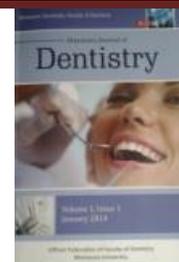




Accuracy of Morita CBCT machine in detecting second mesiobuccal canal in maxillary first molar



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Abstract:

Background: The use of cone beam computed tomography could overcome the inherent limitations of intra-oral radiographs that caused by compression of 3D structures in 2D images. Endodontic treatment of maxillary first molars has the highest clinical failure rates due to its complex root anatomy and variation of mesiobuccal roots.

Aim of the study: An in vitro study to detect 2nd mesiobuccal canal in upper first molar teeth with one machine at different voxel sizes.

Materials and methods: In this study, fifty freshly extracted human first maxillary molars teeth were selected. The teeth were cleaned, disinfected and arranged in horse shoe shaped epoxy resin mold. Then, the molds were exposed using Morita CBCT operated at 0.125 mm voxel size and 0.250 mm voxel size, then sectioned, stained and finally evaluated with stereomicroscope.

Results: Overall, the smaller voxel sizes showed high accuracy in detection of MB2 than higher voxel sizes but with no significant difference between the two voxel sizes (0.125mm³ and 0.250mm³). Also, Using voxel size 0.125mm³ showed that the percentage of detection of MB2 was 100% in the coronal third, 94.1% in the middle third and 77.8% in the apical third. Using voxel size 0.250 mm³ the percentage was 95.3% in the coronal third, 94.1% in the middle third and 77.8% in the apical third.

Conclusion: CBCT is reliable method for detection of MB2 with different voxel sizes.

Keywords: Cone Beam Computed Tomography, maxillary first molars, MB2

Introduction

Radiography is essential to successful diagnosis of odontogenic and nonodontogenic pathoses, treatment of the pulp chamber and canals of the root of a compromised tooth via intracoronal access, biomechanical instrumentation, final canal obturation, and assessment of healing. Imaging serves at all stages in endodontics. ⁽¹⁾

Detection of several endodontic complications on periapical radiographs may be difficult due to the two-dimensional image created using this radiographic technique. In these cases, cone-beam computed tomography (CBCT) is the examination of choice, as recommended by the European Society of Endodontology, because it provides cross-sectional images in any plane, allowing a more accurate evaluation. ⁽²⁾

Perhaps the most important advantage of CBCT in endodontics is that it demonstrates anatomic features in 3D that intraoral, panoramic, and cephalometric images cannot. ⁽³⁾

Type of tooth plays an important role in success of endodontic therapy. Single rooted tooth with single canals poses fewer problems to root canal therapy. Maxillary first molar tooth has complex root canal anatomy. ⁽⁴⁾

Maxillary first molars usually have three roots and three or four canals, several studies have suggested the detection rates for second mesiobuccal root canal ranged from 18% to 96% in maxillary molars. ⁽⁵⁾

The most important causes of non-negotiable MB2 canal location are its narrowness, diffuse calcification, pulp stones debris, and torturous pathways. It is generally accepted that a major cause of failure of root canal treatment is the inability to recognize presence of and to adequately treat all canals of the root canal system. ⁽⁶⁾

Complementary methods of anatomic diagnosis, including cone-beam computed tomographic (CBCT) imaging, may be useful in the diagnosis of mesiobuccal (MB) canals of maxillary molars. ⁽⁷⁾

Aim of the study

An in vitro study to detect 2nd mesiobuccal canal in upper first molar teeth with one machine at different voxel sizes

Materials and methods

Samples selection: Fifty freshly extracted human first maxillary molars were selected for the present study. The teeth were extracted because of periodontal diseases or having severe decay making them unrestorable.

Inclusion criteria are: Only teeth with completely formed roots were included in the present study.

Exclusion criteria are:

1. Teeth with fractured roots.
2. Teeth with severely curved or dilacerated roots.
3. Teeth with pulpal calcifications.
4. Teeth with open apices.
5. Teeth with any signs of periapical surgery, endodontic access, crown preparation, fixed prosthesis.

6. Teeth with carious lesions extending onto root surfaces.

Mold construction:

Teeth inserted in horse shoe wax arches as each arch made from modeling wax to simulate the natural arch form. The base of each arch should be flat so it could be stable in its place on the flat plastic bite plane of CBCT scanner. The roots first embedded in wax then inserted and fixed in the arches. After fixation, transparent polyester resin was poured in arches, resin mixed according to manufacture's instruction, then left to set for about 73 hours. After setting, wax elimination was done and light body condensation silicon injected in the space around roots. Each cast trimmed, polished and coded.

CBCT imaging:

The CBCT images were captured with J. Morita operated at 0.125 mm voxel size and 0.250 mm voxel size with capture parameter set as 90KV, 2mA and an exposure time of 9 seconds with field of view 50 mm x 80 mm. The scans were analyzed using Radiant DICOM viewer.

The three observers asked to detect the presence of 2nd mesiobuccal canal. Adjustment of contrast and brightness could be done if considered necessary.

The results categorized in such away:

1. Score (1): MB2 canal certainly found.
2. Score (2): MB2 canal certainly not found.

The intra- and inter-observer agreements calculated.

After images evaluations, teeth were removed from their places in the casts. The mesiobuccal root was marked at 2mm, 4mm, 6mm from the apex.

Embedding of teeth: The root was embedded in transparent clear resin till the level of cement-enamel junction. The resin was mixed according to manufacturer's instructions and left to set.

