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Comparative Evaluation of interorificial distance in mesial roots of mandibular molars using novel endodontic caliper and CBCT

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Abstract

Aim

Prior knowledge of anatomic variations in root canal systems is essential for improving the success rate of root canal treatment. The aim of this study is to evaluate and establish the interorificial distance using novel endodontic caliper and make predictions for canal morphology.

Methodology

An in vitro study was taken up using 24 extracted mandibular molars. CBCT was done for all the teeth prior to access opening.The interorifice measurements were taken using the caliper after access opening. The measurements were noted along with predictions of canal morphology. The measurements from the CBCT were compared with the same.

Results

Mean and standard deviation for the endodontic caliper group was 2.6 and 0.391. The CBCT group had a mean and standard deviation of 2.5 and 0.431. There was no significant difference between the interorificial distance measured using Endodontic caliper and CBCT ($p>0.05$).

Conclusion

No statistical significance was obtained on comparison of the measure interorificial distance using Endodontic caliper and CBCT analysis for the same. Endodontic caliper has proven to provide clinically significant results and is helpful to the clinician to predict canal variations when other imaging modalities are inaccessible.

Keywords

Endodontic caliper, interorificial distance, aberrant canal morphology, CBCT analysis

Introduction

The effectiveness of endodontic therapy varies based on the biomechanical preparation of the root canal system. Complex root canal anatomy and our limited capacity to see distinctive root canal curvatures in multiple planes on radiographs may make it increasingly challenging to clean and shape root canals properly, which could contribute to endodontic therapy failures. It is getting more difficult to shape and clean a narrow, curved root canal. As the canals become more curved, there is a higher likelihood that an instrument will break, and widely accepted procedural issues like root perforations, zipping, ledging, and canal transportation could emerge (1). Since there are many curvatures, isthmuses, fins, and multiple canals that join and split at different levels of the root, the mesial root of mandibular molars has one of the most complex internal anatomies in the human dentition. This root's intricate configuration has made it the subject of numerous anatomical investigations utilizing radiography, histology, plastic resin injection, scanning electron microscopy, conventional computed tomography (CT), and ink injection sample clearing. These methodical approaches have unquestionably been effectively applied for many years, giving clinicians valuable information. On the other hand, the endodontic literature has often discussed inherent limitations, which have prompted the search for newer techniques that might be able to overcome the anatomical difficulties that the human dentition presents (2,3). An inability to access areas for tools, irrigation solutions, and medications, along with the presence of isthmuses and other irregularities in the root canal system, act as bacterial reservoirs and ultimately result in the failure of conventional root canal therapy. Besides this, surgical treatment may fail if isthmuses are overlooked during periapical surgeries. The success rate of endodontic treatments should ideally rise in the majority of cases with the current practice of advanced preparation and filling of isthmuses during root-end resection. Consequently, a complete understanding of this morphological feature in the apical third of posterior teeth root canals is crucial to enhance the effectiveness of both surgical and nonsurgical root canal therapy treatments (4). Root canal morphology has also been studied using a wide range of techniques. The use of decalcification with injection of India ink , hematoxylin dye , chinese ink or metal castings , in vitro radiography , in vitro macroscopic examination , grinding or sectioning , and scanning electron microscopy (SEM) examination are a few examples of laboratory techniques.

In addition, clinical study utilized cone-beam CT (CBCT), spiral-CT, micro-CT, and computed tomography (CT). The reported results vary in each of these biological and methodological factors (5). The design of a dynamic access cavity can vary depending on the clinical situation, the anatomy of the root and canal, and the advancements in materials and techniques (6,7). The extraction of carious and damaged tissues and restorations always takes precedence over the negotiation into the pulp space in a dynamic access. In order to remove any irreversibly inflamed or necrotic pulp tissue, as well as any existing root filling materials, the approach to the pulp space always begins with a pinpoint exposure that is gradually enlarged (8). Extending the access apertures in a way that will make clinical management easier will help to strategically address challenges with negotiating and disinfecting the anatomical extensions of the root canal system (9). Thus the aim of the current study, is to evaluate and compare

interorificial distance in the mesial roots of mandibular molars using novel endodontic caliper and CBCT in order to predict the potential root morphology of the tooth.

