|| Print ISSN: 2589-7837 || Online ISSN: 2581-3935 ||
International Journal of Medical Science and Diagnosis Research (IJMSDR)
Available Online at www.ijmsdr.com
PubMed (National Library of Medicine ID: 101738824)
Original Research Article
Volume 4, Issue 3; March: 2020; Page No. 07-12

A COMPARATIVE STUDY TO EVALUATE THE ACCURACY OF CBCT, DIGITAL RADIOGRAPHY AND INTRA ORAL PERIAPICAL RADIOGRAPHY FOR THE ASSESSMENT OF THE ANATOMY OF THE MAXILLARY SECOND PREMOLAR ROOT CANALS: AN INVITRO STUDY.

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Conflicts of Interest: Nil

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Abstract:

Aim: To compare the accuracy of CBCT, Digital Radiography and Intra Oral Periapical Radiography in evaluating the root canal morphology of the maxillary second premolar teeth.

Methodology: 76 freshly extracted maxillary second premolars obtained without any cracks, fractures or external root resorption was selected. The peripheral part of samples was covered with modeling wax to simulate soft tissue Samples are then subjected to intra oral periapical radiography, digital radiography and CBCT. All the stages were performed by a trained operator. Exposure parameters were set at 65 kVp, 7.5 mA and an exposure time of 0.80 seconds for conventional radiographs and 0.40 seconds for digital radiographs. The distance between the buccal surface and the focal spot was 20 inches. The E-speed film (Kodak) was used in the conventional method. The films were developed in the same day Digital image were taken by direct system using CCD receptor of 23w14%4mm size. The images were prepared with Adstra software. CBCT scans were carried out using Planmeca Promax 3D (Planmeca, Helsinki,). The images were taken at 84 kVp, 6 mA and 12 sec exposure. The field of view (FOV) was set at 5%5 cm with the pixel size of 0.16 mm and bit depth of 15. The images were analyzed by Planmeca Romexis Viewer

Results: Type ll configuration (35.59%) according to vertucci's classification was most prevalent in 1OPAR group followed by Type IV configuration (31.6%), Type (28.9%), Type V(2.6%), Type lll (1.3%). In RVG group Type I configuration (34.2%) according to vertucci's classification was most prevalent followed by Type II configuration (31.6%), Type IV (30.6%), Type V(2.6%), Type III (1.3%). In CBCT group 1ype ll configuration (35.5%) according to vertucci's classification was most prevalent followed by Type lV configuration (32.9%), Type I (28.9%), Type V (1.3%), Type III (1.3%).

In general, according to the kappa statistical test, the agreement between 1OPAR and digital radiographic imaging in canal configuration was 924 (P-0.001). On the other hand, in terms of canal configuration based on Vertucci's classifications, the agreement between CBCT and lOPAR is .942 (P=0.001). Totally, in terms of canal counts, the agreement between CBCT and 1OPAR 1s .866 (P=0.001). On comparing the groups, statistically significant results obtained with Group III (CBCT) Suggesting a better efficiency for CBCT in evaluating the root canal morphology than Group I (RVG) & II (1OPAR).

Interpretation & Conclusion: Within the limitations of this study, it is concluded that ,the accuracy in determining the root canal morphology was increased by use of CBCT scan in comparison with Digital Radiography, Intra Oral Periapical Radiography.

Keywords: Root Canal Morphology, Maxillary Second Premolar, Digital Radiography, Intra Oral Periapical Radiography, CBCT

Introduction

A thorough knowledge of the root and root canal morphology is needed for the success of root canal therapy so as to locate all existing canals and properly clean, shape, and obturate the root canal space three-dimensionally. Internal and external anatomies of teeth have been studied and the studies revealed that anatomic variations can occur in all groups of teeth which can be extremely complex.[1]

Internal complexities of the root canal have a perfect significance in anthropology and are determined genetically. External surfaces always have a relatively simple and uniform anatomy where the complexities of internal anatomy are often being masked. It is extremely

important for us to have knowledge of root canal anatomy locating and negotiating canals for systematic canal debridement and to prevent misdiagnosis as well as errors during instrumentation, which all can influence the success rate of endodontic treatment. Differences in root canal anatomy and root morphology as a function of race are well established.[2]

One of the most difficult teeth to treat endodontically are maxillary second premolars. Many factors such as the number of roots, the number of canals, the direction and longitudinal depressions of the roots, the various pulp cavity configurations, and the difficulties in visualizing the apical limit by radiographs could be the reasons behind that. Root canal morphology of maxillary second premolar teeth has been investigated and reported significant variations.[3]

