ORIGINAL RESEARCH PAPER
Volume - 11 | Issue - 11 | November - 2022 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

RECENT ADVANCES AND DIGITAL ORTHODONTICS FOR YOUNG AND GENERAL DENTISTS

Orthodontics

Dr. Karthikeyan	MDS
Dr. Vinoth	MDS
Dr. Saravanan	MDS
Dr. Poojaashri A	BDS
Dr. Pondharanieswari. P	BDS

ABSTRACT

The field of orthodontics is entering into a new venture to be more more updated in its technological point of view. Digital technology plays a major role in our lives ever since the modernisation of mobile phones and other such gadgets. The advanced technology has remodelled the diagnosis and treatment plan in the field of medicine in a more efficient way. Digitalisation of various aspects of dentistry has emerged with transformations in the documentation, study casts, analysis of a dental malocclusion, smile designing, treatment planning and for fabrication of orthodontic appliances.

KEYWORDS

Digital orthodontics, digital models, CAD CAM, CBCT, digital data.

INTRODUCTION:

There are many advancement occuring in internet day by day, globalization and advancements has made life much more easier and the recent pandemic has prompted the whole world to become more related to technology. In the recent years, the speciality of orthodontics placed itself with a great significance.Right from the moment when the patient enters for correcting his/he smile the diagnosis , treatment plan and the outcome can be digitalised and can be visualised by each of the patient this results in a greater impact on the patient. The arsenal of digital technology has enabled the orthodontist to approach more wisely, efficiently and more with accuracy.[1]

At present, all written ans scripted data is completely replaced with digital backup all have become software-backed. Conventional imaging methods has taken last seat due to the emergence of digital radiographs and digital photographs. Conventional Plaster models are now being replaced by digitalised models that gives a complete visualisation and more understanding of the treatment plan. Similarly, the revolution in this digital world has taken over cephalometric analysis, simulation/virtual treatment planning, treatment alternatives, outcomes and follow-ups in a more digitalised form and has made work more easier and efficient by the practitioners. This digital revolution in orthodontics has emerged and greatly helps in overcoming previous communication hindrances, improving treatment plan and its final outcome and subsequently increasing productivity. The objective of this article is to highlight the scope, merits and demerits of various digital advancements which are used in field of orthodontics. [2]

Digital Dental Models:

.Digital models can be acquired through various indirect or direct methods. In indirect method, a good and high quality impression and bite registration of the patient is required from which a plaster model is made primarily and the plaster model is then optically scanned to obtain a digitalised model. In the direct method, the impression is not necessary. All the images are obtained directly from the patients mouth intraorally with the use of intra-oral scanners, lasers, CBCT etc.few of the softwares are available and can be made use this more efficient it can also manage and store digital study models and its data. Recent software has emerged with articulation feature to evaluate functions of TMJ and to stimulate various movements and provide with much more effective treatment plan. Some studies have found no statistical significance in measurements between the plaster and digital models.whereas some studies have found the digital models are larger and some have found digital models to be smaller than the plater models.But now digital study models are the new gold standard in orthodontic practice and hence an orthodontist should have the knowledge on dental models and its clinically acceptable accuracy, acquisition techniques, use of each softwares and printing of 3D models in their day to day clinical practise.[3]

MERITS:

1. Inaccurate impressions cannot be used and it requires rescanning.
2. Aspiration of impression material can be eliminated in patients with cleft lip and palate.
3. For patients who are anxious
4. For patients already undergoing fixed orthodontic treatment as the former impressions get distorted very easily.
5. Intra oral scanning takes a shorter duration than conventional methods.
6. Can be accessed anywhere and anytime
7. Does not require disinfection of the impression and transportation of impression as there are many chances of distortion.
8. Storage spaces for dental casts are not necessary
9. Very useful to communicate with patients and to put forth the treatment plan.
10. patient comfort

DEMERITS:

1.Cost is the only drawback.

The orthodontists can get updated with the new venture of orthodontics as there are many traditional methods that are replaced with digital methods in this case getting updated to intra oral scanner which decreases the chair side process and it would be a valuable investment.

