RELATION BETWEEN BUCCO-LINGUAL DIMENSION AND ROOT CANAL MORPHOLOGY IN MANDIBULAR INCISORS: A MORPHOMETRIC STUDY

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ABSTRACT
Background and Aim: The aim of this study was to investigate the relation between bucco-lingual dimension and root canal morphology in mandibular incisors.

Materials and Methods: A total of 100 mandibular incisors were used in this study. The bucco-lingual dimensions of each tooth were measured at the level of cemento-enamel junction by using a digital caliper. Thereafter, the crowns were ground off until the root canal orifice was exposed. The canal orifices of each tooth were negotiated under the operation microscope. Additionally, digital-radiographs were taken from approximal aspect and then grouped according to the Vertucci’s classification. The Student t-test and one-way ANOVA, followed by a post hoc analysis at a level of 0.05 were made.

Results: Statistical analysis showed that both the number and the type of root canals were significantly affected from bucco-lingual dimension.

Conclusions: When the bucco-lingual dimension increased, two canals were observed. During the clinical practice the bucco-lingual dimension of the tooth crown should be considered as a preoperative predictor related to the canal morphology.

Key words: Bucco-lingual Dimension, Mandibular Incisors, Root Canal Morphology

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INTRODUCTION

The variability of the root canal system represents a challenge to both endodontic diagnosis and treatment. Therefore, a clear understanding of root morphology and root canal anatomy is a prerequisite to achieve an optimal obturation of the root canal system. One of the most important factors that lead to the failure of the root canal treatment is missed and untreated major root canals, which may be the origin of acute flare-up during and after treatment. Hoen and Pink found that 42% of the teeth that needed retreatment had missed canals. They also concluded that the clinical application of the thorough knowledge of canal anatomy and meticulous attention to treatment detail are essential to minimizing failure and the need for subsequent endodontic retreatment.

The mandibular incisors, because of their small size and internal anatomy, may be the most difficult access cavities to prepare. The literature on mandibular incisors reveal that 11-68% of mandibular incisors have two canals. Because of this variant a thorough clinical and radiographic evaluation must be carried out before endodontic treatment of such teeth. Generally, the presence of a second canal is noticed only after canal treatment due to persistent postoperative discomfort. It should be known that extra roots and canals are important diagnostic challenges, which begins at the case assessment and involves all operative stages, including cavity design, root canal access, localization, cleaning and shaping of the root canal system. Thus, preoperative predictors related to the detection of root canals are important because they are the only information available before root canal treatment is initiated.

In the light of these observations, the aim of this study was to investigate the relation between bucco-lingual dimension, root canal morphology and number of root canals in mandibular incisors.

MATERIALS AND METHODS

One hundred extracted mandibular incisors were used in this study. The bucco-lingual dimensions of each tooth were measured at the level of cemento-enamel junction by using a digital caliper. Thereafter, the crowns were ground off until the root canal orifice was exposed. The canal orifices were negotiated with a size of 10 K-file (Dentsply-Maillefer, Ballaigues, Switzerland) under an operation microscope (Carl Zeiss, Oberkochen, Germany) with a magnification of 6.4X. The teeth were exposed using digital radiography (Trophy, Radiographic Inc. Vincennes, France) at 55 kVp, 10 mA, and 16 impulses in bucco-lingual direction (proximal view). Then the teeth were grouped according to the Vertucci’s classification as follows (Figure 1):

Type I. A single canal is present from the pulp chamber to the apex.
Type II. Two separate canals leave the pulp chamber, but join to form one canal to the exit site.
Type III. One canal leaves the pulp chamber, divides into two within the root, and then merges to exit in one canal.
Type IV. Two separate and distinct canals are present from the pulp chamber to the apex.
Type V. Single canal leaves the pulp chamber, divided into two separate canals with two separate apical foramina.

Statistical analysis was carried out using the Student t-test at a significance level of p<0.05. One-way ANOVA followed by Tukey post hoc comparison was applied to compare the bucco-lingual dimension and type of the root canals results were considered significant when P<0.05.

RESULTS

The results of the present study are presented in Table 1. Statistical analysis showed that both the number and the type of root canals were significantly affected from bucco-lingual dimension (p<0.05). The mean bucco-lingual dimension was associated with the number of canals. When the bucco-lingual dimension increased, two canals were observed. Table 1 shows the number and percentage of each canal type in the mandibular incisor teeth. The mean bucco-lingual value of mandibular incisors containing one canal was 5.7 mm. Of the 100 mandibular incisors, 47% had a single canal. When a second canal existed in the mandibular incisors the most common types were II and III (93%), whilst two separate apical foramina (type IV and V) occurred in 7% of specimens.