Various methods used to study the internal anatomy of the root canal system includes root canal staining and clearing, conventional, digital and contrast-medium enhanced radiography, and various types of computed tomography. An ideal method should be accurate, Simple, non destructive, and most importantly, a feasible technique in the in Vivo scenario in order to find the root canal morphology. Tooth clearing and Sectioning are considered useful and accurate; however, these methods are limited to extracted teeth and can damage the specimens. Radiography is a conventional method used to identify the root canal morphology; however, it only provides two-dimensional images of three-dimensional objects, resulting in distortion and superimposition. CBCT can non invasively document the internal and external morphologies of a tooth, although their features are different.[4]

Conventional Radiography is a traditional method which is routinely used in the field of endodontics. This technique is unlikely to show the complexities of the root canal anatomy with conventional radiography, although it may demonstrate the main features. Longer preparation time, developing and fixation errors, inability to archive and manipulate the images and a higher required the main disadvantages which we face while using the conventional radiography especially when images need to be repeated.[5]

Considering the limitations of it, digital imaging has been introduced recently. One of the superior characteristics in digital radiography is its ease of handling and also the benefits from various software programs. Direct digital radiography is often more effective than conventional intraoral films except from its limited resolution of images, with features such as real time imaging lower X-ray dose levels up to 60%, higher sensitivity, low noise levels at higher spatial frequencies, no silver halide, possibility of image manipulation and digital storage.[6]

CBCT is a modified form of conventional CT which is widely used in detecting root canal morphology which overcomes the drawbacks of other techniques for use in clinical practice. CT allows a three dimensional reconstruction of root canal systems which is its main advantage. When it comes to the localization and description of root canal systems precisely CT has been suggested as the preferential imaging modality due to its ability to give a three dimensional information. An extra oral imaging scanner is added to Cone-beam computed tomography (CBCT) which gives a three dimensional scans of the maxillofacial skeleton at a considerably lower radiation dose than conventional CT.[7]

Therefore, the aim of this in vitro study was to compare CBCT, digital radiography and conventional radiography in the evaluation of root canal morphology of human maxillary second premolars.

METHODOLOGY:

Freshly extracted intact permanent maxillary second premolars with fully formed apices undergoing extraction at oral surgery department at KVG dental college and hospital Sullia and private dental clinics were collected for this study. Teeth with internal/external resorption, malformed teeth, teeth with developmental anomalies, teeth with Vertical/ horizontal fractures, teeth with Calcified canals, Root canal treated teeth and teeth with any restorations were excluded. At total of 76 teeth were selected for this study Ihe peripheral part of samples was covered with modeling wax to Simulate Sot tissue. Samples are then subjected to intra oral periapical radiography, digital radiography and CBCT.

Inventional radiography & digital radiographic imaging:

All the stages were performed by a trained operator. Exposure parameters were set at 65 kVp. 7.5 mA and an exposure time of 0.80 seconds for conventional radiographs and 0.40 seconds for digital radiographs. The distance between the buccal surface and the focal was 20 inches. E-speed film (Kodak) was used in the conventional method. The films were developed in the same day. Digital images were taken by direct system using CCD receptor of 25x14x4mm size. The images were prepared with Adstra software.

Cbct imaging

The peripheral part of each sample was covered with modeling wax to simulate soft tissue. CBCT scans were carried out using Planmeca Promax 3D (Planmeca, Helsinki, Finland). The images were taken at 84 kVp, 6 mA and 12-sec exposure. The field of view (FOV) was set at 5x5 cm with the pixel size of 0.16 mm and bit depth of 15. The images C analyzed by Planmeca Romexis Viewer (Romexis software version 2.8.1) (Planmeca OY, Helsinki, Finland)

using a 17-inch monitor (LI752SE Series, LGG corporations, South Korea) with a resolution of 1280x1024 pIxels in a dark room. Brightness and contrast for each image was adjusted for better visualization.

RESULTS

A total of 76 samples were evaluated for root canal morphology using RVG, IOPAR and CBCT. Root canal configurations of three groups were compared using kappa statistical test.

Table 1: Frequency of different morphological types according to vertucci's classification observed by different methods

	GROUP		
	GROUP I (IOPAR)	GROUP II (RVG)	GROUP III (CBCT)
Type I	22 (28.9%)	26 (34.2%)	22 (28.9%)
Type II	27 (35.5%)	24 (31.6%)	27 (35.5%)
Type III	1 (1.3%)	1 (1.3%)	1 (1.3%)
Type IV	24 (31.6%)	23 (30.3%)	25 (32.9%)
Type V	2 (2.6%)	2 (2.6%)	1 (1.3%)
TOTAL	76 (100%)	76 (100%)	76 (100%)

Type ll configuration (35.5%) according to vertucci's classification was most prevalent in 1OPAR group followed by Type IV configuration (31.6%), Type I (28.9%), Type V(2.6 %), Type III(1.3%). In RVG group Type I configuration (34.2%) according to vertucci's classification was most prevalent followed by Type II configuration (31.6%), Type IV (30.6%), Type V (2.6 %), Type III (1.3%). In CBCT group Type II configuration (35.5%) according to vertucci's classification was most prevalent followed by Type IV configuration (32,9%), Type I (28.9%), Type V(1.3%)., Type III(1.3%). Greater number of root canal systems was reported by Group 1l (CBCT) than Group I (RVG) and Group II (IOPAR).

