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Digital revolution in orthodontic diagnosis

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Abstract

Everyone wants a beautiful face with a healthy and beautiful smile. Orthodontics is the branch of dentistry that helps patients to achieve pleasing face with beautiful smile by correcting skeletal and dental malocclusions which interfere with their facial esthetics. For achieving this facial esthetics along with structural and functional balance, an accurate diagnosis and treatment planning is necessary. In this article we will discuss some advancement in orthodontic diagnostic system.

Keywords: Orthodontic, Revolution

Introduction

Orthodontic treatment is based on suitable diagnosis and treatment planning. So it is necessary to understand all diagnostic aids for planning orthodontic treatment. Orthodontic diagnosis started with deciding patient or parent's chief complaint. Diagnosis involves a number of steps such as interview of patient, clinical examination and diagnostic records. Diagnostic records are classified into essential and supplement diagnostic aids. Essential aids are dental and medical history, extraoral and intraoral examination, study models, intraoral and facial photographs, radiographs such as panoramic, bite-wing radiograph and periapical radiograph. Essential diagnostic aids include special X-ray such as lateral cephalogram, frontal projections, occlusal intraoral films, electromyographic examination, hand-wrist X-ray, basal metabolic rate and other endocrine tests.(1) Orthodontic records are also used for observing facial growth and development without treatment and with different treatment modalities.(2)

Orthodontic diagnosis has three components like facial, dental and skeletal. The main task of an orthodontist is to rearrange different components of craniofacial complex in anatomical and dynamic balance position and also making them esthetically pleasing. This process needs information regarding relationship of all these components of craniofacial complex in three spatial planes. Most of conventional diagnostic aids provide only 2-dimensional representation of patient.(3)

Advanced technology gives high quality diagnostic information in three planes to orthodontist which helps in designing magnificent treatment plan for patients.

Technological advancements such as digitized dental models, the use of digital dental set-ups to imitate the end result of orthodontic treatment, and three-dimensional imaging of the dentofacial region gave alternative options for patient documentation. Multi-slice computed tomography (MSCT) and lower-dose cone-beam computed tomography (CBCT), recent and precious tools became available for orthodontic diagnosis and treatment planning.(4) Traditional two-dimensional (2D) records are still common, but new technologies may lead to a more specific selection of records to make more efficient orthodontic diagnosis and treatment planning.(5)

Rapid prototyping

Rapid prototyping (RP) is manufacturing of a three dimensional model built by layer by layer from a computer aided design (CAD). Frequent technologies of RP are stereolithography (SLA), inkjet- based system, selective laser sintering (SLS), and fused deposition modeling (FDM).(6)

SLA: SLA method incorporates a photosensitive liquid resin bath, an ultraviolet laser for curing resin, and a model building platform .Layers of resin are added, cured and successively bond to each other to form a solid model.(7)

Inkjet-based system: In this method, a measured amount of raw powder form material dispensed. This powder is distributed, compressed with the help of a roller and a liquid adhesive is added onto powder, make it bond and a layer of model is formed. After completion of one layer, next layer is started. This gradual deposition of layers continued to complete fabrication of an object.(7)

SLS: In this technique layers of specific powder material such as nylon, elastomer and metal are fused into 3D model by adopting a computer directed laser. Powder is distributed with a roller and layers are added one by one and sintered repeatedly. This method is self-sustaining all components can be bond layer by layer.(7,8)

FDM: In this technique, a thermoplastic material is released from a nozzle in layer by layer pattern, regulated by temperature on to a build platform which is maintained at low temperature. This technique makes use of polycarbonates, investment casting wax and

polyphenylsulfone materials. This technique is quickest, cheapest, easy, involving less wastage of material and there is no exposure to toxic materials.[9]

Faber et al used RP technique for diagnosis and treatment planning of an impacted maxillary canine. RP model presents exact anatomical relationship of impacted tooth with other teeth and this model can be used to communicate with patient. Also the model is used for manufacture of metal attachment for canine traction.[10] RP models also help in orthognathic surgery cases. From these models, it is easy to measure discrepancies due to asymmetry, study bony structures of patient and surgical splints also fabricated using STL for orthognathic surgery.[11,12]

RP is also used for fabrication of surgical template for mini-implant placement, RP models of jaws used for fabrication of a distracter to produce mandibular osteogenesis distraction.[13,14] Pessa revealed the potential use of a high-resolution stereolithography for the study of facial aging and in preoperative planning of complex dentofacial anomalies.[15]