SMILE ANALYSIS:

Smile Analysis and design is base for orthodontics diagnosis and treatment .The relation between the lip and the tooth are sometimes not in correlation with each other. Hence, it is difficult at times of planning the orthodontics treatment of biomechanics . Many advances have emerged in orthodontics for example digital videography which helps to analyse and make the patient understand the treatment plan which is to be provided by the orthodontics, to establish better relation with patient . There is complexity in smile designing where patients soft tissue extent and limitation brings the overall facial aesthetics of patient .Patient smilie. movement during speech the oral and pharyngeal are captured simultaneously with the help of digital videography . The video camera captures and produces 5 second clip with 30 frames per second. The captured image is opened through a software called smilie mesh. With this the posture and features of anterior tooth can be evaluated.[4] The visualisation through pictures and the assessment of smilie is done by two process. First is by clinical examination where the measurement of tooth and lip and its relation is established. The second stage is using digital radiographs, photographs, videos and patients study cast that records the smilie both in static and dynamic posture.[5] The record assessment and treatment

planning is concluded with four dimensions - frontal, oblique, sagittal and time. [6] Schabel et al compared the smile of many subjects through photograph and video clip after orthodontics treatment and concluded that there is strong correlation between the measurements obtained from the software named smilie mesh and smilie captured by photograph and video clip. Digital photograph and patients data is considered as key for post treatment analysis and video clip are informative for dynamic smile analysis.[7]

DIGITAL CEPHALOMETRY:

Cephalometry paves way for a better evaluation, diagnosis, planning the treatment of a patient . Errors may also occur in Cephalometry analysis. Landmark identification is a major error in convention Cephalometry. The technological development helps in Cephalometry analysis which is aided by computer. It is faster in processing and analysing the data compared to conventional Cephalometry. Many softwares helps in transforming the digital Cephalometry analysis done in Cephalometry films to digital data.

Chen et al assist Cephalometry landmark on original radiographs and they were compared to digital images and concluded that they were statistically significant. Coming to reliability on its precision on locating the landmarks where comparable expect to a few landmarks like porion, articulare, posterior nasal spine.[8]

These features of digital Cephalometry facilitates orthodontics for better treatment plan and to predict various treatment plan that can be suitable for the particular patient. There are many software which are available for digital Cephalometry some are dolphin, vistadent, quick ceph and nemoceph.

Tripti TIkku et al compared the Cephalometry measurements by manual tracing with the measurements taken with the use of software and concluded that both were clinically significant.

Tuncan Uysal et al accessed the reproducibility and repeatability of landmark by inter and intra examination through hand tracing and computerised method and compared its speed and then concluded that computerised method which was done using dolphin software was more time saving and there was no alteration inter and intra examiner error.[9] [10]

CONE BEAM COMPUTED TOMOGRAPHY:

Computed tomography was invented by Alan McLeod Cormack and Godfrey.Radiographic images were 3 - dimensional assessment of the skull in 1:1 ratio. The only drawback of CT was cost and it needed high radiation dose, hence as an alternative CBCT was developed with the use of less radiation dose.

Cone beam computer tomography (CBCT) is used to make 3 - dimensional images in various fields of view of the head in 1:1 ratio. Virtual head of the patient was obtained by superimposition of digital dental models, CBCT, facial scanning for diagnosis and its treatment plan done by CAD CAM which are computed aided procedures. Softwares like Dolphin, 3Shape can be used for diagnosing and treatment planning of particular cases. Orthodontists at present have started to utilise three.dimensional cone beam computed tomography (CBCT) to attain the inefficiency of two.dimensional radiographic records.

There are specific softwares to alter and to magnify specific parts for better assessment. The software has the ability to merge CBCT, panoramic images, digital impressions and facial scans for diagnosis treatment planning and to fabricate specific appliance. The SICAT Function software measures and visualises the specific jaw movement related to the anatomy of the patient. It helps in studying the jaw movement of healthy and diseased TMJ its deformities and to treat TMJ problems.[11]

CBCT may be an ideal method for evaluating alterations in position of mandibular Condyles and rami after surgical correction.This technique provides a valid and reproducible 3D assessment of craniofacial structures. These methods may be used to identify treatment outcome and different patterns of remodelling following Orthognathic surgery.

CBCT in impacted tooth position is of much need in orthodontics used to evaluate impacted canine.The imaging is precise and determines the labial and lingual relationship and the exact angulation of impacted canine.

Advantages

Increased accuracy of geometric image.
Eliminates magnification, overlapping of landmarks and distortion of anatomic structures.

Assessing of image from three planes. To evaluate the areas of correction with localised and specific transversal cuts. Easy identification of landmarks and for better precision of superimposed images. Adjustment of the head position is not necessary.

Disadvantages

Varied levels of radiation exposure is a drawback Difficult to differentiate soft tissues due to poor contrast resolution.

