Review Article

Endodontic Applications Of Spiral Computed Tomography
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Abstract:
The variations in root canal morphology especially in multi-rooted teeth are a constant challenge for diagnosis and endodontic therapy. Complete knowledge of the root canal anatomy is mandatory because the non-treatment of any one canal may result in endodontic failures. Henceforth, the proper diagnosis and identification of the canals is a prerequisite for successful endodontic therapy. This article intends to highlight the importance of Spiral Computed Tomography in the field of endodontics

Key Words: Spiral C.T., Cone-beam C.T.

Introduction:

The variations in root canal morphology, especially in multi-rooted teeth, are a constant challenge for diagnosis and successful endodontic therapy (Krasner & Rankow, 2004). Complete knowledge of the root canal anatomy is mandatory because the nontreatment of one canal can lead to endodontic failure (Rodig & Hulsman, 2003).

Conventional intra-oral periapical radiographs are an important diagnostic tool in endodontics for assessing the canal configuration. Nevertheless, it is not completely reliable owing to its inherent limitations (Pineda & Kuttler, 1972). Recently newer diagnostic methods such as computed tomography have been valuable in overcoming the disadvantages of conventional radiography by producing a three-dimensional image and have emerged as a powerful tool for the evaluation of root canal morphology.

The term Dental Computed Tomography (CT) does not represent a particular modality but rather a specific investigation protocol. The main features of this protocol include the acquisition of axial scans of the jaw with the highest possible resolution together with curved and orthoradial multiplanar reconstructions. Dentists commonly diagnose and work in the submillimeter scale; hence, a highly detailed image quality is required and challenges C.T. to its technical limits. (Gahleitner et al, 2003) This article aims at bringing forward the valuable contributions of dental C.T. to the field of Endodontics.

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History:

Tomography had been one of the pillars of radiologic diagnostics until the 1970s when the availability of minicomputers and of transverse axial scanning method (due to the work of Godfrey Hounsfield and Allan McLeod Cormack) gradually supplanted it as the modality of C.T. The first commercially viable CT scanner was invented by Sir Godfrey Hounsfield in Hayes, United Kingdom at EMI Central Research Laboratories using X-Rays. Hounsefield conceived his idea in 1967 and it was publicly announced in 1972. Allan McLeod Cormack of Tufts University in Massachusetts independently invented a similar process, and both Hounsefield and Cormack shared the 1979 Nobel Prize in Medicine.

The technique of “Dental CT” also called as “dentascan” was developed by Schwartz et al (1987) when these investigators first used curved multiplanar reconstructions of the jaw (Schwarz et al, 1987 (a & b)).

Technique:

Existing diagnostic methods such as the computerised transverse axial scanning (CT) greatly facilitates access to the internal morphology of the soft tissue and skeletal structures. Recently, a newer CT technique, Spiral Computed Tomography (SCT) or volume acquisition CT has been developed that has its inherent advantage (Hounsefield, 1973). By employing simultaneous patient translation through the X-ray source with continuous rotation of the source-detector assembly, SCT acquires raw projection data.
with a spiral-sampling locus in a relatively short period (Kalender et al, 1990). Without any additional scanning time, these data can be viewed as conventional transaxial images, such as multiplanar reconstructions, or as three dimensional reconstructions. With SCT, it is possible to reconstruct overlapping structures at arbitrary intervals and thus the ability to resolve small objects is increased.

Endodontic Applications:

Specific endodontic applications of spiral CT have been identified as the technology becomes more prevalent. Potential endodontic applications include diagnosis of endodontic pathosis and canal morphology, assessment of pathosis of non-endodontic origin, evaluation of root fractures and trauma, analysis of external and internal root resorption and invasive cervical resorption, presurgical planning, treatment of aberrant and extra root canals, developmental anomalies like dens invaginatus, C-shaped canals, volumetric analysis and more.

Tachibana & Matsumoto (1990) studied the applicability of Computerised Tomography to endodontics. They concluded that this method allowed the observation of the morphology of the root canals, the roots and the appearance of the tooth in every direction. Moreover the image could be analysed, altered and reconstructed by the computer.

Various studies have been conducted in order to analyse and observe the three dimensional view of the dentin-pulp complex in both anterior and posterior teeth with the help of computed tomography. Zoremchhingi et al (2005) conducted an in-vitro study on root canal morphology of human primary molars using computed tomography. The concluded that:

- It was not uncommon to find the distobuccal and palatal roots of the maxillary molars fused. When fusion of these roots occurred it does not mean that the canals are also fused.
- The mesial root canals of the mandibular molars and the mesiobuccal root canals of the maxillary molars showed more frequent and greater variations than did the distal and distobuccal root canals of these molars teeth.
- The primary root canal has a ribbon-shaped root canal system and the apical portion is less constricted without uniform tapering of the root canals. So, a root canal system with a graceful, tapering canal and a single apical foramen ending at the apical foramen is the exception rather than a rule.
- Most of the variations within the root canals of the primary molars were observed in the buccolingual dimensions which would not be detected in clinical radiographic examination.
- The length of the roots are more variable in the maxillary molars but in the mandibular molars the distal root is invariably longer than the mesial root.
- It is also not uncommon to have two well developed and separated mesial roots in the lower primary molars but this may be more prevalent in the second molar.
- The mesial root diverge more than the distal root in the primary mandibular molars whereas in the maxillary primary molars the palatal root showed the greatest divergence.

Similarly, Ballal et al (2007) have also reported a case with a maxillary first molar with a single root and single canal and a fused mandibular second molar and paramolar respectively, both of which have been diagnosed and endodontically treated with the aid of Spiral Computed Tomography, proving its objective in the assessment of root canal morphology.

Conventional radiography produces a two-dimensional image and can lead to superimposition of the root canals. Computed tomography not only helps in understanding the root canal system, but it can also give an accurate measurement for the morphology of the root canal system. It also provides the ability to perform 3-dimensional reconstructions of image data sets. In CT, a series of 2-dimensional image data sets can be integrated mathematically to produce cross sections in any plane or 3-dimensional images.

Computed Tomography has been used successfully in clinical dentistry for detecting root canal filling materials and metal posts, caries and relationships between maxillary sinus and root (Jin et al, 2006). Youssefzadeh et al (1999) showed that CT could be useful in diagnosing the vertical fracture. Jin et al (2006) have reported that CT can also be used as a tool for mass study of the root canal without surgical intervention.
Inadequate cleaning and shaping, improper diagnosis and inadequate location of root canal systems are considered to be one of the most important factors for endodontic failure. To avoid this, the endodontist must consider the judicious use of high-end diagnostic imaging techniques for successful management of complicated cases.

Since, computed tomography requires an elaborate gentry, and is highly costly in addition to which it also requires the guidance and support of a trained radiologist it is not very frequently used. Also it has a high radiation dose, long scan time and inability of its use in day to day dental practice limits its contributions to the field of endodontics.

In order to overcome the above Cone Beam Computed Tomography also known as CBCT or CBVT has been introduced. When compared to medical CT, CBCT has increased accuracy, higher resolution, reduced scan time, a reduction in radiation dose and reduced cost for the patient (Yajima et al, 2006; Ziegler et al, 2002).

As compared to conventional radiography it also eliminates superimposition of surrounding structures, providing additional clinically relevant information.

However, its drawbacks also include limited availability, significant capital investment, and medico legal considerations. But as CBVT technology evolves clinicians will be able to adopt 3-D imaging into their diagnostic repertoire because accurate diagnostic information leads to better clinical outcomes.

Biblography:


