Orthodontics in the Era of Digital Innovation – A Review

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ABSTRACT

The field of orthodontics in its new era is venturing ahead to more up-to-date technological point of view. Digital technology has a significant effect on our lives ever since the modernization of mobile phones. The advances in technology have remodelled the diagnosis and treatment plan in the field of medicine. Digital workflows are currently increasing in the orthodontic practice and has touched every aspect of orthodontics – with transformations in the documentation, study casts, analysis of a dental malocclusion, smile designing, treatment planning and for fabrication of orthodontic appliances.

Three - dimensional imaging of the dentition, skeletal components and the face allows for treatment planning in three dimension and use of computer aided design (CAD) and computer aided manufacturing (CAM) for customization of orthodontic appliances. Software integration of digital models, 3D facial imaging and cone-beam computed tomography (CBCT) makes it possible to simulate the treatment plan and to attain a good communication with the patients. Recent advancement in digital videography has allowed the clinicians to capture patient's speech, oral and pharyngeal function, and smile at the same time.

Effective and optimal tooth movement required for the patient can also be monitored with the digitalization. Moreover, this digital platform has created the advantage of accessing the patient's information from any location with the help of cloud based computing storage systems. These advancements have improved the efficiency, accuracy, consistency, and predictability of the treatment outcomes and have also led to progress in educational component and communication. The digitalization is bringing about a revolutionary change in the field of diagnosis and treatment planning, posing a challenge to clinical efficiency and knowledge.

KEY WORDS
Digital Orthodontics, Digital Workflow, Digital Dental Models, Digital Radiography, CAD CAM, Orthodontics, Review

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BACKGROUND

Imagination will often carry us to worlds that never were, but without it we go nowhere – Carl Sagan. With technological development and imagination being endless, orthodontic treatment continues to evolve. The digital future will pave a way for additional diagnostic tools, treatment modalities that would enhance and develop our specialty. As the field of orthodontics constantly developed, our system was nevertheless complete. Patient records containing case sheet, radiographs and photographs for diagnostic purposes could be lost or misplaced in the work area. To overcome this, digitalization of records created a great impact as the data could always be accessible on a real time basis.[1] The advances in the technology in addition to the digital solutions have remodelled the diagnosis and treatment planning from a two - dimensional to three - dimensional view. Latest advancements and evolution of digital radiography, intraoral scanners, cone-beam computed tomography (CBCT) and customized orthodontic appliances have increased the accuracy, consistency, efficiency, and predictability of the treatment outcome. Recent developments have headed to a rapid growth in digital education, teaching tools, 3D videos and for patient interaction.

Scanning of digital impressions, virtual designing, 3D printing of various orthodontic appliances were obtained with research and development of various technologies and compatible materials. Traditional impressions and cast production are being replaced by digital models that would strengthen the efficiency of practice, satisfaction of the patient for a fully integrated digital workflow. The digital impressions of the patient can be stored according to convenience and easily transported to the lab for the fabrication of customized appliance.

Software integration of digital models, 3D facial imaging and cone-beam computed tomography (CBCT) makes it possible to simulate the treatment plan and to attain a good communication with the patients.[2] Concerning to the patients, they wish to look and discuss the diagnostic setups of the dentition and the forecasted facial changes even before the treatment begins. They also hope for a faster transformation in a less span of time with aesthetics being a major concern. Thereby virtual planning is now possible with 3D imaging that would predict the facial changes after the treatment and provide relevant information to the patient.[3]

The evaluation and diagnosis of clinical orthodontics has undergone vast changes in the last 20 years. Utilizing 3 - dimensional (3D) diagnostic records and imaging can be an exceptionally valuable tool in orthodontics. It can precisely reproduce the patient's data in a secondary environment and when interfaced correctly, it allows the practitioner to manipulate these records as virtual patient. It is of benefit to the patient and the practitioner as it provides a unique platform for treatment and diagnosis.[4] CBCT, intraoral scanners, digital tooth setups, CAD / CAM appliances like clear aligners (Invisalign), robotic formed arch wires (SureSmile), custom fabricated brackets (Insignia, Incognito, Harmony) are making orthodontic treatment more safer, effective and gaining more interest among the orthodontists.[5] This article highlights the digital workflow in orthodontics which is of demand in this technological era.