DISCUSSION

The root canal morphology of mandibular incisors varies greatly in the reported literature. The differences in prevalence may have been affected by factors such as the sample size, examination methods and ethnic diversity. The results of this study indicate that two canals occur in about half (53%) of mandibular incisors. This proportion is less than the findings of Sert et al. (65.5%). However, it is two times greater than that reported by Al-Qudah and Awawdeh who performed a similar study and determined the incidence of a second canal in a Jordanian population to be 26.2%. They also reported that only 8.7% of these canals had two separate apical foramina (types IV and V). Similarly,
Vertucci\textsuperscript{16} who examined the root canal morphology of 300 mandibular incisors reported that 27.5\% of mandibular incisors had a second canal.\textsuperscript{16}

These results were also consistent with the study of Miyashita et al.\textsuperscript{8} who investigated the canal configuration of mandibular incisors in Japan population. They reported that 12.4\% of mandibular incisors contained two canals, but 3\% of these two canals joined in the apical area and exited the apex as a single canal. Of the teeth with two canals, according to the Vertucci’s classification, the prevalence of teeth with one canal in the apex was 93\% (types II and III), that of teeth with two apical canals was 7\% (types IV and V). In the present study, the prevalence of mandibular incisors with two apical canals (3\%) corroborates with that of a previous study (3\%) by Miyashita et al.\textsuperscript{8}

The bucco-lingual dimension of mandibular incisors has a significant effect on the number of root canals in mandibular incisors. This finding corroborates with the results of the study of Gorduysus et al.\textsuperscript{17} They stated that the dimensions of tooth crown which would have interfered with the assessment of root canal morphology should not be overlooked in clinical practice. The present findings indicate that bucco-lingual dimension of mandibular incisors with two canal orifices is at least 6.4 mm. In the present study, the bucco-lingual dimension was 5.7 mm when only one canal orifice was located. In 3\% of the specimens, two separate apical foramina were observed, while 97\% had only one apical canal. Although endodontic access cavities should result in minimum essential removal of the sound tooth structure, these findings indicate that the access cavity design should be enlarged in the bucco-lingual direction when the bucco-lingual dimensions increase. Thus, the possibility of missed canal in mandibular incisors was ruled out.

Additionally, limited intracanal visualization within the field

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\textbf{Type I} & \textbf{Type II} & \textbf{Type III} & \textbf{Type IV} & \textbf{Type V} \\
\hline
\textbf{Number of canals} & \textbf{Single canal} & 5.7 (47\%) & - & - & - \\
\hline
\textbf{Two canals} & - & 6.4 (25\%) & 6.5 (25\%) & 6.5 (2\%) & 6.5 (1\%) \\
\hline
\end{tabular}
\caption{Mean bucco-lingual dimension values (mm) of root canal system types. (n=100).}
\end{table}

Figure 1. A. Occlusal view of the Vertucci’s canal configurations. B. Diagrammatic representation of Vertucci’s canal configurations used in the present study.
of endodontics is also one of the reasons for endodontic failure. As pointed out in the related literature, the use of good illumination and magnification may allow for better viewing of root canal orifices as well as canal preparations.\(^\text{19}\) There are different methods for studying the morphology of human permanent teeth. These include the use of radiographic examination, root sectioning, staining and clearing techniques. The present study utilized digital radiographic examination technique in order to obtain quantitative results. This technique includes placing the files in the canals to determine the canal configuration. This method has a distinct advantage over the conventional radiographs in terms of the visualization of the file-tip. It was shown that particularly when using the smaller size files\(^\text{19}\), the file tip visualization was more exact with digital system. Digital radiographic examination can also enhance the contrast and brightness of the image resulted in better quality.

The identification of the internal root canal morphology as precise as possible is the primary step in the root canal treatment. The observation of dimensions of mandibular incisors may also help to identify or to give indication of supplementary root canals. Therefore, during the clinical practice the bucco-lingual dimension of tooth crown should be considered as a preoperative determinative factor related to the root canal morphology of mandibular incisors. In cases with an increased bucco-lingual dimension, a smaller degree of the presence of a second canal may be foreseen in clinical practice. In conclusion, it is essential that clinicians should be aware of the clinical and radiographic signs that suggest the presence of extra canals. Moreover, bucco-lingual dimensions of mandibular incisors should be taken into consideration before root canal treatment.

REFERENCES