CBCT in Orthodontics helps to evaluate radiographs of Impacted transposed, supernumerary teeth, resorbed root, root length and angulation relationship of tooth bone, cleft lip and palate airway morphology, Obstructive Sleep Apnoea, transverse dimension and expansion placement of temporary anchorage devices, dentofacial deformities and craniofacial anomalies and varies treatment plans such as orthognathic surgery, maxillary expansion, several orthopaedic appliances and Cervical vertebral maturation.[12]

VIRTUAL SETUP:

Virtual setup is a valuable diagnostic tool in orthodontics and surgical treatments and is mainly used to confirm, modify, or reject a suggested treatment plan. Virtual setups have several advantages such as digital storage, digital models which cannot be damaged, the same model can undergo several treatment simulations, and communication between dentists and surgeons and between dentists and patients is facilitated. Patients having severe malocclusion and dentofacial deformities generally subjected to combined orthodontic treatment and orthognathic surgery. Virtual setup is able to simulate the orthodontic treatment by segmenting individual teeth and moving each individual tooth to its desired position in a CBCT using a visual repositioning software. The virtual environment enables the surgeon to perform osteotomies, simulate different treatment strategies, and predict the facial profile post operatively. Using this virtual planning, surgical splints can be made and used to position the jaws in the required positions during surgery. This modality correlates the patient's 3D model with the photographs, CBCT or CT and CAD-CAM software to plan the surgery pre-operatively and compare the outcomes after surgery. Virtual setups are as accurate as manual setups and is more efficient than the conventional setup.

VIRTUAL SEGMENTATION:

A major disadvantage of plaster models and setups is that superimposition is not possible thus making it difficult to compare between two models. An accurate virtual segmentation is done on the digital dental model with the help of CBCT. While the setup is made, the available space in the arch can be calculated by assessing the alveolar bone which can be seen on the digital model. In Ortho Analyzer software, this segmentation process initiates with marking mesial and distal points on each tooth. Then, it draws a segmentation line along the gingival margin. After that, the software separates the crowns of the teeth from the gingiva and refines the interproximal contacts virtually. The advantage of using CBCT is that to check and correct the root position in relation to alveolar bone in treatment planning. The virtual treatment plan provides the need for extraction or interproximal stripping based on the malocclusion present and aesthetic concerns. Thus, Orthodontist plays the main role during the fabrication of setup according to the need of the patient.

MONITORING TOOTH MOVEMENT:

For a desired result in the orthodontic treatment, you need an effective and optimal tooth movement. Tooth movements can be monitoring by intraoral scans and can be analyzed using software like Ortho - Analyzer. Software's like Maxillim, Geomagic, Dolphin and Ortho - Analyser can be utilized to superimpose the crowns of the dentition and compared with early CBCT to the see the treatment progress. A recent monitoring system was introduced called Dental Monitoring which allows to monitor the tooth movement using smartphone. A custom-made cheek retractor is designed and given to the patient. Once the images are uploaded to the dental monitoring lab, the progress of the treatment can be viewed by both the patient and the

orthodontist. 3D matching can be done with the images and the initial digital dental model and gives the actual movement of the dentition.

3D PRINTING:

Three-dimensional printing technology is an additive manufacturing technology that is essential to reconstruct 3D objects by designing virtually or by scanning an object. The first three-dimensional (3D) printing was developed by Charles Hull in 1986 and he found stereolithography (SLA) and developed the first 3D printing system the same year. 3D printed orthodontic appliances have become effortless to fabricate in-office, with just computer software and a low-cost 3D printer system. In-office aligners have become very popular as they provide many advantages, including: simulation control, ability to use a variety of aligner materials, superior logistics, and low in cost. 3D printing helps in attaining high precision with various like dental models, removable appliances, customized brackets, arch wires and occlusal splints.

Technologies of 3D Printing:

1. Stereolithography (SLA)
2. Fused deposition modelling (FDM)
3. Digital light processing (DLP)
4. Polyjet photopolymerization (PPP)
5. Selective laser melting (SLM) and Selective laser sintering (SLS)
6. Electron beam melting (EBM)
7. Inkjet 3D printing
8. Laminated object manufacturing (LOM)

Stereolithography:

Stereolithography has become very popular in the dental field because of its accuracy and rigidity. Stereolithography utilizes stereolithography apparatus (SLA), to fabricate liquid plastic into solid parts. SLA consists of UV-assisted photopolymerization of liquid monomers. A UV laser is scanned on a layer of the liquid monomer to cure the monomer in particular areas. After completion of a layer, another layer of resin is fabricated on top of the cured layer. After the resin sets it becomes solid. This process is called recoating. The process of recoating and curing is repeated until the part is completed and it results in high resolution. The object requires an ultrasonic bath with isopropyl alcohol to get rid of the resin remnants, before the post-processing UV light cure is done. In recent days, the most commonly used three-dimensional printers are the Laser-SLA.

