



Diagnostic Advancements in Orthodontics: A Review

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Abstract

Finding the underlying illness or condition is the foundation for all medical, dental, and surgical procedures. Dental professionals around the world have recently profited from a huge scientific advancement. Several measures may now be examined and taken more quickly thanks to computers. All dental materials now have higher levels of precision and quality because to computer-aided design and manufacture. Orthodontics has had a lot of development. The rising use of technology in recent years has had a significant impact on every business, including health and dentistry. From Angle's time to the current nanorobotic period, orthodontic concepts, biomaterials, and technology have improved substantially. This article describes the various diagnostic aids over the past and also briefly describes the recent advancements that are made in the field of digital diagnosis.

Keywords: *Diagnosis, Orthodontic Treatment, Malocclusion.*

Introduction

Orthodontic diagnosis and treatment planning are now more crucial than ever in our litigious culture thanks to new diagnostic techniques. A bad record may indicate a low level of orthodontic therapy, hence it is essential to keep accurate records of treatment progress.[1] A diagnostic report with study models, radiographs, and pictures is required for orthodontic records in order to establish the case's condition before to treatment and to document the progress of that therapy. Dental records that are issue-oriented make it considerably simpler to make a precise diagnosis. The diagnostic methods that are morphologically focused have significantly improved. Reassembling the human craniofacial complex is the orthodontist's responsibility.[2]

Many of the diagnostic tools in use today only show the patient in two dimensions, despite the fact that orthodontic therapy affects the patient in all three dimensions. Orthodontic therapy's dual goals of function and appearance are evolving. A more advanced three-dimensional (3D) diagnosis and treatment planning technique has been devised as a result of the development of digital technology in private practice. In orthodontics, 3D imaging makes it possible to diagnose and plan treatment in advance, as well as to later assess dentoskeletal connections and facial aesthetics.[3] The purpose of this article was to review the recent diagnostic aids which help the Orthodontist in treatment planning.

Recent Diagnostic Aids

Digital study model: To overcome disadvantages of conventional study models, digital models came into existence. Although the cost of digital models is more, but the advantage of negligible storage space and storage cost makes it a better alternative to plaster or stone models.[4]

Digital photography: In photography, the introduction of digital media has simplified both the acquisition and management of still photographs. Extra-oral and intraoral photographs that can also be instantly transferred into the patient's record and viewed on a patient-visible display.[5]

Digital radiography: Using an electronic sensor and imaging system, the radiographs are taken instantaneously on a computer system. Digital radiography requires less x-radiation than conventional radiography. Reduces errors and saves time when compared to conventional radiography.[6]

Cone Beam Computed Tomography: Craniofacial CBCT was created to address some of the drawbacks of traditional CT scanning technology. The object to be examined is captured by a two-dimensional retractor during a craniofacial CBCT scan. Comparatively to a conventional CT device, where numerous slices are stacked to generate a whole image, this straightforward distinction enables a single rotation of the radiation source to capture an entire region of interest. Comparing the cone beam to typical fan-shaped CT machines, the cone beam also generates a more focused beam and significantly less scatter radiation.[7,8]

Clinical Applications in Orthodontics With CBCT:[9]

1. Orthodontists have many images that are not possible with conventional radiographic measures.
2. Impacted teeth and oral abnormalities.
3. Airway analysis
4. Assessment of alveolar bone height and volume
5. TMJ morphology
6. Lateral and frontal Cephalogram views
7. Skeletal views
8. Facial analysis
9. 3D review of dentition

Advantages [10]

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

Disadvantages [10]

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

Tuned aperture computed tomography: A revolutionary technology for acquiring three-dimensional radiography data was reported by RL Webber. Also called transmission radiography. A number of x-ray projections are made using a reference point to create TACT pictures. They aid in the visualization of the mouth cavity's hard tissues. A TACT slice can be created from any number of x-ray projections. A reference point created by the fiducial item that is placed above the detection plane should be present in each projection. One x-ray source may be utilized to produce TACT slices, and it may be moved through various points in space to produce various x-ray projections. The identification of periodontal, periapical, and caries disorders is not greatly aided by these pictures.[7]

Digital Cephalometry: The lateral cephalogram can reveal a patient's dental, skeletal, and soft tissue morphology as well as the connections between these parts. Cephalometry is a crucial tool for understanding the morphology and growth of the craniofacial complex, spotting anomalies, foreseeing future connections, and organizing orthodontic therapy.[11] The paradigm shift is occurring in orthodontics from the widely accepted film based to digital cephalometry. Rudolph et al. compared the reliability of digital and conventional cephalometric radiographs in terms of landmark identification error. They concluded similar reproducibility and precision in landmark identification using both direct digital and conventional lateral cephalometric head films.[12]

