Advances in Bioresearch
Adv. Biores., Vol 6 (3) May 2015: 103-107
©2015 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV 7.20 [Poland]

Advances in Bioresearch

ORIGINAL ARTICLE

Validity and Reliability of CBCT Imaging In Detection of Distal Canals in Mandibular First Molars

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ABSTRACT

A better understanding of the root canal morphology and the number of root canals plays an important role in successful root canal treatments. The present in vitro study investigated the reliability and validity of CBCT in detecting the number of distal canals in the mandibular first molars compared to sections as gold standard. 64 mandibular first molars were used to form 8 experimental models and CBCT scans were acquired. CBCT scans were reconstructed and observed by two endodontist and radiologist observers to detect the number of existing distal canals. The observations were repeated a week later. The teeth were sectioned and the number of distal canals was determined following the staining by metylene blue and observations by a light microscope as a gold standard. The reliability of the observations compared to the gold standard and second stage results were subjected to weighted kappa analysis. Among teeth samples, 54.7% and 45.3% had one and two roots respectively. In the endodontist observations; sensitivity, specificity, positive and negative predictive value, likelihood ratio positive, likelihood ratio negative and odds ratio were 97%, 93%, 94%, 96%, 14, 0.03 and 45.9 while the values were 94%, 79%, 85%, 92%, 4.5, 0.07 and 63.2 for the radiologist observations respectively. The inter-reliability of endodontist and radiologists were very good and good compared to the gold standard ($p<0.001$). The intra-reliability of the endodontist and radiologist observers with their second-stage observation results were also estimated to be good and very good ($p<0.001$).Indeed, CBCT can be a valid and reliable modality in detecting the number of distal canals in mandibular first molars.

Key words: *Root canal, morphology, Validity, Reliability, Cone-beam Computed Tomography (CBCT)*

Received 09/02/2015 Accepted 19/04/2015

How to cite this article:
Mahkameh M, Nazanin S, Zahra K, Navid Y. Validity and Reliability of CBCT Imaging In Detection of Distal Canals in Mandibular First Molars. Adv. Biores., Vol 6 [3] May 2015: 103-107**.** DOI: 10.15515/abr.0976-4585.6.3.103107

INTRODUCTION

A successful root canal treatment requires complete mechanical and chemical debridement of canals and also perfect removal of all the pulp tissue and microorganisms from the root canal system [1]. The primary reason of root canal therapy failures is also incapability to find all the root canals. Therefore, understanding of root canal anatomy is crucial for improving the predictability of root canal treatment and performing a favorable therapy [2]. Due to this, several researches have been conducted to investigate the configuration of distal root canals in mandible molars [3-5].

A number of researches have evaluated the mandible molars with multiple root canals. Probability of mandibles with four canals are reported variously in different communities, as it has been reported to be 31.57% in Urmia, Iran; 45% in southern China; 46% in Taiwan and 59% in Sudan. The worldwide probability of two distal root canals in first mandible molars has been reported to be 30% [6].

A variety of methods are used to detect number and anatomy of root canals and examine each root's complexities. Conventional imaging methods compress three-dimensional anatomy into a two-dimensional image, resulting in an unwanted neglect of all the existing details of a root [7]. In addition, this method of radiography will be practically useless to distinguish main canals from auxiliary ones or to

detect exact place of main apical foramina let alone facing tooth overlaps or other similar radiographic issues [8-11].

Cone-beam computed tomography (CBCT), introduced in the field of endodontics in 1990 [12] is a non-invasive, 3D imaging technique with various endodontic applications, including morphologic analysis [13] , ability to reduce or eliminate the superimposition of the surrounding structures [14-15] and higher-quality image rendering for assessment of dental hard tissues [16]. Compared to helical CT scanners, CBCT provides higher image resolution and a noticeable reduction in the radiation exposure [17].

In this research, reliability of 3-D CBCT imaging is tested to detect distal root canals in mandible molars, compared to local tissue section results as a gold standard. Influence of clinical experience on detection of molar distal canals was also evaluated by comparing two different examiners: endodontists and radiologists.

MATERIALS AND METHODS

For this cross-sectional *in vitro* experiment, 64 mandible molars - with close apices and without any tooth decays below CEJ level - were collected. The teeth were stored in 10% formalin for seven days to get disinfected. Then all specimens were removed from disinfection medium and air dried for 24 hours. Eight base models were prepared with eight teeth in each model embedded in plaster model.

