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Research Paper

Use Of C-Arm Ct Real Time Imaging System in Endodontics-Aclinical Report.

Medical Science

KEYWORDS : C-arm CT system, Endodontics, Real time Imaging.

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ABSTRACT

C-arm computed tomography is a new and innovative imaging technique. In combination with 2D fluoroscopic or radiographic imaging, information provided by 3D C-arm real time imaging can be valuable for therapy planning, guidance and outcome assessment in the field of modern endodontics.

This paper reports a case of complete endodontic treatment using Artis zee C-arm CT system first time in endodontic practice.

Introduction

The quest for new technologies to incorporate for mutual benefits to the operator and the patient is never ending. Encouraging results have been reported using the latest imaging modalities like Dental Cone Beam CT and Optical Coherence Tomography in endodontics. But none of these systems can provide a three-dimensional real time imaging.

Three-dimensional (3D) C-arm computed tomography is a new and innovative real time imaging technique. Also referred to as C-arm CT, it uses two-dimensional (2D) X-ray projection data acquired with flat-panel detector (Strobel et al.,2009).

C-arm CT is a dynamic radiograph, or radiographic movie, and differs from conventional dental radiography which is static. While physicians can observe these live imaging events, dentists have only possibility of monitoring treatment progress is by making radiographs before and after the procedure. As a result, craniofacial surgeries, endodontic treatments and conventional dental implant placement are invariably blind procedures (Uzbelger et al.,2009).

So, introduction of C-arm systems to endodontic practice will be a giant leap and definitely will provide a cutting edge over existing methods because of its real time imaging advantage.

In the following case report, Artis zee C-arm real time imaging system (Siemens AG, Healthcare Sector, Forchheim, Germany) was used(Figure1).

Case Presentation

A 35 year old male patient reported to our dental clinic with a chief complaint of pain in the upper left back tooth region. On clinical examination, the upper left second premolar tooth was detected as pulpally involved. Pre-operative radiographic assessment of the tooth was done using digital radiography and Artis zee C-arm real time imaging system(Figure1) . A diagnosis of chronic irreversible pulpitis was made and an endodontic treatment was planned. Endodontic access was made under rubber dam isolation (Hygenic,Coltene Whaledent, Switzerland) and two canals (buccal and palatal with Vertuccis Type II configuration) were negotiated with ISO no.10 hand files (Dentsply Maillefer, Switzerland).Working length was established using Artis zee C-arm real time imaging system (Figure2)and confirmed with digital apex locator (Root Zx , J Morita, USA). Glide paths were established using the hand files. Biomechemical preparation was performed in both the canals (Figure3)using 6% No.25 Hyflex CM rotary files (Coltene Whaledent, Switzerland) with 1 % NaOCl (Neodent, New Delhi) as canal irrigant. Final irrigation was done with 17% EDTA solution (Diadent, Korea). Both the canals were obturated with 6% No.25 single gutta percha cones (Coltene Whaledent, Switzerland) with roekoseal sealer (Coltene Whaledent, Switzerland) which was placed using lentulo spirals (JS Dental, Ridgefield, France). During the clinical procedure (Figure1 to 4), Artis zee C-arm real time imaging system was used for real time imaging with an intermittent 2 second, 3second and 5 second recording mode with the strict adherence to minimum radiation exposure (ALARA) protocol for both the patient and the operator. Post obturation image was obtained using Artis zee C-arm real time imaging system(Figure4).

Discussion

On literature search in PubMed data base with the words " C-arm CT in Endodontics" - no results, "C-arm CT in Dentistry" - 4 results, "C-arm Fluoroscopy in Dentistry" - 6 results and in Cochrane data base none of the above words yield any results.

In-office C-arm CT has helped to fulfil a growing demand for minimally invasive procedures in traumatology, orthopaedics, endoscopy, paediatrics and urgent care medicine (Blinov, 2000). Today, C-arm CT accounts for 35% of the medical imaging market (U.S. Food and Drug Administration, 2005).

C-arm cone beam computed tomography (CT) is an advanced imaging capability that uses state-of-art C-arm flat-panel fluoroscopy systems to acquire and display three-dimensional images. C-arm cone-beam CT provides high and low contrast soft tissue (CT-like) images in multiple viewing planes, which constitutes a substantial improvement over conventional single-plannar digital substraction angiography and fluoroscopy (Wallace et al.,2008).