Materials and method

In this study, extensive evaluations were conducted using 12 removed mandibular molar teeth to measure several facets of dental morphology and structure. All teeth had Cone Beam Computed Tomography (CBCT) scans, which produced precise three-dimensional images of their internal anatomy, prior to the start of the experimental procedures. This first action provided an essential basis for the analysis that followed. To allow for additional investigation, access holes were made in the teeth after the CBCT scans. Measurements of the interorifice, which are crucial for comprehending the shapes and sizes of the root canal system, were carefully made with a caliper through the post-access aperture. It's interesting to note that the measurements made using this manual approach agreed with the information gained from the CBCT scans. This consistency between the two methods of measuring highlights the dependability and precision. The device has been formulated for a chair side estimation and prediction of the canal configuration. Traditionally, CBCT is used for this purpose but is expensive and not easily accessible. The device has been formulated for a chair side estimation and prediction of the canal configuration.In the endodontic caliper, out of the two prongs, one is fixed and the other allows movement. While using the caliper, the fixed prong is placed in the orifice first. The other prong is slowly moved and placed in the other canal. This shows a reading on the scale that is the accurate measurement of the interorifice distance Throughout the course of these assessments, teeth with lower Inter-Orifice Distances (IOD) received extra attention. Notably, a higher frequency of canal abnormalities was detected in these teeth. These differences were thoroughly recorded and examined, ranging from anatomical complexities to anomalies in canal architecture. This finding explains the possible relationship between interorifice distances and the existence of variations in the canal, implying that teeth with lower IOD could be more likely to have more anatomical complexity in their root canal systems.
Figure 1 represents the manner in which the interorificial distance can be measured by inserting the prongs inside the access cavity.

Figure 1: Figure representing the modified prong extensions on the novel endodontic caliper that aids in measurement of interorificial distance

Figure 2 represents a section of the CBCT slice used for CBCT analysis in order to appreciate the canal morphology and measure the interorificial distance.

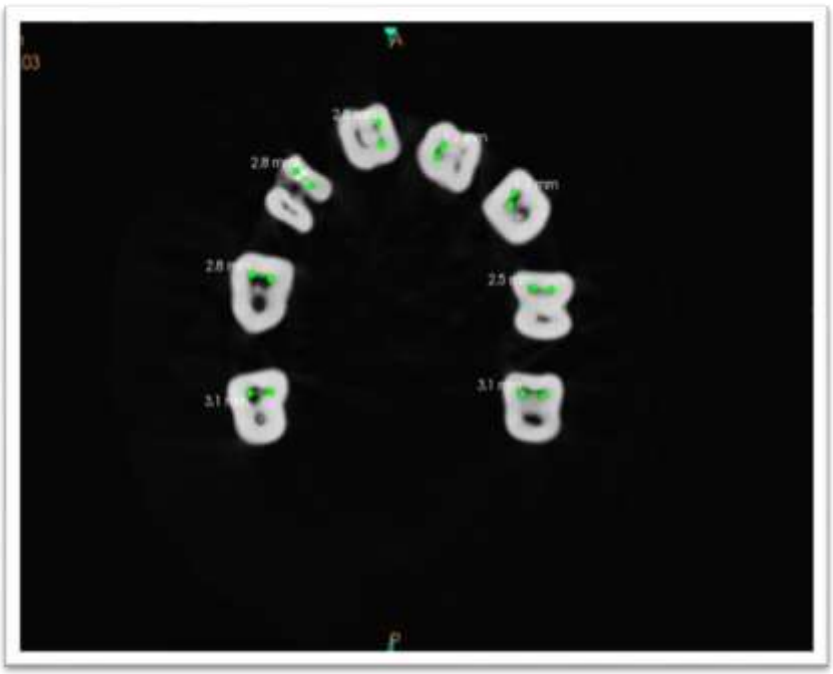

Figure 2: Figure represents the CBCT slice used for measuring the interorificial distance between the mesial canals in all the samples. The interorificial distances are marked at the point of furcation, at the origin of the canal from pulp space