All scans were performed by CBCT (NewTom VGI) in dental faculty of Shahid Beheshti University of medical sciences. The device was operating at 120 kV and set to standard resolution. After scanning, the data was reconstructed by NNT viewer software and cross-sectional images became available for evaluation. A radiologist and an endodontist were initially briefed on the sequences of the research and then were asked to view the images and independently assess the number of distal canals. To determine the repeatability of the evaluations, same two raters viewed and evaluated the images seven days later again.

After completion of observations, teeth were removed from the model and were cleansed finely with brushes and scaling equipment. Specimens were placed in marked plastic cups, soaking in clear acrylic resin for 24 hours. Then resin was removed with polishing lathe and grinding disks so that teeth became prepared for sectioning step. The distal root of each tooth was horizontally sectioned in 2-mm increments and four to five sections were made depending on the root's length. Sectioning was started from apex continued coronally to the furcation. Roots were then stained with methylene blue to highlight the canal spaces and each root section was viewed under a stereomicroscope (Nikon ZMS1000) to determine the number of canals. Photographs were taken using a digital camera and a blind evaluator was asked to assess the specimens. If two canals were detected in any section, the tooth was considered to have two distal canals. Finally this evaluation was compared to the CBCT scan results and the percentage of consistent and correct responses was calculated for each rater.

Data was analyzed using SPSS v18 (statistical package for social sciences version 18). The results of endodontist and radiologist's observation in first and second evaluation were compared to each other and to the gold standard (section assessment) using weighted kappa test. In addition the obtained data was analyzed for sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratio positive, likelihood ratio negative and odds ratio. Scoring levels were determined due to kappa level as: 0 - 0.2 = weak; 0.2 – 0.4 = fair; 0.4 – 0.6 = moderate; 0.6 – 0.8 = good; 0.8 to 1 = very good. Alpha error rate of 0.05 was also applied.

RESULTS

Out of total number of 64 teeth, according to the analysis of the cross sections of the distal roots, 29 teeth (45.3%) had two canals and 35 teeth (54.7%) had one canal. In the first evaluation, the endodontist detected 43.8% of teeth with two canals. In the second evaluation 37.5% of teeth were detected as having two canals. In the first and second evaluation of the radiologist, respectively 39.1% and 40.6% of distal roots were detected to have two canals **(Fig 1).**

Due to the specificity, sensitivity, positive predictive value, negative predictive value, likelihood ratio of positive tests and likelihood ratio of negative test for both raters, validity of the CBCT imaging is in a high and satisfactory level in determining root canal numbers **(Table 1).**

By considering the diagnostic odds ratio of the two evaluators, the radiologist (odds = 63.25) shows higher validity level when compared to the endodontist (odds = 45.9) **(Table 1).**

The reliability of the evaluations was also contemplated by two aspects, the inter-rater and intra-rater reliability. Inter-rater reliability was measured as 'good' which is acceptable (weighted kappa=0.77). Intra-rater reliability of the radiologist shows a consistent evaluation and is determined to be in a 'very

good' level and acceptable (weighted kappa=0.84, p<0.001). For the endodontist, intra-rater reliability was measured to be 'good' which is also acceptable (weighted kappa=0.68, p<0.001).

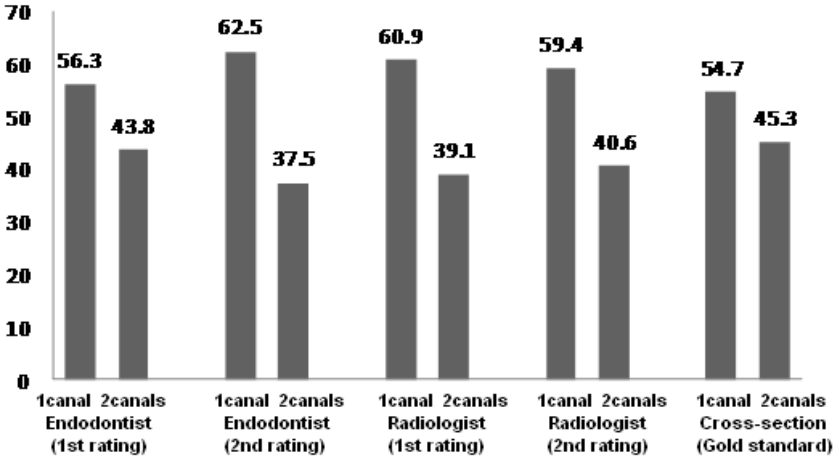

Fig1. CBCT observation and gold-standard result in detecting the number of distal canal in mandibular first molars