CUSTOM MADE RETAINERS USING CAD/CAM:

In custom orthodontic appliance systems, like Insignia, Maintaining the distance between the lower cuspid distance could enhance the stability of the lower arch after correction. However, Clear retainers (passive aligners) is the retainer of choice because of the inaccurate fit of most of the removable retainers with clasps, if removable appliances in the mandible is essential.

With the CAD/ CAM method we can design, fabricate, precise placement of retainer wires and can give effective retention of tooth position for an extended period can be anticipated. This CAD/ CAM method of fabricating retainers can offer high certainty indeed in anatomically tricky regions and limited space.

ADVANTAGES OF CAD/ CAM RETAINERS:

1.Ideal fit.
2. Optimal transfer of retainer to the calculated position.
3. Patient comfort .
4. lower breakage of wire.
5. Prevention of occlusal disturbance.
6. Easy to clean.

CAD / CAM IN CUSTOMISED ORTHODONTIC APPLIANCES:

INSIGNIA:

Software used to manipulate the digital setup to process 3D position of individual teeth, adjust arch form, alter smilie when required and detail the dental contacts in final occlusion.

SURESMILE:

Suresmile gives digital software that the dentist can use for diagnosing and treatment planning , like the other CAD/CAM orthodontics systems.

INCOGNITO:

Incognito combines personalization of base of brackets, slots and arch wires to design a customized lingual orthodontic appliance. It is the only system that provides completely customized lingual orthodontic treatment. The advantages are optimal aesthetics, accuracy of the results, reduced incidence of white spot caries, decrease in discomfort when compared to other lingual appliances and easier, precise rebonding of debonded brackets since the better adaptation of the customized base of the bracket and the disadvantage is error while positioning the bracket.

CUSTOM REMOVABLE APPLIANCES:

INVISALIGN:

The most common application of digital flow are the digital setups and fabrication of clear aligners and it is only part of its clinical applications in Orthodontics. “Invisalign” introduced by Align technology, Inc., was one the first orthodontic treatment with clear aligners.

The combination use of aligners with fixed orthodontic appliances or aligners used to complete treatment after early debonding of fixed appliances will expand the use of aligners for tooth correction. Clear aligners give an aesthetic and comfortable treatment experience, make ease in maintaining oral hygiene, causes decrease in pain as compared to fixed appliances, reduce the frequency of appointments, and fewer necessary of emergency visits.

It utilizes a course of aligners to move the teeth, which is made-up of clear see-through plastic that involves the alveolar surfaces of the teeth. The duration of usage is 2 weeks and it is changed according to the movement. The average movement of teeth is about 0.25 - 0.35 mm and the complete duration of the treatment is about 9 - 15 months.

Invisalign becomes a leading role in aligner therapy with a combination of computerized virtual treatment planning, and stereolithographic prototyping technology for manufacturing.

Advantages

1. Aesthetically pleasing.
2. Easy to use in daily life
3. Comfortable to wear
4. Better oral hygiene compared to conventional appliances
5. No allergic reactions
6. Eliminates dreadful bonding procedure
7. Assessment of treatment options before beginning treatment
8.Use of Virtual model in educating patient

Disadvantages

1. Limited power over movement of root
2. Slight intrusion of posteriors of 0.25 - 0.5 mm
3. No operator control during treatment.
4. Not cost efficient
5. Extrusion

CONCLUSION:

The Advanced technological development has facilitated 3D imaging, printing, virtual setup, monitoring of tooth movement and treatment planning to another level in the diagnosis and treatment aspect in the department of orthodontics. Integration of various softwares of digital models, facial scans and CBCT enables for treatment and to establish a better relationship with patient. The digitalization is bringing about a new venture in diagnosing and treatment plan posing a challenge to clinical efficiency and knowledge. With the fast development of digital technologies, orthodontists are now able to diagnose and plan treatment in a more feasible way.

