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REVIEW ARTICLE

Dentascan: A Revolutionary Aid enriching Oral and Maxillofacial Imaging

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ABSTRACT

The beginning of three-dimensional (3D) imaging has revolutionized the imaging trends in the maxillofacial region. Dentascan is a computer software program which provides computed tomographic (CT) imaging of the mandible and maxilla in three planes of reference: axial plane, panoramic plane, and oblique sagittal plane. The clarity and identical scale between the various views permits uniformity of measurements and cross-referencing of anatomic structures through all three planes. Unlike previous imaging techniques, the oblique sagittal view permits the evaluation of distinct buccal and lingual cortical bone margins as well as clear visualization of internal structures, such as the incisive and inferior alveolar canals. It has been widely used preoperatively for implant surgery, cyst, tumors, distractions, accuracy of root canal obturation, jaw growth, stages of tooth development, and cases of fractures in either the mandibular or maxillary arch. This review summarizes the capabilities of dentascan as an imaging method for the maxillofacial pathologies.

Keywords: Dentascan, Maxilla and mandible, Inferior alveolar canals.

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INTRODUCTION

Dentascan is an interactive computed tomography (CT) imaging software that combines the power and detail of CT imaging with the convenience of interacting with the images on a desktop or notebook computer. To a limited degree in some clinical settings, the clinician can work with the radiology technician to interact with CT imaging. The commercially available desktop interactive software permits the clinician to view the radiographic studies in two or three dimensions, make direct measurements, assess bone volumes and density, manipulate the images to simulate implant placement or bone grafting procedures, and simultaneously view the images in all the three planes.[1]

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For many years, physicians relied on two-dimensional (2D) radiographs of the maxillofacial pathologies and maxillofacial trauma but these radiographs were relatively difficult to interpret because of the superimposition of bony landmarks and defects. In the 1970s, the multislice 2D CT became more widespread and was better able to represent the maxillofacial pathologies.[2]

Numerous studies have underscored the utility of CT over conventional plain radiographs with respect to diagnostic accuracy and preoperative planning. CT's accurate representation of facial fractures and their spatial relationships facilitates surgical exploration, fracture reduction, and the selection and contouring of rigid reconstruction plates. CT, therefore, decreases complications resulting from delays in diagnosis and treatment including malunion, nonunion, and other functional and esthetic deficits that may require revision surgery. Recently, advances in computer software algorithms have permitted three-dimensional (3D) reconstructions of the facial skeleton from 2D CT images. As CT is widely available, dentascan can play a wider role in evaluating lesions of the mandible and maxilla. It provides valuable information in the assessment of oral cavity tumors (pre- and postoperative, postradiotherapy); lesions of the jaw (benign and malignant, infection) and details of tooth anatomy in endodontics.

These 3D reconstructions may further facilitate the diagnosis and treatment of maxillofacial pathologies and maxillofacial trauma numerous authors have suggested that such 3D images may prove superior to 2D CT for presurgical planning in complex trauma, facial pathologies and in craniofacial reconstruction following cancer resection.[3,4]

APPLICATIONS OF DENTASCAN—AS A DIAGNOSTIC AID IN MAXILLOFACIAL RADIOLOGY

The main indication of 3D imaging is diagnosis of maxillofacial pathologies and planning of implants, temporomandibular joint (TMJ) imaging and cyst or tumor diagnostics. Subjectively, the bone structure of TMJs could be determined clearly in CT images and these images gave more radiographic information than the panoramic radiographs. Although, pantomography was often used for assessment of this tumor in the past,

dentascan now provides a better evaluation of the lesion.[5] In addition to identification of the bone contours of the condyle and glenoid fossa in CT images, the joint space could be evaluated. In the implant planning and tooth/root localization examinations the required information was subjectively obtained in all cases.

ORAL AND MAXILLOFACIAL SURGERY

Computed tomography enables the analysis of jaw pathology, the assessment of impacted teeth, supernumerary teeth and their relation to vital structures, changes in the cortical and trabecular bone related to bisphosphonate-associated osteonecrosis of the jaw and the assessment of bone grafts. It is also helpful in analysing and assessing paranasal sinuses and obstructive sleep apnea. As the images are collected from many different 2D slices, the system has proven its superiority in overcoming superimpositions and calculating surface distances. This advantage made it the technique of choice in mid-face fracture cases, orbital fracture assessment and management. Since it is not a magnetic resonance technique, it is the best option for intraoperative navigation during procedures, including gun-shot wounds. CT is largely used in orthognathic surgery planning when facial orthomorphic surgery is indicated that requires detailed visualization of the interocclusal relationship in order to augment the 3D virtual skull model with a detailed dental surface. Dental CT offers superb visualization of impacted teeth and can help the clinician to plan his treatment preoperatively or prior to orthodontic therapy.[6-8] With the aid of advanced software, CT facilitates the visualization of soft tissue to allow for control of post-treatment esthetics, e.g. in cleft palate cases to evaluate lip and palate bony depressions. Research is underway to assess its ability to detect salivary gland defects[9] (Figs 1 and 2).