Table 1. validity modals for each evaluator		
Parameters	Radiologist	Endodonstist
Specificity	79.31%	93.1%
Sensitivity	94.29%	97.14%
Positive predictive value	84.62%	94.44%
Negative predictive value	92%	96.43%
Positive likelihood ratio	4.55	14.09
Negative likelihood ratio	0.07	0.03
Diagnostic Odd's	63.25	45.9

DISCUSSION

In this study, performed in Tehran, Iran two distal canals were found at a rate of 45.3% by the root section evaluation. This is consistent with several researches as Chen et al reported an incidence of 46% using root sectioning technique [18] and Zhang et al reported a rate of 43% using the same method[19] .Walker also reported a 45% rate of two distal canals in mandibular first molars [20]. However, in another study located in Tabriz province of Iran, the incidence of two distal canals was reported as 31.5% that is not close to the previously mentioned studies and Ahmed et al determined the rate of two distal canals as 59% in Sudanese population [21,22]

In the present study, the endodontist and the radiologist determined the rate of two distal canals as 43.8% and 39.1% respectively. Neglecting the direct influence of evaluators' effect on the determination, CBCT shows a high degree of validity that has been approved by a variety of researches. Blattner et al concluded that there was no significant difference in the ability of CBCT scanning method when compared with the gold standard of clinical sectioning [23]. Michetti et al found a strong correlation between CBCT data and histology results, approving the high validity of this imaging technique [24]. In several other researches, CBCT imaging was even used as gold standard for morphology evaluation [25-27]. One important reason for relying on CBCT, compared to conventional radiographs is that the combination of sagittal, coronal, and axial CBCT images eliminates the superimposition of anatomic structures. Therefore, root morphology can be visualized in three dimensions, as can the number of root canals [13,28]. Due to the present study, seven parameters (Table 1) and weighted kappa for each evaluator suggest that CBCT

can be a valid and reliable enough method to determine the number of distal canals in mandibular first molars.

Another noteworthy point is the higher validity of the radiologist's evaluation according to the diagnostic odds ratio. This could be resulted from the familiarity of the radiologist with CBCT technique and digital images and the background knowledge in facing a more complex method of imaging.

Considering the 0.6 to 0.8 and 0.8 to 1 as two fine and acceptable levels of weighted kappa, there exists an acceptable intra-observer reliability for both the endodontist (w.kappa= 0.9) and the radiologist (w.kappa=0.74). These results are consistent with most researches investigating intra-observer agreement [29-31].However, when it comes to inter-observer reliability there could be a controversy. In 2004 Omer et al reported an poor to moderate inter-rater reliability for two endodontists examining root canal systems of maxillary molars [7]. In another research, 6 maxillofacial radiologists showed a moderate inter-observer reliability (kappa =0.55) reading the radiographs of endodontic treatments [32]. In our study a 0.77 inter-observer reliability was found between the radiologist and the endodontist that is consistent with a study in which Matberene et al reported a good inter-observer agreement among three endodontists [33]. As an explanation to poor inter-rater reliabilities some researchers indicate the limited value of radiographs alone when studying certain aspects of the root-canal system, the criteria used, and insufficient practice of evaluators could be responsible for the low agreement rates. However, open discussions and training for radiographic assessment could reduce observer variation to an acceptable level and increase the reliability and validity of the ratings [29-32].

Overall, using CBCT as a helpful and efficient method in understanding the root canal system in mandibular molars has been approved by this study as many other relevant researches [33-39]. CBCT imaging not only provides a clearer image of root canal morphology and configuration, but also strongly aids dentists and endodntists in diagnosing root fractures, detecting additional roots and preventing a large number of operative procedural errors [40-43]. Nevertheless, the radiation dose to patients when using CBCT is higher than conventional intraoral radiography and any benefit to the patient of CBCT scans should outweigh any potential risks of the procedure, in order to be justified. Therefore any creditable decision to prescribe CBCT scans in the management of endodontic problems has to be made on a case-by-case basis.