Digi graph: This technology aids in the measurement of linear distances. They contribute to reducing radiation exposure from patient diagnostics using lateral cephalometric tracings. After the plaster cast is digitized, the mesiodistal breadth of teeth is measured. Digital handpieces were used to collect

mesiodistal measurements. The process is as follows: while pressing the handpiece's button, place the tip of the handpiece on the selected landmark for the scan to be performed.[13]

Micro computed tomography (Micro CT): Gary Yip, Paul Schneider, and Eugene W. Roberts reported about the usefulness of micro computed tomography in orthodontic diagnosis. It evolved as a successor to routine histological sectioning and bone assessment using micro radiographic techniques. Micro CT is a new dental technology to detect subtle changes in bony structures in relation orthodontic implants, dentofacial orthopedics and normal orthodontics. They help to assess the modelling and remodeling of bone in mineralized tissues. This imaging technology is a breakthrough in dental imaging as it helps to evaluate the supporting bone around dental implants.[14]

Multi detector CT: This is a type of diagnostic computed tomography imaging. The detector elements are arranged in a two-dimensional array. As a result, it aids in the acquisition of several thin slices and speeds up CT imaging. Multiplanar reformation of three-dimensional images and panorama reconstruction are made possible by special algorithms. Aids in the thorough evaluation of pathologic deformities. Its acquisition time is significantly shorter, which lessens the motion artefacts brought on by patient movement. greater soft tissue resolution and less noise and scatter radiation than CBCT. The axial, coronal, sagittal, and oblique or curved picture planes can all be used to create images.[15, 16]

Ultrasonography: Sounds are perceived as such by the eardrum due to pressure changes in the surrounding air. These changes happen between 1500 and 20,000 cycles per second (hertz, Hz). The frequency of ultrasound is more than 20 kHz. It is possible to distinguish it from other mechanical waveforms because its vibratory frequency is higher than human hearing range. Diagnostic ultrasonography, a clinical application of ultrasound imaging and analysis, uses a vibratory frequency of 1–20 MHz. Ultrasound is a great alternative because it is a non-invasive, efficient, and affordable diagnostic technique. Ultrasonography has been utilized in a number of investigations to get a static image of the oral cavity, such as the study of tongue morphology and the identification of sialolithiasis, cysts, and malignancies.[17]

3D ultrasound imaging is a new technique that produces more detailed photographs of the fetus's face than earlier 2D imaging methods have managed to achieve. These benefits include being able to adjust planar views without worrying about fetal movement, determining the precise placement of planar pictures with respect to the surface facial image, and giving non-trained observers simple access to realistic 3D visuals. When it comes to diagnosing cleft lip and palate, 3D imaging has substantially greater sensitivity than 2D imaging.[18, 19]

Magnetic Resonance Imaging (MRI): The use of repetitive maxillofacial imaging to monitor the progress of orthodontic treatment is essential to effectively treat orthodontic patients. Three-dimensional imaging is rapidly replacing traditional radiographic methods. This new technology is particularly helpful with orthodontic concerns such as root length, bone structure, and root angulation. In contrast to CBCT imaging, MRI uses nonionizing electromagnetic radiation. MRI allows for repetitive 3-D imaging of dental structures in any age group without worrying about potential harmful radiation exposure.[20]

Advantages to MRI [21,22]

1. Ability to image the TMJ and disk
2. Display of soft and hard tissues
3. Safe to use for patients, who are allergic to the contrast agent
4. All images can be obtained without repositioning of the patient
5. The ability to see inflammatory processes

Disadvantages to MRI [21,22]

1. Cost of equipment and cost to patients.
2. Accessibility and availability in medical and dental centers.
3. Increased possibility of motion artifact due to the length of time to obtain an image. Hard tissues not recorded as well.
4. Discomfort of claustrophobic patients being confined to a small space.

DICOM: DICOM (Digital Imaging and Communication in Medicine) is the standard within Medicine for the transmission of radiologic images and other medical information between computers and various devices that acquire images and between various equipment and software systems that are produced by different manufacturers [5]. A DICOM image file contains the x-ray image or series of images (for example a multiple slice CBCT imaging study) and other patient related information that is selected from a 'library' of standardized terms (e.g. patient name, identification number, and acquisition modality to name a few) that can be pre-selected. The DICOM library is extensive and continually updated to reflect changing identification standards. A DICOM compliant image file can be thought of as similar to the 'layered' file that is created in the Adobe Photoshop software or a JPEG with the information embedded in the data 'set' or metafile. Because of DICOM, picture archiving and transmission technologies have grown in popularity. Its primary purpose is to help in the diagnosis and

planning of treatment and to provide a 3D record of the original malocclusion, at any stages of correction, and the final treatment outcome. [24,25]

Conclusion

The technical developments have benefited the entire dental profession as well as orthodontists. All areas of dentistry, including prosthodontics, endodontics, oral surgery, etc., can benefit from these developments. With the help of these software, diagnosis and treatment planning have become lot more precise, simple, and time efficient.

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