsequent treatment planning process.

Our extensive research expertise ranged from epidemiological studies to randomised clinical trials that have been published in reputed journals [1–10]. This knowledge was instrumental for us to present a review on digital orthodontics.

2. Digital Diagnosis

Similar to a wax setup, the digital setup is a tool that helps with treatment planning and it is up to the creator of the setup to respect the biologic limitations of tooth movement and mimic realistic biomechanics. Previous studies have shown that digital setups can be as accurate and reliable as wax setups.[11] Barretoa et al. reported that the creation of a digital setup is much faster than creating a wax setup due to the lab work required when working with plaster[12] In addition to the potential time savings, working with digital setups offers advantages that were not possible with plaster, such as the ability to superimpose the setup with the original models and also the ability to determine the precise amount of movement for each tooth. Digital setups can also be easily stored and shared by transmitting an electronic file.

3. Digital Study Models

Plaster study models have been the "gold standard" in orthodontic diagnosis and treatment planning, and also play a pivotal role in orthodontics. Philipp Pfaff first described an impression-taking technique by using heated sealing wax to obtain a negative representation of the dental arches [13] followed by Chapin A. Harris in 1839, who advocated using a calcined plaster to fabricate casts from wax impressions [14]. Later advances brought about even more dimensionally stable impression materials such as elastic polyether and polyvinyl siloxane; yet irreversible hydrocolloid alginate has remained the most common impression material used in the clinics today with continued use of plaster, namely Type II Dental Stone, for fabrication of the casts [15]

Study models provide a three dimensional view of a patient's occlusion and are more amenable to routine measurements like tooth size, arch length, arch width, overjet, overbite, midline discrepancy, curve of Spee etc. The disadvantages of plaster study models are a tendency to breakage, wear from continued measurements contributing to inaccuracy, and storage space required in a busy orthodontic practice. The concept of three dimensional (3D) virtual orthodontic models seems very favourable in eliminating the problems of conventional plaster models, and also to simplify the practie management and communication between different specialties. Virtual study (Ortho Cad™) models made their first appearance on the orthodontic market in 1999 [16] . Virtual study models have reduced the number of limitations associated with the use of conventional plaster models.
Shape Ortho System is a recently introduced 3-D representation of a patient's dentition on the computer screen with an accuracy of 20 µm tested with Mitutoyo gauges. The system utilizes a propertied laser scanner R700 which projects a laser line onto the surface of the model or impression, 3-axis motion system and two high resolution charge-coupled-device cameras, one on either side of the laser that observes the profile of the line as it falls on the object. The two-camera system reduces scanning time, because less reorientation of the model is required to capture surface detail that would be missed by a single camera due to shadowing [17]

4. Digital Radiography

Also known as Digital radiography, which uses x-ray–sensitive plates that captures the required data during the patient examination and transfers it to a computer system without the use of an intermediate cassette as is the case with Computed Radiography [CR]. Commonly referred to as plates, these flat panel detectors use a mixture of amorphous silicon detectors with cesium or gadolinium scintillators that convert X-ray to light which is ultimately rendered by thin film transistors into digital data. This technology is significantly costlier than CR technology, but the pictures are of the very best quality and are seamlessly sent to a computer screen. These systems are popular in dedicated imaging facilities

5. Computed Tomography

Three dimensional computed tomography has been available for 30 years now, the high radiation exposure and the cost of this technology have till now precluded its use in orthodontics. The new CT machines can perform a full scan of the head in a few seconds and give the patient effective dose of 50 microsieverts. Radiation concerns are reduced when one considers that a single Ct scan can replace a number of conventional radiographs that are now considered essential for almost every orthodontic procedure.

Conventional CT machines acquire image data by using either a single narrow x-ray beam or a thin broad fanship x-ray beam. These beams rotate around the patient in a circular spiral path as a patient moves to the scanning machine. Series of detectors register the attenuation of these x-rays and from the data gathered the machine reconstructs the internal structure of the patient's body and stored in the form of voxels.[18]

In the present, the new digital imaging breakthrough, the new Tom QR 9000 volume scanner is now available for clinical practice. This CT uses a cone shaped x-ray beam that is large enough to encompass the region of interest it produces a very focused beam, minimising scatter, thus reducing the absorbed radiation dose to 45 micro Sieverts. The conventional CT imaging the patient remains stationary throughout the procedure in a single resource and the pictures acquired undergo a primary construction according to patients and not and not to me into a single bed and mention volume. Thus in a sible exposure, frontal, lateral and panoramic views are obtained. Uses of 3D computed tomography are assessment of tooth position, temporomandibular joint, impacted teeth positions, air airway analysis.[19]

6. Digital Photographs:

Orthodontists, in recent times, can record patients data with the help of digital photographs. From digital scanning to eliminating

the need for film-based X-rays, records are available right away for treatment planning, significantly the entire orthodontic process. First, the use of intraoral scanners permits the production of digital models of the dental arches, thus reducing the need for fabrication of physical models.[20]

Digital photography is now commonly used to document orthodontic adult patients. The digital single lens reflex 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 techniques. Digital photography was introduced to evaluate facial harmony. It allows clinicians to establish a more proportional focus on all three structures of the triad to assess patient's deformity

An important objective of orthodontic treatment is to achieve proper, stable and accurate tooth positions that involve not only the crowns, but also the roots of the teeth.