REFERENCES

1. Peters, O.A., Laib, A., Gohring, T.N., Barbakow, F. (2001). Changes in root canal geometry after preparation assessed by high-resolution computed tomography. J. Endod., 27:1-6.
2. Vertucci, F. (2005). Root canal morphology and its relationship to endodontic procedures. Endod. Topics, 10:3-29.
3. Hess, W. (1925). Anatomy of the root canals of the teeth of the permanent dentition. Part I. J Am. Med. Assoc., 85(26):2052.
4. Skidmore, A.E., Bjordal, A.M. (1971). Root canal morphology of the human mandibular first molar. Oral Surg. Oral Med. Oral Pathol, 37:105-106.
5. Vertucci, F.J. (1984). Root canal anatomy of the human permanent teeth. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod., 58:589-599.
6. William, T.J., Anne, E.W. (2008). Isolation, Endodontic Access and Length Determination. In: Fouad A, Torabinejad M, Walton RE. Endodontics: principles and practice. Missouri: Elsevier Health Sciences., p 247.
7. Omer, O.E., Al Shalabi, R.M., Jennings, M., Glennon, J., Claffey, N.M. (2004). A comparison between clearing and radiographic techniques in the study of the root-canal anatomy of maxillary first and second molars. Int. Endod. J., 37:291-295.
8. England, M.C. Jr, Hortwell, G.R., Lance, J.R. (1991). Detection and treatment of multiple canals in mandibular premolars. J. Endod., 17:174-178.
9. Nattress, B.R., Martin, D.M. (1991). Predictability of radiographic diagnosis of variation in root canal anatomy in mandibular incisor and premolar teeth. Int. Endod. J., 24:58-62.
10. Blaskonivh-Subat, V., Maricic, B., Sutalo, J. (1992). Asymmetry of the root canal foramen. Int. Endod. J., 25:158-164.
11. Orstavik, D. (2007). Radiology of apical periodontitis. In: Orstavik D, PittFord TR: Essential Endodontology. Prevention and treatment of apical periodontitis, Blackwell, Oxford, 131-152.
12. Tachibana, H., Matsumoto, K. (1990). Applicability of x-ray computerized tomography in endodontics. Endod. Dent. Traumatol., 6:16–20.
13. Patel, S., Dawood, A., Pitt Ford, T. et al. (2007). The potential applications of cone beam computed tomography in the management of endodontic problems. Int. Endod. J., 40:818–830.
14. Durack, C., Patel, S. (2012). Cone beam computed tomography in endodontics. Braz. Dent. J., 23:179-91.
15. Silva, J.A., Alencar, A.H.G., Rocha, S.S., Lopes, L.G., Estrela, C. (2012). Three-dimensional image contribution for evaluation of operative procedural errors in endodontic therapy and dental implants. Braz. Dent. J., 23:127-34.
16. Hashimoto, K., Kawashima, S., Kameoka, S. et al. (2007). Comparison of image validity between cone beam computed tomography for dental use and multidetector row helical computed tomography. Dentomaxillofac Rad., 36:465–471.

