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ASSESSMENT OF THE OCCURRENCE OF MIDDLE MESIAL CANAL IN MANDIBULAR MOLARS USING CONE-BEAM COMPUTED TOMOGRAPHY AND DENTAL OPERATING MICROSCOPE: AN IN VITRO STUDY

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ABSTRACT

Introduction: Failures of root canal treatments may be resulted due to missed canals and ignorance of the clinician about the complex anatomy of the root canal system. One such example of anatomic variation is the middle mesial (MM) canal in mandibular molars. Literature on methods for identifying them is limited. Aim: This in vitro study aimed to assess the occurrence of MM canal with cone-beam computed tomography (CBCT) and then under dental operating microscope (DOM) in the mandibular first and second molars. **Materials and Method:** A total of 40 extracted intact human permanent mandibular first and second molars were selected. These were subjected to CBCT imaging and magnification under DOM for the detection of MM canals. The percentage of incidence in the detection of MMC was compared between these two methods. **Results:** The incidence of MM canals detected in mandibular molars using CBCT and DOM was 7.50 and 10 % respectively and the comparison between the two methods was statistically not significant. **Conclusions:** Since the incidence of MM canals was higher with the use of DOM, it is preferred to use simpler, chairside aids like magnification and ultrasonic troughing. On the other hand, one should be judicious in preoperative CBCT evaluation in finding accessory canals like MM.

KEYWORDS : Accessory canal, cone-beam computed tomography, mandibular molar, microscope, middle mesial canal.

INTRODUCTION

The primary objective of root canal therapy is complete cleaning, disinfection followed by three dimensional obturation. [1] Clinicians should have comprehensive knowledge about aberrant pulp-dentin complex anatomy. A potential error at this phase unleashes a plethora of complications leading to questionable treatment prognosis. Failure to locate all the canals and proper biomechanical preparation of root canal system may provide a persistent source of microbial contamination, altering long-term success of endodontic therapy.[2] Karabucak *et al*. evaluated missed canal prevalence in root canal treated teeth with the help of cone-beam computed tomography (CBCT) and concluded that the missed canal increases the possibility of developing a lesion in a tooth by more than 4 times.[3]

Mandibular molars are one of the most frequently root canal treated teeth,[4] showing variations in anatomical forms such as C-shaped canals, isthmus, and an additional third canal in the mesial root, i.e., the middle mesial canal (MM).[5,6] There is a very high incidence of intercanal and intracanal communications in mandibular molars (83%),[7] but success in accessing and negotiating the MM canal is poor, ranging from 1% to 25%.[8,9] Despite being the most commonly treated tooth with a wide range of anatomic variations, the published literature available on the identification of MMC is scanty and thus was a topic of choice of our study.

A detailed preoperative and intraoperative assessment of landmarks is essential and would minimize the number of missed canals and therefore improve the percentage of clinical success.[10,11] CBCT-based imaging technology overcomes many of the disadvantages of dental radiography. With CBCT the operator can visualize the anatomy of the specimen in three-dimensional slices without destruction of specimen with better image accuracy and resolution offering a minimal X-ray dose and decreasing in imaging errors such as artifacts and superimposition.[12,13,14]

The resolution power of human unaided eye is only 0.2 mm. So, optical aids such as dental operating microscopes (DOM) (×3.5–25) should be helpful to enhance the resolution of human eye by many orders of magnitude. The studies discussing and comparing the preoperative CBCT assessment and intraoperative microscopic assessment methods for finding and recording the incidence of MM canal are very few; thus, we aimed to record the incidence of these MM canal in mandibular first and second molars using CBCT and DOM.

MATERIALS AND METHOD

This *in vitro* study was carried out in the Department of Conservative Dentistry and Endodontics, Awadh Dental College and Hospital, Jamshedpur on 40 human intact permanent mandibular first and second molars extracted for periodontal reasons. Teeth with no developmental anomalies, absence of root canal fillings were included in the study, while teeth with root resorption and fractured roots were excluded from the study.