PERIODONTICS AND IMPLANTOLOGY

In periodontology and implantology, assessment of the condition of teeth and surrounding alveolar bone depends largely on 2D imaging modalities, such as conventional and digital radiography. Though these modalities are very useful and have less radiation exposure, they still cannot determine a 3D architecture of osseous defects. Hence, an imaging modality which would give an undistorted 3D vision of a tooth and surrounding structures is essential to improve the diagnostic potential. Computed tomography provides 3D images that facilitate the transition of dental imaging from initial diagnosis to image guidance throughout the treatment phase. This technology offers increased precision, lower doses, and lower costs when compared with medical fan-beam CT. Field of interest for

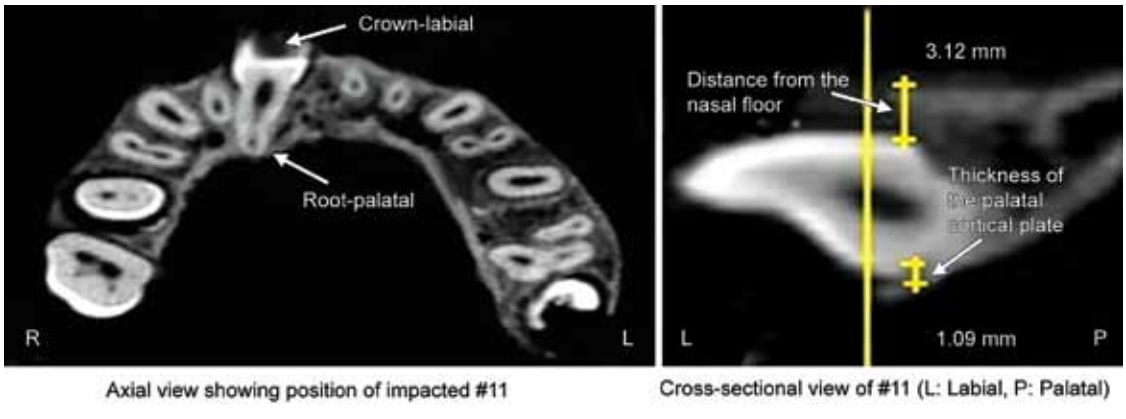

Fig. 1: Assessment of the position of the impacted teeth (#11)

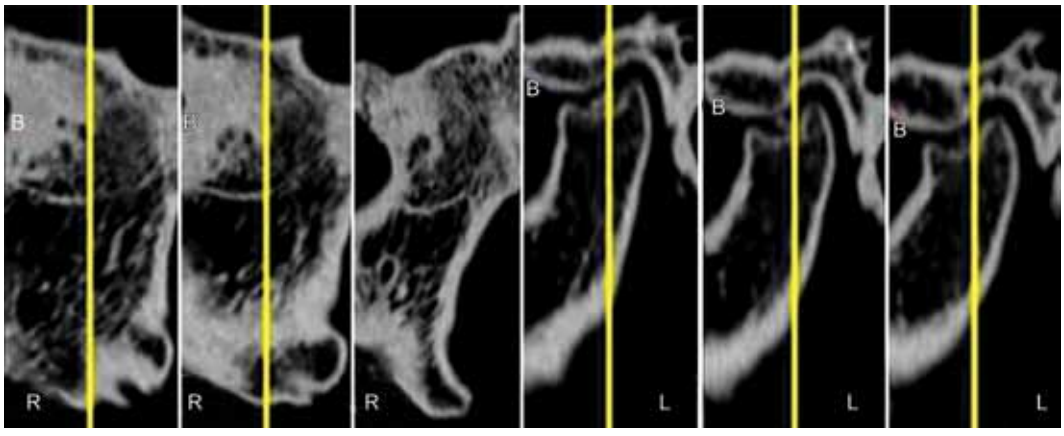

Fig. 2: TMJ analysis (bony ankylosis with respect to the right side TMJ and altered condylar morphology with respect to left side)

