



Review Article

Three dimensional technique of imaging in orthodontics: A review

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ABSTRACT

The process of deploying the two dimensional data in to the three dimensional format is three dimensional imaging. Now a days three dimensional imaging is developing as an emerging factor in the field of dentistry. Three dimensional imaging is useful in the field of orthodontics, to view the anatomy along with the morphology of the bone for desired tooth movement, it is useful in the field of prosthodontics to check or verify the bone morphology, exact height and width of the bone for the process placing implant, three dimensional imaging is quite useful in the field of endodontics along with oral surgery to view the anatomy of the root curvature, to confirm the presence of accessory canals to confirm the bony architectural defect in oral surgical procedures. So in present days three dimensional imaging plays an important role in diagnosis as well as treatment planning in the field of dentistry.

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1. Introduction

In the field of orthodontics it requires careful acquisition as well as proper interpretation of information to achieve proper diagnosis and treatment planning accordingly. Three dimensional imaging plays an important aspect of diagnosis as well as treatment of various oral disorders. Three dimensional imaging provides faster as well as efficient ability of analysis. This 21st century has been known as the digital era of the dentistry with respect to dental imaging.¹ Now a days CAD CAM processing of the prosthesis is very much common as it requires very less time for the fabrication of the prosthesis and the prosthesis being fabricated from the cad cam process is highly esthetic. So CAD diagnosis make the use of imaging techniques three dimensional along with three dimensional image processing tools.² Three dimensional imaging technique makes the things very much easier to use, reliable and economical. Among all the different investigatory procedures, the best

among the all is three dimensional imaging technique in orthodontics to document dimension and attain the exact information of the anatomy of the alveolar bone or different structures in the craniofacial region.³ However the depth of obtaining the craniofacial structures is not possible exactly with the use of static two dimensional imaging technology.⁴ The recent three dimensional machine is quite biologically friendly as compared to static two dimensional imaging process as it utilizes very less ionizing radiation as compared to the radiation processed by cephalograms and other panoramic views in contrast to other things with the use of three dimensional imaging one can get detailed information with very much less radiation exposure to the patient.⁵

Three dimensional imaging technique uses in a row of series and is congregated with the help of high technology advanced equipment which is managed with the help of a computer to check the misapprehension with respect to deepness of the anatomical structure.³ Imaging of hard tissue, soft tissue and teeth and tooth structure plays an important role in treatment planning of the orthodontic

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treatment.⁶ So imaging at these particular site acts as an therapeutic diagnostic tool for the clinician to determine the orthodontic treatment outcome.⁷

1.1. Drawbacks of two-dimensional imaging

1. External error known as radiographic projection error is associated with the use of two dimensional technique in association with size, magnification, distortion of the image, positioning of the patient, distortion related to projection.
2. Low accuracy and precision with respect to manual data collection as well as processing.
3. Ill-defined outlines, hard edges.
4. Difficulty in location of land marks.

1.2. Three dimensional imaging

It uses voxel, which is the smallest element of the three dimensional image. The volume of a voxel is thought to be a three dimensional array of the images that are bitmapped with the each voxel having height, width and thickness. There are different types of geometric strategies for the measurements to be in three dimension, most common is

i) Measurement by triangulation: This system viewed the object basically from two positions in the space and simultaneously captured the images from both the positions over the film or over some digital medium that too in rapid succession. The three-dimensional measuring system should be capable enough to identify the identical anatomical land mark at three different position.

If there is greater separation between the two images of the x-ray sources, it would be more difficult in identification of the same landmark in the two images.

In literature, it was found that there are two different methods of producing study models digital i.e. i) by the process of non-destructive imaging:- it utilizes structured light, laser light, x-ray to the image while leaving the original cast intact. And the ii) is by the process of destructive imaging:- helps in removing the parts of the cast when it is being imaged.

1.3. Various uses of digital study models

1. No chances of breakage of the model.
2. No need to store the model for future reference
3. Immediately retrieval of the data
4. Easy to communicate with the laboratory for any reference or change.
5. Changes to the digital model can be made through e-mail.

1.4. Different disadvantages of digital study model

1. There is no tactile input from the dentist.

2. These digital models can not be articulated virtually with reference to the patient temporomandibular joint.
3. Requires time to learn the procedure.

Various methods that produces three dimensional imaging are as follows

1. Computed tomography: The devices that used for computed tomography are basically divided in to two groups i.e. cone beam and the other is fan beam. In the conventional fan beam the x-ray source and frame metal rotate around the firstly in the horizontal manner computed tomography scanner works. The patient is being positioned over the table, through the center point of the machine the table moves. With respect to computed tomography some of the anatomical structures seem to be higher with in the image.⁸ Some of the disadvantages with respect to computed tomography are, expensive, distant lesions can be missed, chances of artifact formation, when compared to different soft tissue imaging system the data acquired by computed tomography is quite insufficient.⁹
2. Cone beam computed tomography (CBCT): Cone beam computed tomography was basically designed to overcome the short comings of computed tomography technique.¹⁰ Cone beam computed tomography comes with a lot of difference from computed tomography in reference to positioning of the patient, scan period, amount of radiation emission as well as resolution.¹¹ With the help of cone beam computed tomography technique, all the volumetric data that too with small exposure of radiation can be achieved with single exposure.¹² Literature revealed that the radiation dose that is achieved from computed tomography is 15 times more than the dosage of cone beam computed tomography and as well as approximate dosage that is achieved from cone beam computed tomography is equals to 12 panoramic radiographic dose.^{11,13,14} In orthodontics data can be obtained as a self determining solution from different craniofacial areas.⁹

1.5. Cone beam computed tomography can be helpful in orthodontics in terms of

1. Identifying the anatomy whether it is typical or atypical.
2. Identifying length of the root as well as alignment.
3. Measure the distance of the teeth in between the jaws.
4. Discrepancy between arch size and teeth can be examined.
5. Relationship of maxilla to the mandible in three dimension.
6. Determining the exact position of the impacted tooth in the jaw.

1.6. Benefits of cone beam computed tomography in orthodontics

1. Less expensive as compared to conventional computed tomography.
2. Less maintenance value of cone beam computed tomography.
3. Decreased dosage of radiation as compared to computed tomography.
4. With the use of cone beam computed tomography all the information can be achieved in single exposure.

1.7. Disadvantages

1. Occurrence of artifacts with metal brackets or with restoration over the tooth.
2. Unable to make images of soft tissues.
3. Distortion of the image.¹⁵

1.8. Three dimensional laser scanning

It is used in capturing the facial morphology as well as morphology of the soft tissue. It is a non-invasive technique of tissue imaging. The validity of this technique has been confirmed by various researchers.^{16,17} Accurate three dimensional facial models can be fabricated from this technique.¹⁸ As compared to cone beam computed tomography it is less expensive.

1.9. Scanning technique based on vision

These are basically non-invasive technique of three dimensional imaging. The different techniques that utilizes vision based scanning includes moire topography, stereo photogrammetry which is basically used in orthodontics.

1.10. Four dimensional imaging technique

It includes basically documentation of the facial movements dynamically and modify the dynamics of expressions of the face. Facial expression and dynamic in facial motion with or without repaired cleft lip using video stereophotogrammetry has been studied. This technique reduces unnecessary and unavoidable complications therefore help in improving the prognosis of the treatment.

2. Conclusion

Three dimensional imaging procedure plays a vital role in determining and prognosis of the orthodontic treatment. It also reduces the chair side time of the dentist as well as the patient. Although evidence-based guidelines for 3D imaging is still needed to get it into commonplace dentistry.

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4. Conflicts of Interest

There are no conflicts of interest.

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