Digital Workflow

The Orthodontic setups are now being moved to digital workflow (Fig. 1) with intraoral scanners, CBCT, 3 - D printers, Digital tooth setups, and CAD / CAM appliances. The orthodontics office is moving towards a digital workflow with intraoral scans, digital tooth set ups, 3D printers, and CAD / CAM. Few studies have reported that CAD / CAM appliances decreased the duration of treatment and improved the patient outcome.[5] The digital models, documentation and appliance design will be transferred to the digital lab and the process of appliance manufacturing is known as the digital workflow.[3]

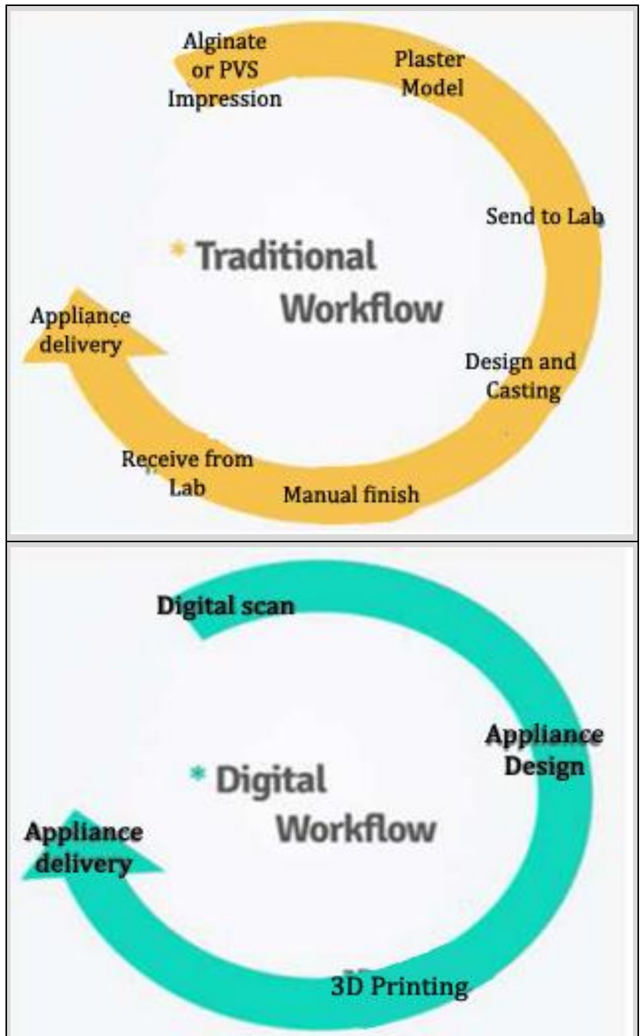

Figure 1. Comparison between the Traditional and Digital Workflow[2]

The accurate open file formats are included in the electronic health records of the patient that can be stored, accessed, and managed from anywhere through a secure portal like a cloud - based digital storage system. The digital intraoral scanners work combined with the cloud - based technology to transmit the scanned image and also to process it for further reference. Cloud computing offers enormous storage and computing power that does not need end user knowledge about the location or system configuration.[2]

The attained 3 - D data is saved in a standard triangulation language (STL) format. Most of the capturing systems can use the STL in various programs and allows export of data directly to the lab or for data manipulation according to the required function.[6]

DIGITAL DENTAL MODELS

They are obtained by indirect method which need transport of plaster casts or impressions for laser or computed tomography (CT) scanning to the specialized company. Cone beam computer tomography (CBCT) is the direct method to capture the dentition for dental analysis, but CBCT is not indicated for imaging dentition alone because of its radiation dose.