17. Mozzo, P., Procacci, C., Tacconi, A. et al. (1999). A new volumetric CT machine for dental imaging based on the cone-beam technique: preliminary results. Eur. Radiol., 8:1558–1564.
18. Chen, G., Uao, H., Tong, C. (2009). Investigation of the root canal configuration of mandibular first molars in a Taiwan Chinese population. Int. Endod. J., 42(11):1044-1049.
19. Zhang, R., Wang, H., Tian, Y.Y., Yu, X., Hu, T., Dummer, P.M.H. (2001). Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. Int. Endod. J., 44:990-999.
20. Walker, R.T. (1988). Root form and canal anatomy of mandibular first molars in a southernmChinese population. Dent. Traumatol., 4(1):19-22.
21. Shahi, S.H., Yavari, H.R., Rahimi, S., Torkamani, R. (2008). Root canal morphology of human mandibular first permanent molars in an In Iranian population. J. Dent. Res. Dent. Clin. Dent. Prospect., 2(1).
22. Ahmed, H.A., Abu-bakr, N.H., Yahia, N.A., Ibrahim, Y.E. (2007). Root and canal morphology of permanent mandibular molars in a Sudanese population. Int. Endod. J., 40(10): 766-771.
23. Blattner, T.C., George, N., Lee, C.C., Kumar, V., Yelton, C.D.J. (2010). Efficacy of cone-beam computed tomography as a modality to accurately identify the presence of second mesibuccal canals in maxillary first and second molars: a pilot study. J. Endod., 36:867-870.
24. Michetti, J., Mallet, J.P., Diemer, F. (2010). Validation of cone-beam computed tomography as a tool to explore root canal anatomy. J. Endod., 36(7):1187-1190.
25. Silva, E.J., Nejaim, Y., Silva, A.V., Haiter-Neto, F., Cohenca, N. (2013). Evaluation of root canal configuration of mandibular molars in a Brazilian population by using cone-beam computed tomography: an in vivo study. J. Endod., 39(7):849-52.
26. Kim, Y., Lee, S.J., Woo, J. (2012). Morphology of maxillary first and second molars analyzed by cone-beam computed tomography in a korean population: variations in the number of roots and canals and the incidence of fusion. J. Endod., 38(8):1063-8.
27. Estrela, C., Bueno, M.R., Sousa-Neto, M.D., Pécora, J.D. (2008). Method for determination of root curvature radius using cone-beam computed tomography images. Braz. Dent. J., 19(2):114-8.
28. Cotton, T.P., Geisler, T.M., Holden, D.T., Schwartz, S.A., Schindler, W.G. (2007). Endodontic applications of cone-beam volumetric tomography. J. Endod., 33:1121–32.
29. Saunders, M.B., Gulabivala, K., Holt, R., Kahan, R.S. (2000). Reliability of radiographic observations recorded on a proforma measured using inter- and intra-observer variation: a preliminary study. Int. Endod. J., 33(3):272-8.
30. Molven, O., Halse, A., Fristad, I. (2002). Long-term reliability and observer comparisons in the radiographic diagnosis of periapical disease. Int. Endod. J., 35(2):142-7.
31. Goldman, M., Pearson, A.H., Darzenta, N. (1974). Reliability of radiographic interpretations. Oral Surg. Oral Med. Oral Pathol., 38:287-293.
32. Goldman, M., Pearson, A.H., Darzenta, N. (1972). Endodontic success – who's reading the radiograph? Oral Surg. Oral Med. Oral Pathol., 33:432-437.
33. Abraham, D., Bahuguna, N., Manan R. (2012). Use Of CBCT In The Successful Management Of Endodontic Cases. J Clin Imaging Sci;2:50.
34. Shenoi, R.P., Ghule, H.M. (2012). CBVT analysis of canal configuration of the mesio-buccal root of maxillary first permanent molar teeth: An in vitro study. Contemp. Clin. Dent., 3(3):277-81.
35. Silva, J.A., de Alencar, A.H., da Rocha, S.S., Lopes, L.G., Estrela, C. (2012). Three-dimensional image contribution for evaluation of operative procedural errors in endodontic therapy and dental implants. Braz. Dent. J., 23(2):127-34.
36. Jeger, F.B., Lussi, A., Bornstein, M.M., Jacobs, R., Janner, S.F. (2013). Cone beam computed tomography in endodontics: a review for the daily clinical practice. Schweiz Monatsschr Zahnmed., 123(7-8):661-8.
37. Kottoor, J., Velmurugan, N., Sudha, R., Hemamalathi, S. (2010). Maxillary first molar with seven root canals diagnosed with cone-beam computed tomography scanning: a case report. J. Endod., 36:915-921.
38. Patel, S., Horner, K. (2009). The use of cone beam computed tomography in endodontics. Int. Endod. J., 42:755-756.
39. Matherne, R.P., Angelopoulos, C., Kulild, J.C., Tira, D. (2008). Use of cone-beam computed tomography to identify root canal systems in vitro. J. Endod., 34(1):87-9.
40. Zhang, R., Wang, H., Tian, Y.Y., Yu, X., Hu, T., Dummer, P.M. (2011). Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. Int. Endod. J., 44(11):990-9.
41. Kajan, Z.D., Taromsari, M. (2012). Value of cone beam CT in detection of dental root fractures. Dentomaxillofac Radiol., 41(1):3-10.
42. da Silveira, P.F., Vizzotto, M.B., Liedke, G.S., da Silveira, H.L., Montagner, F., da Silveira, H.E. (2013). Detection of vertical root fractures by conventional radiographic examination and cone beam computed tomography - an in vitro analysis. Dent. Traumatol., 29(1):41-6
43. Durack, C., Patel, S. (2012). Cone beam computed tomography in endodontics. Braz. Dent. J., 23(3):179-91.