First Step- Assessment of middle mesial canals using cone-beam computed tomography (CBCT) scan

The 40 mandibular molar samples were embedded into customized modeling wax blocks for mounting on the CBCT machine with 2 sets of 20 specimens in each block. (Figure)

Analysis of CBCT images

The CBCT volumes were analyzed in axial sections for locating the canals by using imaging software (Software

Planmeca Romexis 3.4.0.R, Helsinki Finland) following the manufacturer's guidelines. (The enlarged view of axial section is shown in Figure.) The volumes were observed by two evaluators; Cohen's kappa value was determined for inter-observer reliability. The volumes were observed by two evaluators; Cohen's kappa value was determined for inter-observer reliability. There was a strong agreement between the two observers, □ = 0.790 ($P < 0.001$). So, there was a substantial agreement between the two observers. As values ≤ 0 as indicating no agreement and 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41– 0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect agreement.

Second Step-Locating intra-operatively middle mesial canals using dental operating microscope (DOM)

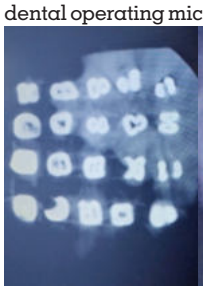
All teeth were then demounted from the wax models used for CBCT scans. Standard endodontic access cavities were prepared using air-rotor hand piece with an Endo Access bur set. The teeth in which mesial subpulpal groove was located, the preparation was further modified using standardized guided troughing method. The ultrasonic tips were used to perform the guided troughing (Figure). The canals were then negotiated using #8 and #10 K-files. Photomicrographs were then taken using dental operating microscope (DOM) at ×6 magnification. If MM canal were found, they were confirmed radiographically.

Statistical Analysis

The data for the occurrence of MMC were tabulated systematically to compare the two methods (CBCT and DOM). The data were subjected to nonparametric McNemar test. The statistical significance was set at $P < 0.05$.

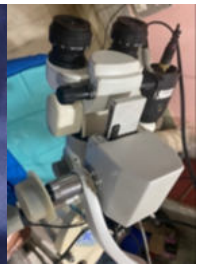
RESULTS

The incidence of middle mesial canal detected using dental operating microscope was found to be 10% [4 out of 40 cases. Graph] while using CBCT it was found to be 7.50% [3 out of 40 samples , Graph]. Statistical analysis was carried out using Mc Nemar test, but significant difference was noted between the two diagnostic aids [p< 0.05]. McNemar test P=0.327 not significant. CBCT: Cone-beam computed tomography, DOM: dental operating microscope.



A. CBCT axial image of first group samples

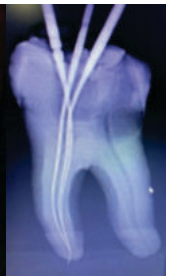
B. CBCT image of showing MM canal



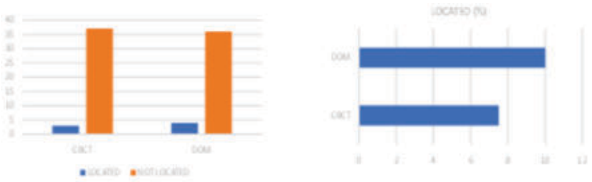
C. Dental operasting microscope

A. Ultrsonic Endo access refinement kit

B. Mandibular molar showing MM canal



C. Radigraph showing mandibular molar showing MM canal



Graph- Comperative percentage of incidence of MM canals in CBCT and DOM inspection.