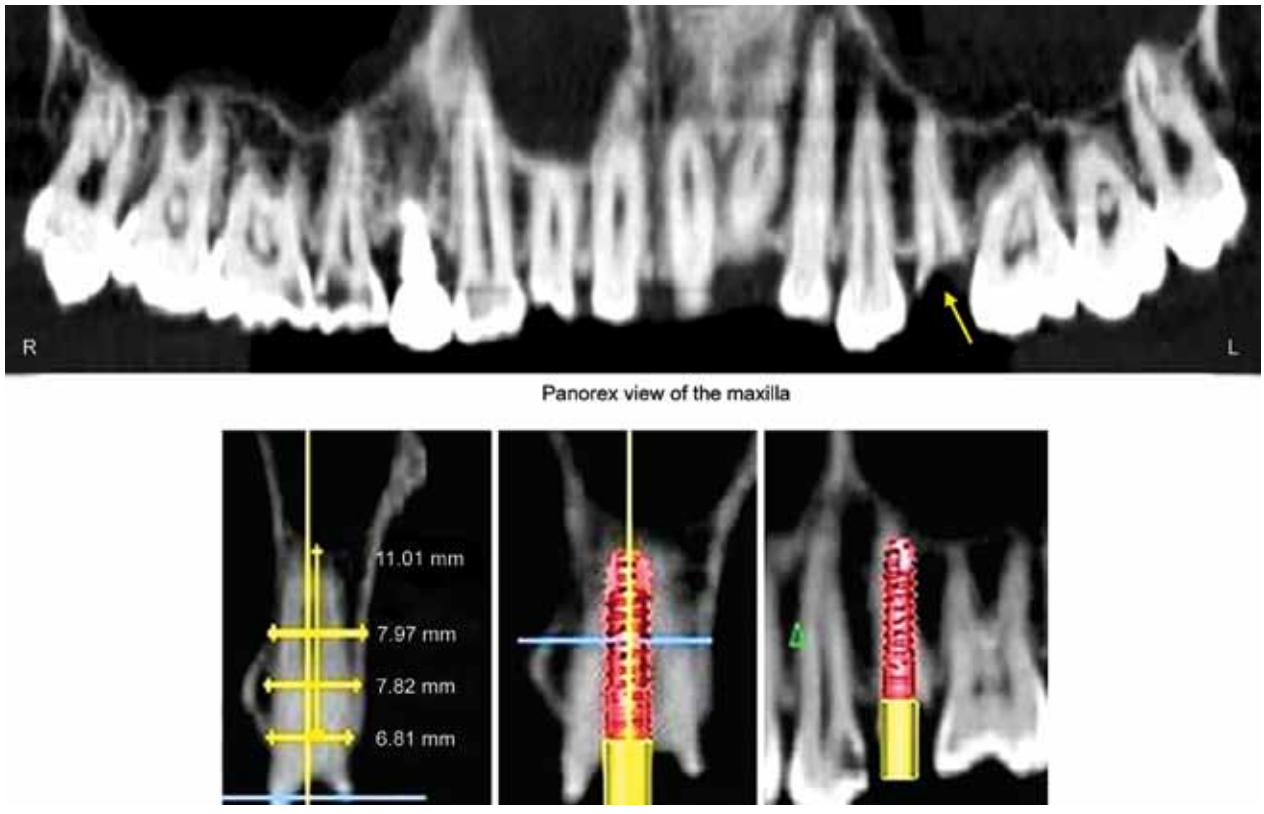

Fig. 3: Implant planning with respect to 25

the use in periodontology would be the diagnostic and quantitative measurements of soft tissue and alveolar bone levels in three-dimensions, imaging of periodontal intrabony defects, dehiscence and fenestration defects, diagnosis of furcation-involved molars, periodontal ligament space measurement, bone loss measurement and implant site imaging. Dental CT can demonstrate the root tip within a small osteolytic region (the enlarged periodontal space)[10] (Fig. 3).

ENDODONTICS

Computed tomography is a very useful tool in diagnosing apical pathologies. A number of studies have demonstrated its ability to enable a differential diagnosis of apical pathologies by measuring the density from the contrasted images of these lesions, in whether the lesion is an apical granuloma or an apical cyst. CT also demonstrated superiority to 2D radiographs in detecting fractured roots. Vertical and horizontal root fracture detection is described in several clinical cases. It is also agreed that CT is superior to periapical radiographs in detecting these fractures, whether they are buccolingual or mesiodistal. Utility of dentascan is not only confined to preoperative assessment of bone but it also find its usage in endodontology as extra canals are a common findings and missing these canals leads to endodontic treatment failure. Hess pointed out that 54% of his 513 maxillary molar specimens had four canals[11] (Fig. 4).