7. Digital Treatment Planning:

The orthodontist can study the records and trace each digital after the digital photographs of the patients are available. X-ray to determine the relationship between your facial bone and tooth positioning. This helps to devise a pre-treatment plan and create a customized treatment plan for the patient. The orthodontist can also track progress and monitor any necessary changes within the digital chart. In digital dentistry, all patient files are completely digital. Hence, the information stored is available within a matter of seconds, rather than having to wait for staff to sort through various charts.

The evolution of cone beam computed tomography [CBCT] and digital softwares has has allowed orthodontists to furnish more accurate diagnosis and treatment. The most common use of CBCT imaging allows orthodontists to visualize the precise position of supernumerary or impacted teeth, especially impacted canines. By doing so, the exact angulation of impaction and proximity of adjacent roots can be evaluated by orthodontists, allowing them to choose the required vector forces for tooth movement while minimizing root resorption. Even though 2D panoramic images can be used to view the position of the impacted canines, they have limitations, like it is not possible to evaluate the impacted tooth position in 3D structure. A precise knowledge of root position improves the determination of success in orthodontic treatment.

8. Conclusion:

Orthodontics is inclining digitally in every possible aspect for a better quality treatment. Replacing digital with the manual type, saves time and easy chair side routine for the orthodontists. Like recent advancement in the concern of ortho braces , invisalign set a trend by adding up more to orthodontic correction and also adding up to patients esthetics .Orthodontics is an interdisciplinary department which definitely needs digitalisation to provide quality treatment and time saving.

References:

1. Korath AV, Padmanabhan R, Parameswaran A. The Cortical Boundary Line as a Guide for Incisor Re-positioning with Anterior Segmental Osteotomies. *J Maxillofac Oral Surg* 2017; 16: 248–252.

2. Felicita AS. Orthodontic management of a dilacerated central incisor and partially impacted canine with unilateral extraction - A case report. *Saudi Dent J* 2017; 29: 185–193.

3. Felicita AS. Orthodontic extrusion of Ellis Class VIII fracture of maxillary lateral incisor - The sling shot method. *Saudi Dent J* 2018; 30: 265–269.

4. Krishnan S, Pandian S, Rajagopal R. Six-month bracket failure rate with a flowable composite: A split-mouth randomized controlled trial. *Dental Press J Orthod* 2017; 22: 69–76.

5. Felicita AS. Quantification of intrusive/retraction force and moment generated during en-masse retraction of maxillary anterior teeth using mini-implants: A conceptual approach. *Dental Press J Orthod* 2017; 22: 47–55.

6. Reddy AK, Kambalyal PB, Shanmugasundaram K, et al. Comparative Evaluation of Antimicrobial Efficacy of Silver, Titanium Dioxide and Zinc Oxide Nanoparticles against Streptococcus mutans. *Pesqui Bras Odontopediatria Clin Integr* 2018; 18: e4150.

7. Charles A, Ramani P, Sherlin HJ, et al. Evaluation of dermatoglyphic patterns using digital scanner technique in skeletal malocclusion: A descriptive study. *Indian J Dent Res* 2018; 29: 711–715.

8. Pandian KS, Krishnan S, Kumar SA. Angular photogrammetric analysis of the soft-tissue facial profile of Indian adults. *Indian J Dent Res* 2018; 29: 137–143.

9. Chinnasamy A, Ramalingam K, Chopra P, et al. Chronic nail biting, orthodontic treatment and Enterobacteriaceae in the oral cavity. *J Clin Exp Dent* 2019; 11: e1157–e1162.

10. Felicita AS, Thirumurthi AS, Jain RK. Patient's Psychological Response to Twin-block Therapy. *World Journal of*

Dentistry 2017; 8: 327–330.

11. Im J, Cha J-Y, Lee K-J, et al. Comparison of virtual and manual tooth setups with digital and plaster models in extraction cases. *Am J Orthod Dentofacial Orthop* 2014; 145: 434–442.

12. Barreto MS, Faber J, Vogel CJ, et al. Reliability of digital orthodontic setups. *Angle Orthod* 2016; 86: 255–259.

13. Han UK, Vig KW, Weintraub JA, et al. Consistency of orthodontic treatment decisions relative to diagnostic records. *Am J Orthod Dentofacial Orthop* 1991; 100: 212–219.

14. Winstanley RB, Carrotte PV, Johnson A. The quality of impressions for crowns and bridges received at commercial dental laboratories. *British Dental Journal* 1997; 183: 209–213.

15. Peluso MJ, Josell SD, Levine SW, et al. Digital models: An introduction. *Semin Orthod* 2004; 10: 226–238.

16. Tomassetti JJ, Taloumis LJ, Denny JM, et al. A comparison of 3 computerized Bolton tooth-size analyses with a commonly used method. *Angle Orthod* 2001; 71: 351–357.

17. Barry M. In-office digital study models. *J Clin Orthod* 2011; 45: 385–389.

18. Kumar V, Ludlow J, Soares Cevidanes LH, et al. In vivo comparison of conventional and cone beam CT synthesized cephalograms. *Angle Orthod* 2008; 78: 873–879.

19. Stratemann SA, Huang JC, Maki K, et al. Evaluating the mandible with cone-beam computed tomography. *Am J Orthod Dentofacial Orthop* 2010; 137: S58–70.

20. Charkhandeh S, Kuhns D, Kim S. A fully digital workflow and device manufacturing for mandibular repositioning devices for the treatment of obstructive sleep apnea: a feasibility study. *J Dent Sleep Med* 2017; 4: 97–102.