Dentascan

Dentascan is a computed tomography software program which provides images of maxilla and mandible in three planes that are axial, panoramic and cross-sectional. It provides improved evaluation of osseous maxilla and mandible and very useful in head and neck surgery.[16-18] Dentascan evaluation is simple and painless. Patient is asked to wear loose clothing with no metal parts, also asked to remove any dentures, jewellery, hair accessories and hearing equipment's. In Dentascan, for taking images high resolution spiral CT is used. The mandible of patient is maintained in fixed position on a Styrofoam surface, attached to head holder of CT machine for patient's right position having mandibular base perpendicular to horizontal plane. Axial slices of 1.5mm thickness with 1mm slice interval, 120 kVp, 120 Ma are used for CT examination. This Axial CT data send to a workplace, reformatted by Dentascan and paraxial and panoramic images are produced and printed on films.

Dentascan provides detailed information of bone morphology in three dimensions and therefore helping in implant placement. It can also be used for evaluation of cysts, tumors and jaw fracture. It has few limitations such as greater exposure to radiation and it is expensive also. Therefore case selection for dentascan use is very important.[19,20]

Sure smile

Aim of Sure smile is to use new advanced technology for all type of patients and supporting a complete transition of orthodontic practice to a digital platform. It is useful for diagnosis, visualizing alternative treatment plan, discussing treatment plan with patient and helps to plan more aesthetics smile. Sure smile gives a view of end outcome of treatment on computer screen which is very much accurate than conventional wax setup. It provides multiple treatment options with end result, so that final treatment plan can be decided after discussion with patient.[21]

Procedure

Dentition is prepared and scanned after applying a thin white film with OraScanner. OraScanner is equipment for capturing real-time images of dentition. It takes pictures in white light and in rapid succession and its images are not affected by movement of patient or scanner. These images are processed in OraScanner image processing software to generate an accurate, three dimensional display of dentition for sure smile work station. The final treatment plan is presented in three dimensional digital diagnostic setup. After finalizing treatment plan, bracket positions are determined from a digital library of most common bracket types and prescriptions. Then geometry of archwire is automatically generated in three dimensions for the finalized bracket positions on arches. In final step, each tooth is seen in close up view using zoom function and individual tooth position is corrected more precisely by altering bracket position, geometry of archwire or combination of both. Thus the end result is a digital prescription of customized bracket positions on images of teeth with malocclusion along with archwire designs. This prescription is sent to sure smile appliance center for manufacturing archwires and precision bracket trays. Bonding of brackets is done by indirect method by placing brackets in these precision trays. Trays are easily removable without affecting the brackets.

Thus this system reduces errors in treatment which are due to appliance management.[22]

Digital study models

Study models are integral part of orthodontic diagnosis and treatment planning. Study models also provide record of malocclusion before treatment, stages of treatment and final outcome of treatment. Study models are crucial to orthodontist, but have number of limitations such as storage, durability and transportability. The consumer Protection Act 1987 stated that it is necessary to retain all patient records for atleast 11 years. In expanding computer technology, introduction of digital study models provided an alternative to plaster study models. These digital study models have lots of advantages over plaster models such as: no laboratory procedure needed, negligible storage space needed, fast and efficient retrieval at any place, no chance of physical damage and easy transportability. Digital study models also have some limitations such as lack of tactile input, expensive, inability to mount on an articulator and additional equipment requirement and skill. Because of these limitations, orthodontists did not totally depend on them.[23-25] Precision in measurements taken from these

models like tooth size, arch length and width, midline discrepancy, space analysis, overjet, Bolton analysis, overbite, molar and canine relationship, make them valid for clinical use.[26-31] Digital models can be made from alginate impressions or with intraoral scanners.[32,33]

Summary and Conclusion

Digital records provide three dimensional assessment of patient's dentofacial morphology which is very crucial for orthodontic diagnosis and treatment planning. These digital records also improve storage, access, conservation, communication with patient and duplication capabilities regarding records. But these still have some limitations. Therefore it is necessary that an orthodontist should be well aware of indications, benefits, potential hazards and specific guidelines needed, while using these digital diagnostic aids. Thus future of orthodontics looks more promising if these advanced techniques used innovatively.

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