ORTHODONTICS

Treatment planning with 3D imaging will evaluate more factors than linear measurements, angles, goals of occlusion and facial esthetics. Using the anterior surface of the cranial base for superimpositions orthodontists more accurately evaluate growth and treatment response. Orthodontists can use CT images in orthodontic assessment and cephalometric analysis. Today, CT is already the tool of choice in the assessment of alveolar bone, impacted tooth position, temporomandibular joint assessment, surgical patients and those with syndrome and clefts, tongue size and posture, root resorption, facial growth, age, airway function, disturbances in tooth eruption and planning for placement of dental implants. 3D CT studies on patients who underwent orthognathic surgery, have allowed better evaluation of postsurgical condylar resorption.[12] CT is a reliable tool in the assessment of the proximity to vital structures that may interfere with orthodontic treatment. In cases in which mini-screw implants are placed to serve as a temporary anchorage, CT is useful for ensuring a safe insertion and to assess the bone density before, during and after treatment. Having different views in one scan, such as frontal, right and left lateral, 45° views and submental, also adds to the advantages of CT. As the images are self-corrected from the magnification to produce orthogonal images with 1:1 ratio, higher accuracy is ensured. CT is thus considered a better option for the clinician.

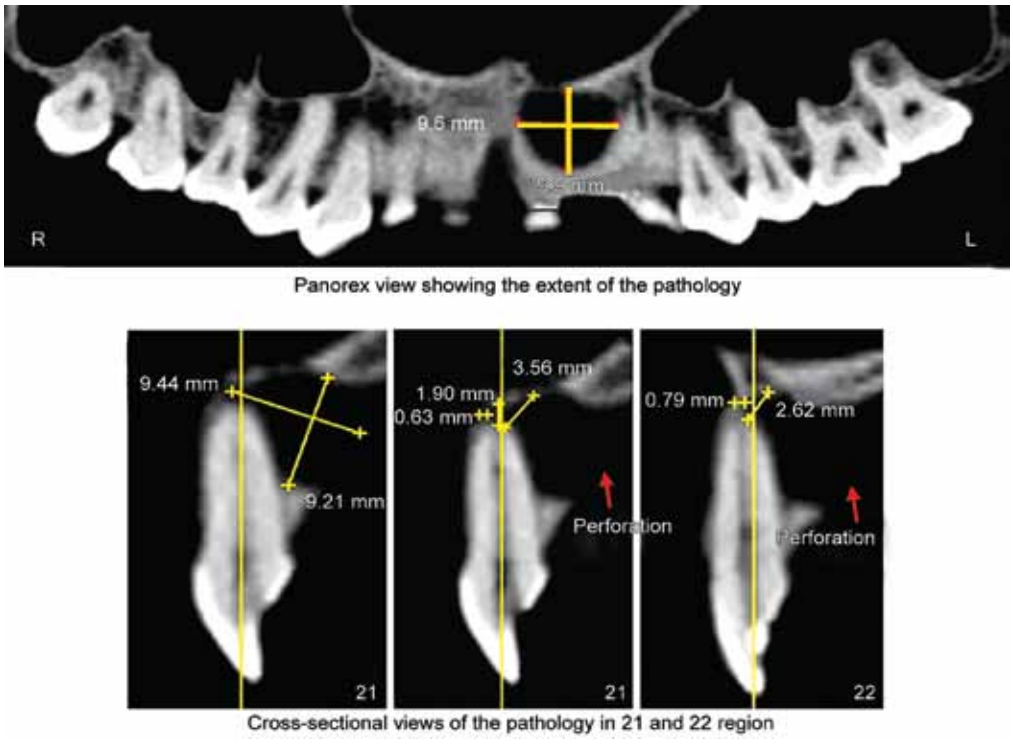

Fig. 4: Assessment of periapical cyst

PREPARATION FOR DENTASCAN

Preparation for a dentascan is very simple and painless procedure, and it can easily be performed in a matter of minutes.

- Wear loose comfortable clothing without metal snaps or zippers, such as a cotton sweat suit. Patient might be asked to change into a hospital gown.
- Do not wear any makeup or jewelry.
- Remove dentures, wigs, hairpins and hearing aids.
- Notify the radiologist if the patient is pregnant or breastfeeding.
- Patients who are allergic to iodine and shellfish should be medicated prior to the exam.[3]

PATIENT'S POSITIONING AND EXPOSURE PARAMETERS

In Dentascan, the images are acquired by high resolution spiral CT equipment. The mandibles are maintained in a fixed positioning on a Styrofoam surface, attached to the head holder of the CT equipment in order to stimulate the patient's correct positioning in which the mandibular base are perpendicular to the horizontal plane. Two millimeter thick axial tomographic sections are made with 1 mm intervals at 80 kV and 60 mA and field of view (FOV) of 15.8 cm. The images obtained through this procedure are denominated as standard-position images (SP).