Advantages

1. Inaccurate impressions just require rescanning.
2. For anxious patients
3. In cleft lip and palate patients – eliminates the aspiration of impression material
4. For patients already undergoing fixed orthodontic treatment as the traditional impressions get distorted easily.
5. Time needed for intraoral scanning is shorter and depends on the familiarity.
6. In limited mouth opening patients
7. Does not require disinfection and transportation.
8. Rejects the need for storage space of dental casts.
9. Instantly available to discuss the treatment plan with the patient.
10. Comfort to the patient

Disadvantages

1. Cost

The cost of buying an intraoral scanner would be a valuable investment as it decreases the need for procedures involved in traditional impression taking.

Accuracy of Digital Dental Models

Fleming PS et al. (2011) conducted a systematic review to assess the tooth size, arch length, irregularity index, arch width and crowding with the use of digital models versus measurements on plaster models with digital callipers in patients with and without malocclusion. Digital measurements were comparable to that obtained from plaster models. Digital models offered a high degree of validity when compared to direct measurement on plaster models.[7]

Many studies have assessed the accuracy and reliability of digital dental models using various methods and software, which limits the ability to compare the outcomes. Reference point varies between examiners and directly affects the measurement. Direct measurement on plaster casts or digital model varies even while points are described precisely. Identification of points in digital models are more accurate because it can be enlarged and segmented for a better view.

Superimposition of digital dental models with software (Geomagic, Maxillim) compares the size and volume of the dentition and the alveolar bone. Colour scales is used to evaluate the difference in size and volume of digital models.

Smile Analysis

The basis for the orthodontic diagnosis and treatment planning is smile analysis and design. The lip - tooth relationship is also considered in the orthodontic problem list and during the planning of biomechanics. The recent advances in the technology lead to the development of digital videography, which helps in analysing the smile and to maintain a good rapport with the patient. Smile designing is complex with a broader knowledge on the patient's soft tissue limitations and to the extent where facial aesthetics can satisfy the patient and the orthodontist.

Digital videography captures patient's smile, speech, oral and pharyngeal function, at the same moment. The camera captures 30 frames per second and produces a 5 second clip for a total of 150 frames captured. Then the smile image is opened in a software called Smile Mesh. The Smile Mesh software was designed by TDG Computing (Jon Coopersmith and Greg Cassileth) for Dr. James and Marc Ackerman that measures 15 attributes of smile. It was initially used manually by Hulsey and modified and computerized by James and Marc Ackerman. With digital technology, the patients dynamic anterior tooth display can be evaluated.[8]

Picturization and assessment of smile dynamics is a two - stage process. First is the clinical examination (measurement of lip - tooth relationships) and second is record taking using digital photography, videography, radiography, and plaster study cast that records the smile both dynamically and statically. A frontal and oblique view is taken to assess the characteristics of smile three dimensionally.[9]

To record, assess and plan the treatment of smile it is evaluated in 4 dimensions - frontal, oblique, sagittal and time (maturation and aging of soft tissues). Latest technologies have developed the ability to view the patients more dynamically and enable quantification and communication of newer concepts of function and appearance.[10]

Schabel et al. compared the smiles of the subjects obtained by clinical photography vs smiles from digital video clips (Smile Mesh) after orthodontic treatment. The results of the study concluded that there is a positive correlation between Smile Mesh measurements obtained from the smiles captured by clinical photography and digital video clips. The standard digital photograph can be immediately viewed and is considered a valid tool in the post treatment smile analysis whereas the digital video clips offer more information for the dynamic analysis of the smile.[11]

Digital Cephalometry

Cephalometry is the foremost key in diagnosis, treatment planning, evaluation of treatment and prediction of growth in orthodontics. Errors in cephalometric analysis are radiographic film magnification, errors in tracing, recording and identification of landmarks. The landmark identification is a major source of error in the conventional cephalometry.

The technological advances have led to computer aided cephalometric analysis which is faster in acquisition and analysis of data than the conventional cephalometry. Various software helps in performing the computer aided cephalometric analysis by digitalization of the landmarks or the cephalometric films can be transformed to a digital format by a scanner or the video camera.

