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# Digitization in Orthodontics: An Overview

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**Abstract**

The routine diagnostic orthodontic records include study models, lateral cephalograms, panoramic radiographs and photographs. However, the conventional methods are associated with some drawbacks as a result of which there have been continuous developments for search of better methods in the field of orthodontic diagnosis. Different ways through which digitization in clinical practice and in the laboratory can be done are direct digitization using an intraoral scanner, digital photography or indirect methods using cone beam computed tomography (CBCT) or a cast scanner, computer aided cephalometric analysis. In the latter case, scanning of both impressions and cast is possible. Although impressions do not require creating a study cast, cast scanner show difficulties detecting undercuts. Moreover, digitization using CBCT requires plastic impressions trays. After the initiation of 3D imaging systems, it was possible to evaluate structures in real three dimensional anatomy that is the hard tissues, soft tissues and also craniofacial region. These new systems have several other advantages. Good sense of understanding can be created between the dentist and his dentally oriented patients to help reduce their dental fear and impose trust and education regarding their oral health conditions. These intension scan be achieved by the use of intraoral camera, education. The hardware, software and materials that support image capture and CAD/CAM processes are advancing rapidly, with some applications, such as the direct digital impression, only recently becoming a reality. Whilst the cost of cutting edge technology is high initially, it inevitably reduces with time and it seems likely that dentistry and its associated specialties will increasingly incorporate 3D digital technology into most areas of diagnosis, treatment planning and delivery. There is also great potential for dental education, patient motivation by showing the steps of treatment and virtual treatment outcome through the application of 3D virtual models and simulators. With recent advances, it become possible for virtual designing and 3D printing technology to create different orthodontic appliances which will be helpful to ease the treatment method and make orthodontic appliances more comfortable for all types of patients. It is crucial to closely monitor both the potentials and the challenges posed by digitalization in dentistry.

***Keywords:*** *CAD-CAM, CBCT, digital photography, intraoral scanner, 3D printing.*

## INTRODUCTION

The advances in diagnostic records have created a milestone in the field of orthodontics. Records are key source for case assessment and decision of specific treatment, discussion with other teammates and assessment of case progress is easy with records.

The routine diagnostic orthodontic records include study models, lateral cephalograms, panoramic radiographs and photographs. However, the conventional methods are associated with some drawbacks as a result of which there have been continuous developments for search of better methods in the field of orthodontic diagnosis. Direct digitization can be done using an intraoral scanner, digital photography and indirect methods using cone beam computed tomography (CBCT) or a cast scanner, computer aided cephalometric analysis in clinical practice.

Different treatment options could be compared by the practitioner whether tooth should be removed or not, fixed(implants or bridge) or removal prosthetic replacement in case of missing teeth. The final outcome is better way of communication between the orthodontist and patient, permitting for better understanding of treatment results and a greater measure of agreement among patients.

**Acquiring Digital Data**

In 1987 3-D impressions were first presented by CEREC 1 (Siemens, Munich, Germany)[1], for obtaining a virtual model utilizes infrared camera and optical powder.

Latest IOS are used for securing of optical impressions are constantly changing the practice all over the world. Upgrades in the inspection method have come about in really convenient nonchalant system and direct information to connected systems.

Intraoral scanners offer various applications in orthodontics for example, digitized study models and future programming after study model examination for advanced treatment planning of that particular patient.

Scanners smooth out and speed up the conventional work process,decrease the patient's visits, and broadens the treatment options and cost reserve funds in the orthodontic clinics.

**Intra Oral Scanners**

Different scanning system are available that utilize optical components and structural light sources used in orthodontics.[2]

Different companies use different scanning system for securing of digital impression like

*iTero® (Align Technology)* which was established in 2011, utilizes confocal microscopy technique similarly *True Definition (3M ESPE)* was dispatched in 2013 works on"3D-in-motion video technology", another *Lythos™ (Ormco Corporation* in same year(2013), utilizes accordion periphery interferometry innovation*, one more CS 3500 (Carestream)*At the end of 2013, utilizes confocal laser scanner microscopy procedure. Recently,*PlanmecaPlanScan® (E4D Technologies)* is launched works on optical coherent tomography with blue laser innovation.

**Facial Scanners**

- *3D surface imaging*

Initially, 3D surface imaging was used which gives geography of the facial structures and aids in investigation of evenness and stretch of face. Facial aggregate could be assessed such as syndrome associated (fetal alcohol syndrome), cleft lip and palate patients[3], and short-run and long-run outcomes of NAM.