According to the kappa statistical test, in terms of canal configuration, the agreement between Group I (RVG) and Group II (IOPAR) in canal configuration was 924 (P=0.001) ,between Group III (CBCT) and Group II (1OPAR) is .942 (P-0.001), Group III (CBCT) and Group I (RVG) is .866 (P-0.001) respectively suggesting a statistically significant results for Group III (CBCT) when compared with other groups.

In the current study, the statistical analysis revealed significantly greater accuracy for Group III (CBCT), when compared with Group II 1OPAR) and Group (RVG). Group II (IOPAR) showed a significantly higher accuracy than RVG. (RVG) and Group II (IOPAR).

Discussion

Various methods used to study the internal anatomy of the root canal system includes root canal staining and clearing, conventional, digital and contrast-medium enhanced radiography, and various types of computed tomography. An ideal method should be accurate, simple, non destructive, and most importantly, a feasible technique in the in vivo scenario in order to find out the root canal morphology. Tooth clearing and sectioning are considered useful and accurate, however, these methods are limited to Extracted teeth and can damage the specimens.

The dentist must be familiar with the various pathways that root canals take to the apex. The pulp canal system is complex and canals may branch, divide and rejoin. Weine categorized the root Canal systems in any root into four basic types. Vertucci et a, utilizing cleared teeth which had their pulp cavities stained with hematoxalin dye, found a much more complex Canal system and identified eight pulp space configurations.

Maxillary second premolar supplements maxillary first premolar in function. It is less angular, giving a more rounded effect to the crown from all aspects. It has a single root. From the buccal aspect it is noticed that the buccal cusp of the second premolar is not as long as that of the first premolar and it appears less pointed. Also the mesial slope of the buccal cusp ridge is usually shorter than distal slope. Weine stated that second premolar has single root with ovoid canal in 60 % cases. It is well known that tooth anatomy varies according to racial origin. Therefore it is very important to be familiar with variations in tooth anatomy and characteristic features in various racial groups since such knowing can aid in location and negotiation of canals, as well as their subsequent management

Digital imaging in dentistry is a rapidly changing field. Within a span of years, new devices and computers systems have been introduced to record A-ray images and to manipulate those images using a variety or 1mage processing operations. These developments have generated interest and excitement, as well as exaggerated claims of Superiority.

The aim of this study was to compare conventional radiography, digital radiography and CBCT, in evaluation of root canal morphology of human maxillary second premolars in an in vitro setting. A total of 76 maxillary second premolars were evaluated in this study. The teeth were mounted in wax and subjected to conventional radiography, digital radiography and CBCT. The images were then evaluated in order to determine the root canal configuration based on Vertucci's classification. In the present study, Group I (IOPAR group), exhibited Type II configuration (35.50%), Type IV configuration on (31.6%), Type I (28.9%), Type V(2.6 %) and Type I (1.3%).

The results are comparable with the previous study conducted by Al-Nazhan S et al who concluded that more than 50% of the second maxillary premolar is having two canals and found out Type II configuration (42.4%) was

more prevalent followed by Type I (39.6%), Type IV (16.9%) in Saudi Arabian sub population.

In the present study, Group (Digital Radiography Group), exhibited Type II configuration (31.6%), Type IV (30.6%), Type V(2.6 %) and Type II (1.3%).

The results are comparable with the study conducted by Raj et al who found out more incidence of Type II configuration (33.6%), followed by Type IV (31.1%) and Type I (29.2%) in maxillary second premolars using clearing technique which 1s als0 Supporting with the results of this study.[1]

In the current study, Group I1I (CBCT group) exhibited Type II configuration (35.5%), Type IV configuration (32.9%), Type I (28.9%), Type V(1.3%) and Type Ill (1.3%).