Results

The endodontic caliper group's mean inter-orifice distance (IOD), with a standard deviation of 0.39109 and a standard error of the mean of 0.11290, was determined. This indicates that there were, on average, 2.6250 units separating the root canal orifices in this group. The IOD measurements within this group are spread out or variable, as indicated by the standard deviation of 0.39109, which also shows the degree to which individual measurements deviated from the group mean. Furthermore, the sample mean estimate's precision is shown by the standard error of the mean, which stands as 0.11290. This information gives insight on the precision of the computed mean value. With a standard deviation of 0.43135 and a standard error of the mean of 0.12452, the CBCT group's mean Inter-Orifice Distance was marginally lower at 2.5333. This implies that there were, on average, roughly 2.5333 units separating the root canal orifices in the CBCT group. When comparing this group's IOD measurements to those of the Endodontic Caliper group, the standard deviation of 0.43135 shows a somewhat higher but comparable spread or variability. To illustrate the accuracy of the sample mean estimate for the CBCT group, the standard error of the mean, 0.12452, is provided. In order to help with the interpretation and comparison of the data gathered from these two distinct measurement techniques, these statistical values provide insightful information about the distribution and reliability of the IOD measurements obtained from both the endodontic caliper and CBCT methods. Figure 3 represents the device and the measurement being done for the given samples.

Figure 3: Figure representing the working methodology of the novel endodontic caliper for making the interorificial measurements in the given samples

Table 1 represents the mean value and standard deviation for both the interventions carried on.

Table 1: Illustrates the mean value obtained from measuring the Inter- Orifice Distance (IOD) selected 12 mandibular molars.

METHODS	N	MEAN VALUE	STANDARD DEVIATION	STANDARD ERROR MEAN
ENDODONTIC CALIPER	12	2.6250	0.39109	0.11290
CBCT	12	2.5333	0.43135	0.12452

Graphical representation of the data obtained shows no significance when comparing the novel endodontic caliper and CBCT images as seen in Figure 4.

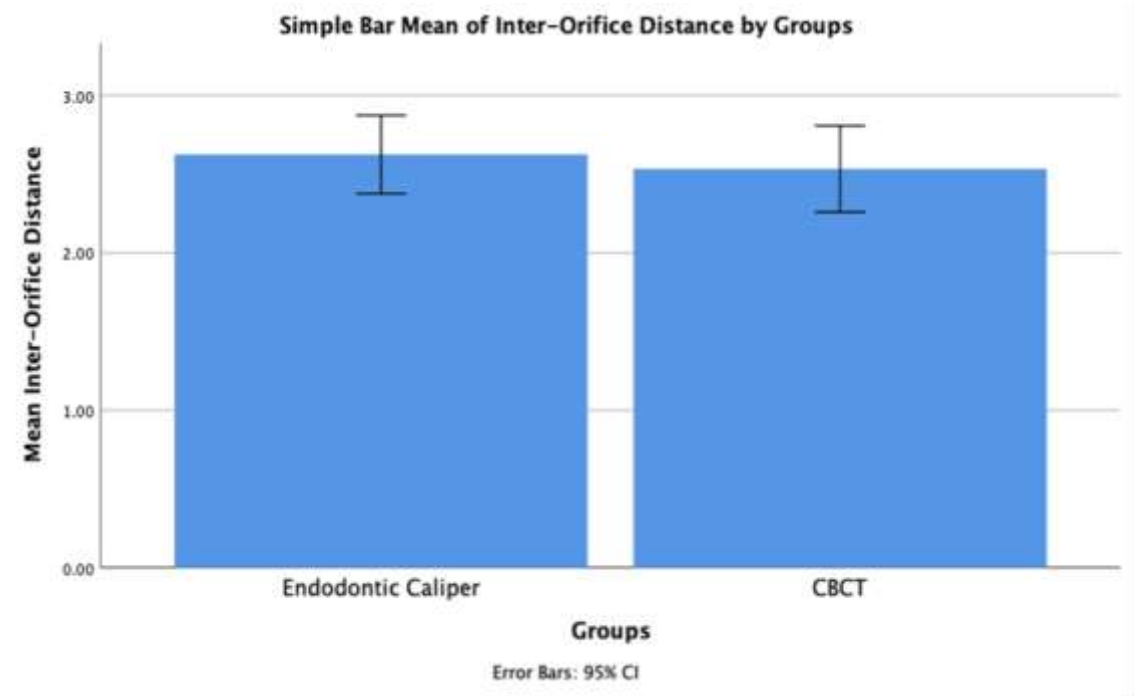

Figure 4 : Represents the mean value with illustration of standard deviation and standard error mean from the measurement taken on Inter-Orifice distance as mentioned above. X axis denotes the two methods employed in this study. Y-axis denotes the mean Inter- Orifice Distance