Chen et al. assessed the identification of landmarks on digital images compared to original radiographs. The differences in location of landmarks were statistically significant. Reliability of identification of landmarks in digital images were comparable except for a few points like porion, articulare, posterior nasal spine and mesiobuccal cusp of upper first molar.[12]

Of late, various software programs are available, which is an effective diagnostic tool. It facilitates the clinician to select the best treatment plan as it stimulates and predicts the varied treatment options. Numerous studies have evaluated the validity and reproducibility of linear and angular measurements by cephalometric software programs like Dolphin, Vistadent, Quick ceph and Nemoceph.

Tripti Tikku et al. assessed and compared the digital cephalometric measurements (using Nemoceph software) VS the hand tracing of their digital radiographic printouts. The results of the study concluded that both the techniques were clinically significant.[13]

Tuncan Uysal et al. assessed the intra-examiner repeatability and inter-examiner reproducibility of landmarks using manual and computerized techniques and compared the speed. The study concluded that digital method (using Dolphin software) was time saving and it did not increase the intra and inter examiner error.[14]

Cone Beam Computed Tomography (CBCT)

Alan McLeod Cormack and Godfrey Hounsfield invented computed tomography (CT) radiographic images that was used for 3 - dimensional assessment of the skull in 1:1 ratio. The limitations of CT radiographs were that it was expensive and needed high radiation dose, hence as an alternative CBCT was developed with reduced radiation.

Cone beam computer tomography (CBCT) is used to make 3 - dimensional images with different fields of view (FOVs) of the head in 1:1 ratio. Virtual head of the patient is attained by superimposition of digital dental models, CBCT and facial scanning for diagnosis, treatment plan and computer aided design (CAD) and computer aided manufacturing (CAM) procedures. Software like Dolphin, Anatomage and 3Shape can be used for diagnosis and treatment planning. Orthodontists at present have started to utilize three-dimensional (3D) cone beam computed tomography (CBCT) to conquer the insufficiency of two-dimensional (2D) radiographic records.[15]

The head of the CBCT machine turns a full or half circle over the head and the flat panel detector captures the photons and sends a signal to the computer. The recent CBCT machine makes a half turn around the head and the information gathered can reconstruct a full head scan. The CBCT can be viewed in any angle along with axial, sagittal and coronal slices of the skull with imaging software or DICOM viewers. To make specific parts more visible, the CBCT files (DICOM files) can be altered with specific software (Anatomage, Dolphin) for analysis. The software has the ability to merge CBCT, panoramic images, digital impressions and facial scans for diagnosis, treatment planning and appliance fabrication.

The first one to combine CBCT image, 3D facial scan and digital dental models was the Planmeca Oy ProMax machine. The SICAT Function software measures and visualizes the patient specific jaw movement related to the jaw anatomy of the patient. It helps in studying the jaw movement of healthy and diseased TMJ joints, to diagnose jaw deformities and to treat TMJ problems.

Advantages

- Increased accuracy of image geometry
- Eliminates magnification, overlapping and distortion of structures.
- Assesses image from three planes.
- To evaluate the areas of clinical interest with localized and specific transversal cuts
- Easy identification of landmarks and higher precision of superimposed images
- Fine adjustment of the head position is not required

Disadvantages

- Amount of radiation is the biggest controversy
- Due to poor contrast resolution, differentiation of various soft tissues becomes difficult.

CBCT in Orthodontics

Radiographic evaluation of

1. Impacted and transposed teeth
2. Supernumerary teeth
3. Root resorption
4. Root length and angulation
5. Tooth bone relationship
6. Cleft lip and palate
7. Airway morphology and Obstructive Sleep Apnoea
8. Maxillary transverse dimension and maxillary expansion
9. Placement of TADS (Temporary Anchorage Devices)
10. Dentofacial deformities and craniofacial anomalies
11. Treatment outcome - orthognathic surgery, maxillary expansion and several orthopaedic appliances
12. Cervical vertebral maturation (CVM)[15]

Virtual Setup

The segmented dentition on the CBCT radiographs will be used to simulate the dental movement which is required to correct the malocclusion using the virtual repositioning software and a setup of the dentition can then be made. File transfer protocol (FTP) allows easy and protected uploading of the files by the orthodontic labs.

Dental setup has been established as a valuable diagnostic tool in orthodontics and surgical treatments to approve, alter or reject the planned treatment. Initially Kesling's diagnostic setup in which the crown of the teeth ideally positioned with wax was used to plan the orthodontic treatment. The limitations of this setup were that the cast had to be copied and was a time-consuming procedure.

As software programs are available now, a virtual setup can be made faster with the digital models without the need for dental casts. For a digital setup, the dental crown must be segmented in the digital dental models.

Virtual Segmentation

With the help of software like Insignia, an instant virtual segmentation is done on the digital dental model. A reference plane is marked for the dentition and alveolar bone. In some setup, occlusal plane and palatal midline are taken as reference. After the segmentation, virtual roots are added to the dental crown according to the planned root movement.

The estimated root position of each tooth by the software should be corrected before the actual segmentation.

Actual Segmentation

In this, the actual segmentation will be done automatically with the help of analysing program like Ortho-Analyser according to the segmentation lines on the digital mode. While the setup is being made, the space available in the arch can be evaluated by assessing the alveolar bone which was displayed on the digital model.

A virtual archwire will be constructed for the maxillary and mandibular arches on the digital model. Arches will be used as reference during the process of constructing a setup. With CBCT, the dental crowns can be superimposed on the crowns of the teeth. The advantage of using CBCT is to assess and correct the root position in relation to alveolar bone in treatment planning. The virtual treatment plan discloses the need for extraction or interproximal stripping based on the individual malocclusion and aesthetic concerns.

Grids are used to control the symmetry of the setup. A single or a group of teeth can be moved at the same time while making the setup. The occlusal contacts should be assessed and corrected in the setup when needed.

The setup is based on the biological principles and clinical experience. Orthodontist plays a major role during the fabrication of setup according to the need of the patient – expansion of arch, interdental reduction of tooth material or extraction. As the procedures and appliances are designed digitally, the treatment plan can be explained to the patient. The digital workflow system allows excellent communication between the patient and the orthodontist.[3]

Monitoring of Tooth Movement

Effective and optimal tooth movement is required for a desired outcome. Monitoring of tooth movement is necessary as hyalinization occurs in the periodontal ligament after the activation. This can be analysed using software like Ortho - Analyser. Progressive scans will be taken during the subsequent visits to know the tooth position. Disadvantage of this method is that the patient has to visit the orthodontist just to take an intraoral scan.

CBCT taken at the initial stage of the treatment can also be used to view the tooth movement. Some software like Maxillim, Geomagic, Dolphin and Ortho - Analyser can be used to merge the crowns of the dentition and CBCT to see how the treatment progresses and it seemed to be clinically accurate.

Of late a new monitoring system was developed called Dental Monitoring, which allows to monitor the tooth movement using smartphone. To take photographs easily, a custom cheek retractor will be designed and provided to the patient. Once the images are uploaded to the dental monitoring lab, the progress of the treatment can be viewed by the patient and the orthodontist.[3]

3D Printing

3 D printing, also called additive manufacturing was developed in 1990 by Wilfried Vancraen. 3D printing helps in achieving high precision with various products like dental models, removable appliances, customized brackets, arch wires and occlusal splints. It is being commonly used for fabrication of clear aligners and retainers. It permits the user to design or print 3D prototypes, physical objects, and production parts of any shape from a virtual model. The 3D printing usually starts with a 3D model that is designed virtually or obtained by scanning of a physical object. A slicing software changes the data to a stereolithographic file which is sent for building the object.

Technologies of 3D Printing

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

Stereolithography (SLA)

The stereolithography technique was first introduced by Charles W. Hull in 1986 for creating solid items by successively printing thin layer of materials solidified by concentrated UV laser light. Since many layers (5 - 20 per mm) are used it results in a high resolution. The built object is immersed into a solvent bath to remove the excess resin and then placed in a UV oven to finish curing process. SLA models are used for planning cranial, maxillofacial and neurosurgical procedures. Surgical guides for the placement of implants are also produced by stereolithography. It was first called as rapid prototyping process.

Camardella et al. assessed the accuracy of 3D printed models from intraoral scans with different designs of model bases using 2 types of printing techniques - stereolithography and triple jetting technology (polyjet). The result concluded that printed models made by the polyjet printer were accurate irrespective of the design of the model base and on stereolithographic models with the regular model base and the horseshoe - shaped base with a bar were accurate.[16]

Customised Orthodontic Appliances CAD / CAM in Customised Orthodontic Appliances

Insignia

The Insignia system (Ormco, Orange, CA, USA) utilizes a customized slot which is cut into the bracket at the desired position. The base of the bracket is standard, and the slots are custom made according to the desired tooth movement. Once the digital models are sent and a virtual setup is created, the brackets without slots are placed in the virtual setup. Based on the desired tooth position the slots will be cut into the actual brackets. The bracket position to the tooth is recorded on the setup and transferred to the model. An indirect bonding tray comprising of the bracket transfer jigs is made to transfer the virtual bracket position to the patient's mouth. The tooth movement depends on the position of the slot and not the bracket. The main advantage of the Insignia system is the customization of bracket slots and the disadvantage is error in bracket positioning.

SureSmile

It (Orametrix, Inc., Richardson, TX, USA) utilizes customized arch wires with conventional brackets to compensate for the individual tooth anatomy and errors in bracket placement. The customization occurs in the final stages of the treatment. Once the aligning and levelling phase is completed in the usual manner, an intraoral scan is taken, and a diagnostic setup is made. In this system the wire bending robot forms a wire according to the desired outcome and the custom wire fabricated will be sent to the orthodontist. The advantage of this system is that preferred bracket system could be used and precision can be increased during the finishing stage.

Incognito

It (3M - Unitek, Monrovia, CA, USA) combines individualization of bracket bases, slots and arch wires to design a customized lingual orthodontic appliance. The base of the bracket is custom-made according to the anatomy of the tooth & its position in the dental arch and slots based on the ideal tooth movement required. A series of wire will be formed based on the position of the bracket slot in the virtual setup. With the help of the indirect bonding tray the virtual position of the bracket will be transferred. Incognito is the only system that offers fully customized lingual orthodontic treatment.

The advantages of it are optimal aesthetics, accuracy of outcome, reduced incidence of white spot lesions, decrease in discomfort compared to other lingual systems and easier and precise direct rebonding of debonded brackets due to the good adaptation of the custom base of the bracket and the disadvantage is error in positioning of bracket.[17]

Custom Removable Appliances

Invisalign

In the year 1997, the concept of Invisalign was developed by Align Technology Inc. (Santa Clara, CA, U.S.A.) and was available in the year 1999. It uses a sequence of aligners to move the teeth, which is composed of see through plastic that engages the buccal, lingual, palatal, and occlusal surfaces of the teeth. The duration of wear is 2 weeks and it is changed and advanced accordingly. The movement of teeth is about 0.25 - 0.35 mm and the total duration of treatment is about 9 - 15 months.

	Fixed Appliances	Clear Aligners
Force	Exerts a “pull” on teeth	“Push” on teeth
Engagement	Arch wire into the bracket	Plastic around the teeth
Anchorage	Reciprocal anchorage	Anchorage segments may be predetermined
Extrusion	Single tooth	Anterior segment
Intrusion	Relative intrusion	Entire segment or selective intrusion
Torque	Labial and lingual root torque	Lingual root torque through power ridges
Root inclinations	Control of root inclinations through bracket positioning and arch wire bends	Through optimized attachments and virtual gable bends

Table 1. Fixed Appliances VS Clear Aligners[18]