Alqedairi A et al found out Type I (49.4%), Type ll (25.8%), Type Ill (5.%), Type IV (11.6%), Type V (5.7%) and Type VI (1.6%) in maxillary second premolars of Saudi population using CBCT.[16]

AL-Ghananeem et al found out Type IV (60.8%) was most prevalent followed by Type II (24.9%), Type I (13.8%), and Type VII (0.46%) in maxillary second premolars of Jordanian population using CBCT.[23]

Celikten B et al concluded that most root canal configurations were Type I (49.4%) the maxillary second premolars, followed by Type II (27.8%), Type IV (10.5%) Type V (2%) and Type III (1.7%) in Turkish Cypriot population using CBCT.[32]

According to the kappa statistical test, the agreement between 1OPAR and digital radiographic imaging in canal configuration was .924 (P-0.001), indicating that the accuracy of conventional radiography is better than digital radiography in determining root canal morphology.

Moshfegi et al concluded that, the highest diagnostic accuracy was achieved by conventional radiographic images when compared with digital radiographic images in determining root canal morphology.[5]

Wu DM et al concluded that there is only a limited value of Direct Digital Radiography (DDR) alone when studying root canal type. The results of their study are pretty much comparable with our study where the results are showing a significant difference in checking the accuracy of DDR when compared with IOPAR and CBCT.[11]

Gullickson et al studied the root canal morphology using digital image processing technique and concluded that this will be an effective method of evaluating instrumentation procedures. They also told that morphology of the root canal could be followed from before instrumentation through completion using the same tooth.[15]

A digital image is an image formed and represented by a spatially distributed set of discrete sensors and picture elements (pixels), respectively. Comparisons based on the ability to perceive artificial test patterns suggest that digital images are not as good as or are the equivalent of film. While these technical assessments suggest that film images contain more information than digital images. Our ability to see detail when viewing an image is constrained by the properties of the image itself, the environment, such as the background lighting or light box glare and our visual system.

Optimizing the environment is relatively straight forward and achieved by reducing ambient lighting, masking the image on the Light box or monitor, adjusting the light box luminescence or monitor brightness and working in a room tree from distractions.

So, it is very important to differentiate accuracy and precision. Digital imaging may increase measurement precision, but not accuracy. Good basic radiographic technique with attention to image geometry and processing (if using flm) will assure accuracy. Digital image analysis of poor radiographs may yield precise (many significant digits) but erroneous (inaccurate) results.

In the same way, incorrect X-ray exposure (kVp or mAs) or variability of Digital Imaging Radiography's (DIR) sensitivity caused by fluctuations in electrical current will also yield inaccurate but precise results. Computers with their many numeric & and precise results often suggest accuracy even when not warranted.[53]

Similarly, the agreement between CBCT and 1OPAR 1S 942 (P=0.001) and the agreement between CBCT and Digital Radiography is .866 (P=O.001), indicating that CBCT shows a significant difference in evaluating root canal morphology when compared with digital radiography and conventional radiography.

Matherne et al, concluded that the evaluation of CBCT images always resulted in a greater number of root canal systems identified than evaluations of digital radiographic images.[12]

Domark et al found out that the canals which are aligned in a buccolingual plane cannot be easily differentiated from each other when we use two dimensional radiographs when compared with CBCT.[22]

Neelakantan et al compared modified canal staining and clearing technique, cone-beam computed tomography, peripheral quantitative computed tomography, spiral computed tomography, and plain and contrast medium enhanced digital radiography and concluded that CBCT and p QCT were as accurate as the modified canal staining and tooth cleaning technique in identifying root canal systems.[15]

Da Silva et al concluded that CBCT imaging was more accurate compared with digital periapical radiography in identifying root canal morphology.[24]

The Indian population is generally considered to be a hybrid of several ethnic groups with characteristics of Caucasian, Mongoloid, and Negroid races, which is generally referred to as the Dravidian group. Regarding the influence of ethnicity on the anatomical configurations of the root canals, the results of this study can vary and more extensive studies with larger samples are recommended.

Conclusion

Within the parameters of this study in determining the root canal morphology ot maxilary second premolar using digital radiography, conventional radiography and CBCT, the following conclusions can be drawn:

Group (IOPAR group), exhibited Type II configuration (35.5%), Type IV configuration (31.6%), Type I (28.9%), Type V (2.6 %) and Type II (1.3%).

Group II (Digital Radiography Group), exhibited Type II configuration (31.6%), Type IV (30.6%), Type V(2.6 %) and Type III (1.3%).

Group III (CBCT group) exhibited Type II configuration (35.5%), Type IV configuration (32.9%), Type I (28.9%), Type V (1.3%) and Type III (1.3%).

Accuracy of CBCT in detecting root canal morphology is greater when compared with Digital Radiography and Intra Oral Periapical Radiography. Intra Oral Periapical Radiography showed better results than Digital Radiography in evaluating the root canal morphology.

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