Discussion

The application of a new endodontic caliper can be beneficial in a variety of circumstances, particularly when treating molars. They can be used, for example, to determine the Vertucci Classification of canal configurations in molars, which provides insight into the internal structure of the teeth's roots (10). Additionally, they can be designed to detect the presence of any additional canals, such as MB2 canals in upper molars or middle mesial canals in lower molars. They are also critical in identifying whether any isthmuses—small bridges that connect different sections of the root canal—are present (11). Furthermore, these techniques can aid in forecasting any variations or curvatures in the canal structure, providing dentists with forewarning of possible findings during treatments. Endodontic caliper is fashioned from the Iwanson metal caliper. Metal calipers are originally used to measure crown thickness (12). The tip has a pointed metal extension soldered for the purpose of measuring the inter orifice distance inside the chamber.

Once one hundred first and second mandibular molars that required root canal therapy were assessed in vivo, Pomeranz et al.'s classification stated the occurrence of MMC variants. Fin, confluent, and independent are the three distinct MMC variants he suggested. Some researchers have found different MMC configurations, but they've not they achieved so as the main focus; instead, they have included the configurations in their own, more general classifications of canal types (13).Vertucci (14) Hsu and Kim (15), Sert and Bayirli (16) are some of the authors currently working on portraying and grouping MMC. Advanced diagnostic methods like micro-CT imaging, CBCT, and DOM have enabled us to understand MMC and its sub variants by recognizing the complexity of numerous canal configurations (17-19). Essential trends presented in the literature, age, gender, and ethnic predisposition to specific canal configurations have been pertaining to both clinical and radiographic prediction. The third mid-mesial canal has been shown to quite often have a smaller diameter than the other two in terms of canal diameter (20). It is common to characterize mandibular first and second premolars as single-rooted teeth with ovoid roots in cross sections and developmental concavities on the mesial and distal surfaces of the root surfaces. Nonetheless, there aren't many reports of two, three, and four-rooted variations in the literature. Numerous studies revealed that the complexity and variety of root canal configurations in mandibular premolars contributed to a high rate of endodontic failures and flare-ups. Numerous studies on mandibular premolars support these findings (21,22). Llena et al. (2014) found that among a Spanish population's mandibular first premolars, type I (78.1%) and type V (12.3%) were the most common types according to Vertucci's classification (23).

Furthermore, type I was found to be the most common configuration in six studies on the Chinese population (86.8% to 54%). Type V was found to be the second most common configuration in all of these studies. Additionally, 10% of all teeth were reported to be type IV, and 6% to be type II and III. Type I canals were also the most common among Turkish (60.6%), Jordanian (58.2%), Indian (80%, 72%, 67.4%), and Egyptian (61.2%) populations, although the prevalence of the other types varied. Much like in first mandibular premolars, the majority of root canals in second mandibular premolars among Indian, Jordanian, Turkish, Chinese, and Spanish populations were Vertucci's type I. In the remaining varieties, type V root canals accounted for the majority (24- 26).

The mean values make a clear statement that proves the difference in measurements has no reliable significance to address the usage of calipers in place of CBCT. On the whole, the detailed method used in this study involved manual measurements, CBCT imaging, and detailed observations of canal variations—offers useful insights about the complex nature of dental anatomy and of accurate diagnostic techniques in endodontic research and practice.

Conclusion

In contrast to a CBCT scan, which takes a lot of time, is expensive for the patients, and inevitably exposes them to radiation, this study is at the frontline of recent modalities used to understand the complexity and make chairside diagnoses. This is because no previous contemporary study has used calipers to measure the Inter-Orifice Distance (IOD). Innovative calipers may be helpful for patients who refuse to have a CBCT or for physically challenged patients who have trouble opening their mouths, tremors, delayed cognitive development, etc. In order to perform the CBCT scan precisely and eliminate any margin of error, new calipers can be utilized as a formative diagnostic method in the chairside setup. These calipers aid in a formative understanding of the condition of the patient's root structure. To fully understand the application of novel calipers, a larger sample rate is necessary. More research on these calipers is necessary to gain a thorough understanding of their effectiveness and precision.

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