- *4D facial dynamics*

The 4D framework is utilized to evaluate capacitatem of face combined with normal development of head, useful advancement and treatment results and careful intercessions. Facial structure of human is equipped for remarkable microexpressions[4] which last only around 0.04 seconds.

**Desktop Scanners**

Various types of 3D scanners are intended to catch 3D pictures of traditional models as well as of impression for securing them into digital models.[5] This technique utilizes beam of laser that will not be harmful and few advanced cameras to recreate better image quality of the object.

**Manipulating the Data**

Digital models without being forever changed can likewise be virtually manipulated (ie, cross-sectioning or virtual trimming and segmenting). Digital models have been demonstrated to be a satisfactory substitute for stone casts. Investigations such as tooth width, overjet, overbite, midline discrepancy, intermolar width, intercanine width, and molar and canine relationship[6] were determined on plaster study models and digital study models.

Advanced investigation models were presented economically in 1999 by OrthoCad_ (Cadent, Carlstadt, NJ, USA) and in 2001 (emodels_; GeoDigm, Chanhassen, MN, USA).[7]

- *Photographic analysis*

Using Nemoceph 2.0® (NemotecDental Systems, Madrid, Spain) software program,the photographic records were digitized and analysed for the Windows operating system. The program customization done with the landmarks.[8]

- *Radiographic analysis*

**Computer Aided Analysis**

Evolution of cephalometric investigation by computer aided method, requires manual identification of landmarks and computerized analysis of the landmark relations. This methodrequires less time, but chances of errors is there.[9]

**Automatic Landmark Identification**

This way is totally computerized as cephalometric picture is transferred into system and both landmark identification and cephalometric analysis is carried out by automatically. This method provide more precision, give more proficient utilization of time, and aid in accurately diagnosing the problems.[9]

**CAD-CAM**

During the 1980s, computer-aided design and computer-aided manufacturing (CAD/CAM) systems were introducted in the department of dentistry.

Computer aided design/CAM (figure 1) consists of three leading segments:

1) Information recording and digitizing;

2) Information processing and design; and

3) Constructing[11]

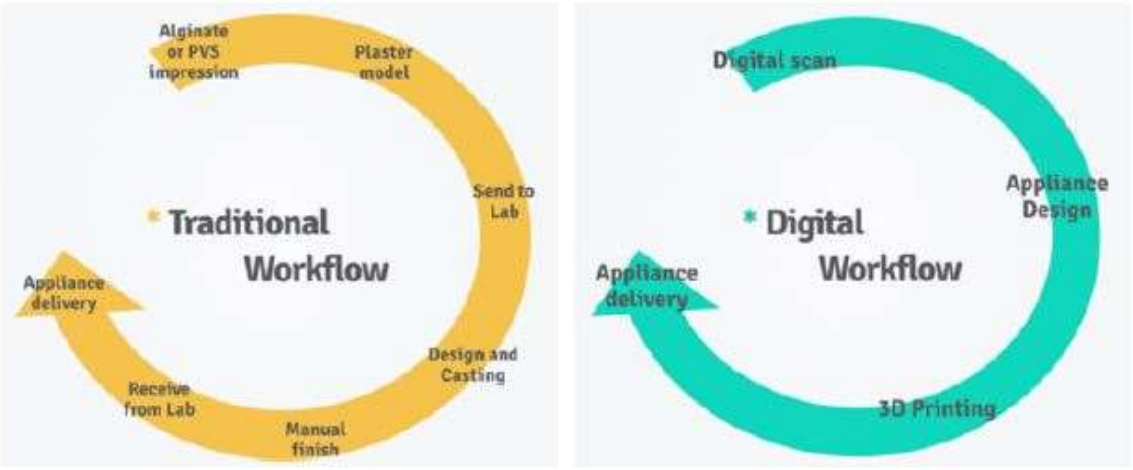


**Figure 1 -Conventional versus electronic technology in orthodontic office**

Most advanced intraoral scanners work on internet backup system as it allows realistic images once examined to be communicated safely and distributing it to storage office and rectified for indicative outcomes. Distributed computing has fundamentally affected the medical services industry in the previous years. The idea gives gigantic measures of capacity and processing ability.