DISCUSSION

In this *in vitro* study, the incidence of MMCs in 40 mandibular molars was observed using two methods: imaging by CBCT and guided troughing done under DOM. The incidence of MMCs detected using an operating microscope showed a higher percentage (10%) than that of CBCT (7.5-%), which was statistically not significant. This is in agreement with an *in vitro* study on the incidence of MM canal in mandibular molars by Karapinar-Kazandag *et al*.[9] using DOM which showed an incidence of around 18% and 22% in the first and second mandibular molars, respectively. In our study the incidence of MMcs detected using CBCT was lower. A study conducted by Akbarzadeh *et al*.,[16] showed higher incidence of MM canal to be 14.7%. The frequency of MM canasl in an *in vivo* study observed using DOM by Sherwani *et al*.[17] on different age groups of 11–30 years, 31–50 years, and patients >50 years was 36.6%, 22.6%, and 18.4%, respectively. The results of our study are not in agreement with another *in vivo* study conducted by Azim *et al*.[8] which showed a very high incidence of 46.2% of MM canals in mandibular molars after guided troughing under magnification using DOM. This may be due to the *in vivo* design of that study which included mandibular teeth from younger age group in contrast to the relatively aged teeth evaluated in our *in vitro* study. Most *in vivo* studies include molars from all age groups including teeth from younger individuals, while *in vitro* studies are conducted mainly on mandibular molars extracted for periodontal reasons in the elderly patients. The location of MMCs in molars decreases in incidence due to the progressive age-related calcification process,[9,11] making it difficult to visualize, locate, and negotiate the canals. Our results are also in agreement with an *in vitro* study by De Toubes *et al*.[7] which compared the efficacy of four diagnostic methods of clinical examination, digital radiography, DOM, and CBCT. Higher incidence of MMCs was detected using DOM (30%) compared to (27%) CBCT.

The MM canal orifice is usually small[18] with a mean minor diameter being three times smaller (0.16 mm) than the main mesial canals (0.50 mm), hence is a technical challenge. The operator must frequently explore the mesial subpulpal groove and troughing in apical direction to visualize the mesial isthmus to detect and negotiate instrument this accessory canal with an endodontic instrument like DG 16. Troughing of the mesial subpulpal groove when done under the guidance DOM not only helps in the location of the orifice of MMCs but also mapping its relation to the main mesial canals which can be used by clinicians as a navigation guide for searching MMC in routine cases which must be the reason for more MMCs detected by DOM in our study.[8]

The gold standard methods to study the anatomy of root canals are mainly destructive experimental methods performed in a laboratory [19] which are not applicable in clinics. Hence, in our study to simulate the clinical scenario, we selected a preoperative and an intraoperative method of assessment for the detection of MM canals. Successful management of endodontic disease is dependent on preoperative assessment using diferrent diagnostic imaging techniques to provide critical information about the teeth and their surrounding anatomy. Periapical radiograph is one of the most common choices for preoperative assessment. But it

carries certain limitations like compression of three-dimensional structures to two-dimensional imaging, distortion, and anatomical structures superimposition.[20]

In the past few decades, newer and more accurate methods have been introduced [20] to enable the nondestructive evaluation of the anatomical variations and morphological characteristics of the roots; one of them is CBCT. It facilitates the clinician to preoperatively assess the anatomy of the tooth in different planes with the feasibility of manipulating the images; hence, this contemporary radiological imaging technique was included in our study because of its more reliabile over other traditional preoperative assessment methods of radiographic evaluation.[21]

DOM is another device that can enable the visualization and location of root canals as a result of its clear magnification, illumination, and significant field of view.[22] It facilitates improved intraoperative accessory canal identification and evaluation of root canal systems which gives it an edge over other routinely used methods such as clinical examination, dye tracing, or magnification using loupes.[22] Troughing in the pulp chamber floor under DOM has been suggested by many authors to improve accessory root canal identification, and hence, troughing with the magnification was the method of choice in our study.[2,4,6,9] Ultrasonic tips were selected for troughing over the access modification burs because troughing in the floor of the pulp chamber at this level requires specialized instrument, clear visual field, precision, and caution to avoid perforating the floor and its complications.[23,24]

CONCLUSIONS

Although our study showed a lower incidence of MM canal with the use of CBCT compared to DOM, the use of CBCT to study morphologic visualization of the canal trajectory cannot be undereatimated. This holds true specifically in the mid and apical thirds of the roots where visualization with DOM is limited only to the straight portion of the canal. However, it has been suggested [25] that not all canals can be detected with CBCT; thus, it should be used as an auxiliary method in identification rather than as a replacement for careful clinical scouting techniques.

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Conflicts Of Interest -None

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