REFERENCES:

1. Camardella LT, Rothier EK, Vilella OV, Ongkosuwito EM, Breuning KH. Virtual setup: application in orthodontic practice. J OrofacOrthop 2016;77:409-19.
2. El-Zanaty HM, El-Beialy AR, Abou El-Ezz AM, Attia KH, El-Bialy AR, Mostafa YA. Three-dimensional dental measurements: An alternative to plaster models. Am J OrthodDentofacialOrthop 2010;137:259-65.
3. Nathasha MM, Chakravarthi NCS, Srinivasan D, et al.. Orthodontics in the era of digital innovation – a review. J Evolution Med Dent Sci 2021;10(28): 2114-2121, DOI: 10.14260/jemds/2021/432
4. Ackerman MB, Ackerman JL. Smile analysis and design in the digital era. Journal of Clinical Orthodontics 2002;36(4):221-36.
5. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: part 1. Evolution of the concept and dynamic records for smile capture. Am J Orthod Dentofacial Orthop 2003;124(1):4-12.
6. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: part 2. Smile analysis and treatment strategies. Am J Orthod Dentofacial Orthop 2003;124(2):116-27.

7. Schabel BJ, Baccetti T, Franchi L, et al.. Clinical photography vs digital video clips for the assessment of smile esthetics. Angle Orthod 2010;80(4):490-6
8. Chen YJ, Chen SK, Chang HF, et al.. Comparison of landmark identification in traditional versus computer- aided digital cephalometry. Angle Orthod 2000; 70(5):38792.
9. Tikku T, Khanna R, Maurya RP, et al.. Comparative evaluation of cephalometric measurements of monitor- displayed images by Nemoceph software and its hard copy by manual tracing. J Oral Biol Craniofac Res 2014;4(1):35-41.
10. Uysal T, Baysal A, Yagci A. Evaluation of speed, repeatability and reproducibility of digital radiography with manual versus computer-assisted cephalometric analyses. Eur J Orthod 2009;31(5):523-8.
11. Nathasha MM, Chakravarthi NCS, Srinivasan D, et al.. Orthodontics in the era of digital innovation – a review. J Evolution Med Dent Sci 2021;10(28): 2114-2121, DOI: 10.14260/jemds/2021/432
12. Kaygısız E, Tortop T. Cone beam computed tomography orthodontics. In: Halefoğlu AM, ed. Computed tomography - advanced applications. Intech Open 2017: p. 117.
13. Nathasha MM, Chakravarthi NCS, Srinivasan D, et al.. Orthodontics in the era of digital innovation – a review. J Evolution Med Dent Sci 2021;10(28): 2114-2121, DOI: 10.14260/jemds/2021/432
14. Camardella, L.T., Rothier, E.K.C., Vilella, O.V. *et al.* Virtual setup: application in orthodontic practice. *J Orofac Orthop* **77**, 409–419 (2016). https://doi.org/10.1007/s00056-016-0048-y
15. [**Ahmed Mohammed Alassiry (2021);** DIGITAL ORTHODONTICS- A CONTEMPORARY VIEW OF FUTURISTIC PRACTICE *Int. J. of Adv. Res.* **9** (Apr). 723-732] (ISSN 2320-5407). www.journalijar.com
16. Baan, F., de Waard, O., Bruggink, R. *et al.* Virtual setup in orthodontics: planning and evaluation. *Clin Oral Invest* **24**, 2385–2393 (2020). https://doi.org/10.1007/s00784-019-03097-3
17. Ma Yaqi and Li Zhongke, "Computer aided orthodontics treatment by virtual segmentation and adjustment," 2010 International Conference on Image Analysis and Signal Processing, 2010, pp. 336-339, doi: 10.1109/IASP.2010.5476100.
18. Cunha, T., Barbosa, I., & Palma, K. K. (2021). Orthodontic digital workflow: devices and clinical applications. *Dental press journal of orthodontics*, *26*(6), e21spe6. https://doi.org/10.1590/2177-6709.26.6.e21spe6
19. Salah, P. and Breuning, K.H. (2017). Monitoring of Tooth Movement. In Digital Planning and Custom Orthodontic Treatment (eds K.H. Breuning and C.H. Kau). https://doi.org/10.1002/9781119087724.ch8
20. Sukanya .D. "Application of stereo lithography in orthodontics –a review." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), 19(5), 2020, pp. 09-13
21. DOI:https://doi.org/10.1053/j.sodo.2021.09.004
22. Wolf, M., Schumacher, P., Jäger, F. *et al.* Novel lingual retainer created using CAD/CAM technology. *J Orofac Orthop* **76**, 164–174 (2015). https:// doi.org/10.1007/s00056-014-0279-8
23. https://www.jco-online.com/archive/2014/08/475/#print
24. Tsolakis, I. A., Gizani, S., Panayi, N., Antonopoulos, G., & Tsolakis, A. I. (2022). Three-Dimensional Printing Technology in Orthodontics for Dental Models: A Systematic Review. *Children (Basel, Switzerland)*, *9*(8), 1106.https://doi. org/ 10. 3390/children9081106