*Customised brackets and wires*

The issues customarily connected with lingual orthodontics can't be settled with regular assembling measures; all things considered, total individualization of all machine segments is required. In the methodology introduced here, the cycles of section creation and enhanced situating of the manufactured sections on the tooth, which are typically very isolated, are combined into 1 unit. Individualization of the section base, a cycle utilized in different research facility measures and consistently basic in the lingual procedure, happens during creation of the single brackets,[11-13] at the end of the day, every tooth has its own tweaked section, made with cutting edge computer-aided design/computer-aided manufacturing (CAD/CAM) programming combined with high-end, rapid prototyping methods.

The archwire subsequently runs like a strip. By utilizing custom programming, the section bodies are added to the arrangement and the cushion surfaces, and are masterminded with the goal that the openings are adjusted in the virtual archwire plane. Very good quality fast prototyping machines are utilized to change over the virtual section arrangement into a wax simple and afterward into an eventual outcome made of an incredibly hard composite with a high gold substance. This material has a Vickers hardness of 310 kg/mm$^2$. In light of the all-encompassing redid base, which allows obvious situating on the tooth, the sections can be legitimately reinforced by the orthodontist.

*Clear aligner*

Clear plastic are clear plastic used for moving teeth as metal braces. These are astounding choices for grown-up and capable youths, hesitant to traditional fixed metal braces and to avoid clinicians appointments, and certain grievance that circles mellow to direct arrangement issues. In 1944,the

custom made appliance for proper tooth positioning was created by Kesling which allow early removal of the appliance.[14] Dynamic developments often accomplished through tooth positioner:-

1. Arrangement of teeth in overcompensated manner
2. To fasten closure of bands gap
3. Setting the position of canine crown
4. Tipping during treatment could be rectified by occlusal plane angle
5. To rectify the hindrance on the balancing side
6. To rectify the mesio-distal and labio-lingual angulation of incisors
7. To commute the canine-premolar relationship, so that premolars are not visible in smiling profile
8. Placing the teeth in their correct position by lessening the overcompensated effect

**3D Printing (Additive Manufacturing)**

In 1990,Wilfried Vancraen, CEO and Director of Materialise NV, founded the first Rapid Prototyping sector company in the Benelux region. This applied science allows the fabrication of 3D items, templates and also allows manufacturing of any figure from a virtual model(Figure 2).


**Figure 2: CAD Model**

*Application*

The additive manufacturing is proficient way of producing various products with high level of accuracy. Fabrication of clear retainer and aligner are among most common procedures carried out through this technology. It is narrated in the literature of orthodontic that an attempt has been made to build 3D models, orthodontic appliances, customised brackets and archwires, etc.

**Challenges and Opportunities**

*Ethical challenges*

Challenges 1: Big data/ data security and data manipulation
Challenges 2: Dental practitioner-patient relationship
Challenges 3: Digital literacy
Challenges 4: Assumption of responsibility in complex technical systems

Challenges 5:Changes in professional profile and self image
Challenges 6:Cost trap/overtreatment/ shift of standard
Challenges 7: consumption spiral/ecological fingerprint of digital technology
Challenges 8: (Lackof)clinical evidence

**Patient education and Motivation**

Great insight can be built among the practitioner and patients, in reducing fright among them and building trust and educating them about good oral hygiene. These aim can be carried by the use of imaging of various dental procedures, intraoral camera, educational videos. This enables the practitioner to explain the patient and placing various functional objects to stimulate the changes that could be carried during treatment, and aids in straightway consultation that boost confidence, optimize the timing and give marked inspiration for treatment.

**Digitization In Orthodontic Education**

In dentistry, the Simodont® provide multiple ventures for learning task and aid in grooming students for various procedure carried during clinical practice as this will overpass the breach between an artificial tooth simulated and the real life clinical practice.[15]

**Future Prospects**

Artificial Intelligence assisted in orthodontics during decision making. On the basis of comprehensive exams and patient analysis, the demand of orthodontic treatment could be assesed. The results revealed that AI could detect the orthodontic outcomes with an increase in facial attractiveness and a decrease in the appearance of age. To pre-visualize treatment result for prospective patients , orthodontic treatment simulation was applied by machine learning.

**Conclusion**

Digitization has been one of the most prospering aspect in the recent years in the field of dentistry. Various articles narrated about digitization in dentistry as “paradigm shift” or “revolutionary”;[16] these articles guide the patients to imagine about digital dental procedures as the current upcoming normal of day to day dental procedures.

With recent advances, it become possible for virtual designing and 3D printing technology to create different orthodontic appliances which will be helpful to ease the treatment method and make orthodontic appliances more comfortable for all types of patients. As a future perspective, digitization should participate in field of research for more effective and efficient methods which can help for more advance innovations.

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