Since the introduction of image intensifying principles in 1942, and first image intensification unit in 1953, the harmful effects of radiation have been considerably reduced (Eisenberg,1992; Chamberlain,1942). An image intensifier, in combination with the use of low milliampere levels, lower patient and operator dose, provides dynamic real-time imaging and allows the operator to position the patient to visualize anatomy and pathology of interest. Video images recorded this way or by digital detectors are stored in a computer, where they can be viewed on a monitor in real time or printed to film. To keep the radiation dose from becoming a health hazard, the exposure rate in C-arm CT image intensification is several orders of magnitude lower than in radiography (Carroll & Fuchs,2003).

To obtain 2D radiographic projection data, the C-arm performs a sweep around the patient e.g. over 200^{0}. Up to several hundred images are acquired depending on the acquisition protocol selected. Reconstruction of three-dimensional voxel data sets from 2D raw projection data is performed using a 3D cone-beam reconstruction algorithm. Resulting voxel data sets can be visualized either as cross-sectional images or as 3D data sets using different volume rendering techniques(Strobel et al.,2009; Saint Felix,1994; Koppe et al.,1995; Fahrig et al.,2006).

3D C-arm imaging comprises a stand and a C-arm to which the detector, X-ray tube and collimator are attached. The C-arm keeps the X-ray tube, collimator, and a flat-panel detector exactly aligned under varying view angles. This design maximizing the number of degrees of freedom for movements while minimizing the required space for the gantry itself, C-arm systems achieve high positioning flexibility and provide excellent patient access (Strobel et al.,2009;Bani Hashemi et al.,1998; Jaffray & Siewerdsen,2000).

In this study , we have used a new type of multi-axis C-arm system. The multi-axis stand facilitates greater flexibility, more accurate, faster movements and better patient coverage, such systems are especially well suited for minimally invasive procedures and surgery (Strobel et al., 2009; Groh et al., 2002, Zellerhoff et al.,2005).

Artis zee high-end imaging system enables the operator for a image guided therapy. Artis zee offers high-end applications for surgery through real time 3D imaging, high frame rates, and excellent image quality at low dose.

C-arm CT systems with automated exposure control adjust X-ray exposure parameters such that the detector entrance dose remains constant. Detector entrance dose is the X-ray dose measured behind the antiscatter grid. System dose is the detector entrance dose evaluated at a reference detector zoom format. System dose is an important set-up parameter for C-arm CT imaging protocols on Artis zee systems. Due to internal adjustments, the detector entrance dose for C-arm CT is about half the system dose (Strobel et al.,2009; Ritter et al., 2007; Kalender & Kyriakou,2007). The radiation exposure with C-arm system is 60-80 % less as compared to Spiral CT(Linsenmaier,2002). As per the manufacturers, the maximum radiation dose for the present system used is 0.25mSv for 5 second exposure time.

C-arm CT acquisition using an Artis zee system is mostly operated either in a 2x2 binning mode or in a 4x4 binning mode. For 2x2 binning usually used for 3D C-arm imaging in the head, we get a detector frame rate of 30 frames per second. And high-contrast C-arm CT scan protocols result in a significantly lower dose to a patient(Strobel et al.,2009). In our Cases, the images obtained and the real time imaging provided a three dimensional viewing of involved tooth intricate anatomical details for improved quality of treatment. Regarding the limitations of this system in endodontics is that, it requires complete supine position of the patient and moderately higher exposure protocol for real time imaging and the design that suits a large volume of tissue to be scanned. So, a limited view chair side C-arm real time imaging system with radiation guidelines is the need of the hour.

Conclusion

Several advanced radiography techniques for the precise detection of lesions and root canal systems have been in use in endodontics, namely CT, CBCT, TACT, micro-CT and OCT for *in vitro* studies (Boruah et al. 2010).While the use of C-arm CT system provides a real time imaging of the root canal system, lesions and surrounding anatomical structures, during clinical procedure , it will definitely gain lot of attention for routine endodontic use in coming days.

Figures(with legends)

Figure 1: Preoperative view.
Figure2: Working length determination.
Figure3: Bio-mechanical preparation.
Figure4: Post Obturation Image.

Figure 1

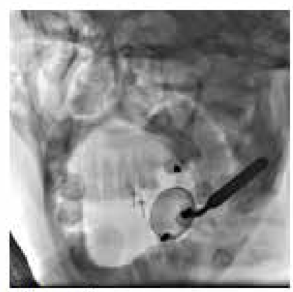

Figure2

Figure3

Figure4

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