Samples sectioning: All samples were cut at 2, 4 and 6 mm distance from the apex perpendicular to the root long axis using a precision saw-edged disc with a blade of thickness 0.5 mm, a diameter of 80mm and fitted into precision machine.

Stereomicroscope samples evaluation: Finally, the sectioned surfaces of the samples were stained with methylene blue and evaluated under a stereomicroscope (Nikon UFX-DX, Tokyo, Japan) at a magnification x30.

Results

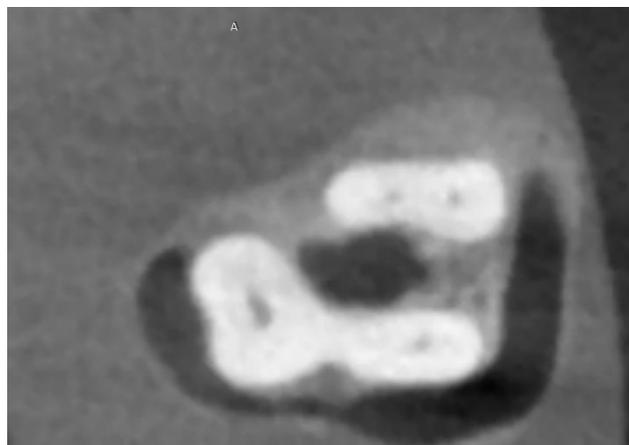
The inter-observer and intra-observer was high >0.7 as inter-observer agreement between first reader and second reader was (1, 0.98), first and third reader was (0.98, 0.95) and second and third reader was (0.98, 0.93). Intra-observer agreement, for the first reader was (0.81, 0.83), second reader was (0.85, 0.81) and third reader was (0.88, 0.81).

The accuracy of the machine in detecting the number of second mesiobuccal canal was 97.3% at voxel size 0.125 mm³ and 96% at voxel size 0.250 mm³ (figure 1.2)

Statistical analysis showing that the percentage of detection of second mesiobuccal canal at voxel size 0.125 mm³ at the coronal third was 100 %, middle third was 94.1% and apical third was 77.8%. As for using voxel 0.250mm³, the percentage at the coronal third was 95.3 %, middle third was 94.1% and the apical third was 77.8%.

According to accuracy, Morita 0.125 mm³ showed higher accuracy than Morita 0.250 mm³

Figure (2):coronal third of upper first molar using Morita 0.125



Discussion

The frequency and risk of missed canal anatomy are strictly linked with the complexity of the root canal system. CBCT is a relatively recent innovation that overcomes many of the limitations of conventional radiography. It has many applications in endodontics because its three dimensional images allow inspection of the tooth in the axial, coronal, and sagittal planes. The axial plane is particularly useful in helping the clinician to determine the number of root canals and their location relative to one another. ⁽⁸⁾

In our study, the purpose of cutting the roots into thirds was to obtain anatomic information to apply a gold standard as this technique is used also in other studies. ⁽⁹⁾

The use of CBCT to explore the anatomy of root canals has been compared to histological studies with a high correlation. ⁽¹⁰⁾

In present study, using Morita CBCT machine with voxel size 0.125 mm³ the percentage of detection of second mesiobuccal canal was 97.3%, other study ⁽⁸⁾ using same machine with the same voxel size showed that the percentage of second mesiobuccal canal was 96% while another study showed that the percentage was 69%. ⁽¹¹⁾

In our study using Morita CBCT machine at voxel size 0.250 mm³ the percentage of MB2 was 96% while in another study was 63.6% which was similar to that of Alavi et al (67.3%) while in studies of Korean, Burmese, Chinese and Japanese populations showed a similar prevalence which was in the range of 50.4%-70%. ⁽¹²⁾

The coronal part showed high percentage of mb2 more than the middle third and the middle third showed higher percentage than the apical third this showed agreement with other studies although one of these studies used one machine with four different voxel sizes⁽¹³⁾ and the other one used one machine with one voxel size. ⁽¹⁴⁾

While when using Morita CBCT machine at voxel size 0.125 mm³, the percentage of second mesiobuccal canal in coronal

third was 100%, in the middle third was 94.1% and in the apical third was 77.8%.

Using Morita CBCT machine at voxel size 0.250 mm³ the percentage of second mesiobuccal canal in coronal third was 95.3 %, in the middle third was 94.1% and in the apical third was 77.8%.

The current study compared to other studies showed variations in the percentage of presence of second mesiobuccal canals and this is probably due to factors as sample size or population studied as reported in another study.⁽¹⁵⁾

Also, other study proved that when the bone is present it can complicate the interpretation of CBCT scan images by increasing the percentage of errors caused by different bone densities surrounding each tooth.⁽¹¹⁾

In the present study, small voxel sizes are proved to be more accurate and have more resolution than the large voxel sizes as showed in other studies.^(16,13) The explanation of this is that the smaller voxel sizes the higher spatial resolution.⁽¹⁷⁾

In our study, there was intra-observer and inter-observer agreement which in accordance with the work of Rohan et al.,⁽⁸⁾ although other studies showed that there is no agreement as this depends on each observer's past experiences and personal beliefs may have an influences also.⁽¹⁸⁾

In current study, the group intra-class correlation coefficient and percentage of agreement were extremely high but not perfect, which still allows a small space for personal variations.

In conclusion, CBCT imaging (0.125 voxel size) was found to be more accurate than (0.250 voxel size) in detecting an MB2 canal in maxillary first molar teeth but with no significant difference.

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