New axial sections are performed with the mandible in the same fixed position but with a deviation of the gantry angle in the two directions, +19 and –19 to simulate mandibular inclination. Using this principle, it was assumed that when gantry is inclined to +19 it simulated a lower inclination of the mandible and a –19 gantry position simulated an upper inclination. Those are respectively denominated as image with lower mandible inclination (LP) and image with upper mandible inclination (UP). After that, all the axial CT data is transferred to a work station, to generate panaromic and cross-sectional reformatting images by the dentascan software. These images are printed on a radiographic film by a chemical printer.[3,4]

INTERPRETATION OF DENTASCAN

Axial scans at 1 mm are obtained continuously through either the maxilla or mandible. Using the axial scan through the roots of the teeth, the curvature of the alveolar ridge is drawn on the computer screen. Software program then produces sequential oblique cross-sections every 2 or 3 mm around the entire curvature of the alveolar ridge. Each of the cross-sections is sequentially numbered and matched to tick marks on the axial views. Finally, five panoramic views are obtained and the oblique views are keyed to the panoramic scans as well.[13,14]

Advantages of Dentascan

- It has a rapid scan time as compared with panoramic radiography.
- It gives complete 3D reconstruction and display from any angle.

- Multiplanar image can be 'thickened' by increasing the number of adjacent voxels included in the display, referred to as ray sum.
- 3D volume rendering is possible by direct or indirect technique.
- The three positioning beams make patient positioning easy. Scout images enable even more accurate positioning.

CONCLUSION

Normal anatomic features as well as the appearance of frequent dental pathologies are described with their typical findings, which the radiologist should communicate to the referring clinician. Dentists should ask themselves whether these imaging modalities actually add to their diagnostic knowledge and raise the standard of dental care or whether they only place the patient at a higher risk. Continuous training, education and thorough research are thus absolutely essential.

REFERENCES

1. Thomas B. Dodson Interactive CT software in oral and maxillofacial surgery atlas. Oral Maxillofac Surg Clin N Am 2005;13(1):69-81.
2. Yanagisawa K, Friedman CD, Vining EM, Abrahams JJ. Dentascan imaging of the mandible and maxilla. Head Neck 2006;15(1):1-7.
3. Bhatia HP, Goel S, Srivastava B. Dentascan. J Oral Health Comm Dent 2012;6(1):25-27.
4. Azari A, Nikzad S. Computer-assisted implantology: historical background and potential outcomes—a review. Int J Med Robotics Computer Assist Surg 2008;4(2):95-104.
5. Del Balso AM. RSNA special course in head and neck imaging. Radiological Society of North America Inc; 1996. p. 23-31.
6. Hirschfelder U. Radiological survey imaging of the dentition: dental CT versus orthopantomography. Fortschr Kiefer Orthop 1994;55(1):14-20.
7. Bodner L, Sarnat H, Bar-Ziv J, Kaffe I. Computed tomography in the management of impacted teeth in children. ASDC J Dent Child 1994;61(5-6):370-377.
8. Krennmair G, Lenglinger FX, Traxler M. Imaging of unerupted and displaced teeth by cross-sectional CT scans. Int J Oral Maxillofac Surg 1995;24(6):413-416.
9. Dolly MJ, Siewerdsen JH, Moseley DJ, et al. Intraoperative cone beam CT for guidance of head and neck surgery: assessment of dose and image quality using a C arm prototype. Med Phys 2006;33(10):3767-3780.
10. Abrahams JJ, Berger SB. Inflammatory disease of the jaw: appearance on reformatted CT scans. Am J Roentgeno 1980; 170(4):1085-1091.
11. John II, Van TH, Carl EH, Gerald NG, Thomas S, Paul AR. Endodontic cavity preparation. In: Endodontics. 5th ed. BC Decker; 2002. p. 405-570.
12. Baily LH, Cevidanes LH, Proffit WR. Stability and predictability of orthognathic surgery. Am J Orthod Dentofac Orthop 2004;126(3):273-277.
13. Monsour PA, Dudhia R. Implant radiography and radiology. Australian Dent J 2008;53(S1):S11-S25.
14. Maher WP. Topographic, microscopic, radiographic, and computerized morphometric studies of the human adult edentate mandible for oral implantologist. Clin Anatomy 1991;4(5):327-340.