Polyvinyl siloxane impressions, bite registration in centric occlusion, OPG, lateral cephalogram and photographs are required. These records would be sent to the Align Technology. Impressions are poured in plaster, placed in a tray, and encased with epoxy and urethane and placed into a scanner to create 3 - dimensional model. This 3 - dimensional model of the patient’s anatomy helps in making faster and accurate diagnosis, treatment options, changes can be monitored and displays the final treatment outcome. (Table 1)

The virtual orthodontic technician utilizes a special software to cut the virtual models and also separates the teeth for it to be moved individually and a virtual gingiva is placed along the gingival line of the clinical part of the crown which would serve as a margin of limitation for the aligners. The bracket prescriptions are followed to position the teeth and align it properly. These data would be sent to the orthodontist to view the virtual corrections at each stage and this is called as ClinCheck. Once the orthodontist confirms the treatment plan, a series of aligners will be manufactured using the CAD / CAM technology.

Advantages

1. Aesthetic
2. Easy to use
3. Comfortable to wear
4. Better oral hygiene
5. No metal allergic reactions
6. Eliminates bonding procedure
7. Evaluation of treatment options at the beginning of treatment
8. Virtual model – educational tool to the patient

Disadvantages

1. Limited control over root movement
2. Slight intrusion of posteriors (0.25 - 0.5 mm)
3. Absence of operator control during treatment.[18]

Indications for Clear Aligner Treatment

1. Class I spacing with minor to moderate crowding and existing good buccal occlusion
2. Half cusp class II with minor crowding
3. Class III with minimal overjet / overbite non extraction cases
4. Deep bite
5. Anterior open bite
6. Lower incisor extraction
7. Premolar extraction with minor crowding
8. Orthognathic surgery[19]

Functional Appliance

Use of CAD / CAM technology and space age materials like grade 5 titanium to design Digital Titanium Herbst (DTi Herbst) was simpler, faster and more accurate than fabrication of conventional Herbst. The cost of the appliance is higher due to the lab work and precision of CAM involved in the process.

The disadvantages of a conventional technique are casting defects like airbubble, crystal micro crack and coating and coal residue inclusions that reduce the mechanical resistance of the appliance. When the components of the appliance are positioned manually there is more chance for inaccurate placement and soldering defects.

Grade 5 titanium is highly biocompatible, and the ion stability makes it resistant to corrosion. Grade 5 titanium splints demonstrates superior adhesion due to the oxidizing capacity of the material, which is able to interact with the cement. Further adhesion can be enhanced by the addition of retentive areas on the inner surfaces of the splints.

Virtual design and fabrication permit splint thicknesses and cementation gaps to be precisely specified in the design phase and to eliminate casting and soldering defects in the manufacturing phase. The DTi Herbst offers better stability than traditional splints due to the exact fit. There is no need for separators, and oral hygiene can be maintained between the splint and the gingival margin.[20]

Custom Retention after Orthodontic Treatment

Stabilisation of dentition specially in the incisor and canine region is necessary after the orthodontic tooth movement. The traditional removable retainers were substituted by the fixed lingual retainers as it requires less patient compliance and as an alternative to the removable retainers came the invisible retainers.

To reduce the failures of fixed retainers and to increase the efficiency, various materials and methods were used to fabricate the retainers. With digital dental models and CAD / CAM technique, a retainer can be designed and fabricated. The idea of using CAD / CAM for fabrication of retainers was developed by Dr. Pascal Schumacher from Germany. CAD / CAM technique can offer high predictability even in the anatomically demanding regions and limited spaces.

Advantages of CAD / CAM Retainers

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

CONCLUSIONS

Digital workflow has aided in saving time and producing complex appliances with high precision. It is of benefit to both the patient as well as the orthodontist. The technological advancement facilitated 3D imaging, 3D printing, virtual setup, monitoring of tooth movement and treatment planning to another level in the diagnosis and treatment aspect of our specialty. Software integration of digital models, 3D facial scans and CBCT enables simulation of treatment and to bring about a good communication with patients. The digitalization is bringing about a revolutionary change in diagnosis and treatment planning posing a challenge to clinical efficiency and knowledge. With the fast development of digital technologies, orthodontists can now propose diagnosis and treatment plan in a feasible way.

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