Endodontic configuration of the lower incisors in a Romanian population: a radiological study

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Abstract
The significant rate of failure of endodontic treatment to lower incisors was attributed to poor knowledge of their endodontic morphology. As emphasized by Tinelli ME et al. (2011), the morphology of the endodontic system is strongly related to ethnicity, making possible the existence of important anatomical variations at different population groups. The present study analyzes, using radiological means, the endodontic anatomy of lower incisors extracted from a Romanian population. Five hundred seventy-five lower central and lateral incisors were radiographed and Weine’s classification was used to evaluate their endodontic morphology. After processing the data, it was concluded that 81% of the studied teeth have one canal and the remaining 19% have two canals. In terms of endodontic configuration, 81% of 575 studied teeth are Weine Type I, 17% Type II, 1% Type III and 1% Type IV. Results obtained in this study are within existing international endodontic literature. Type II and IV configurations have a high degree of treatment difficulty. This requires thorough clinical and radiological examination of several incidents, possibly cone beam computed tomography (CBCT) and individualized therapeutic means to ensure treatment success. This study is the first of this magnitude in the Romanian specialty literature.

Keywords: morphology, lower incisors, endodontic configuration.

Introduction
The significant rate of failure of lower incisors’ endodontic treatment was attributed to insufficient knowledge of their endodontic morphology. This was the assertion leading to this study. The first such research was conducted by Rankine-Wilson RW and Henry P [2], after the existence of a second root canal on the lower incisors was brought into question and received with reluctance by the dental world. Another paper was later published, confirming previous results and highlighting the high anatomical variability of these teeth. This often makes the endodontic therapy of lower incisors difficult, Weine FS considering that these teeth, by the degree of treatment difficulty, may be located immediately after molars and mandibular first premolars with more than one canal [3].

In this study, we used radiological means to analyze the endodontic system of extracted lower incisors coming from a Romanian population. Its aim is to observe the frequency of different endodontic configurations, in order to provide a comprehensive statistical image of lower incisors’ endodontic morphology to dental clinicians treating the local population.

Materials and Methods
This is a radiological in vitro study, in which 575 lower central and lateral incisors were radioographed. The extracted teeth originated from Romanian private dental clinics. Name, age and sex of the patients, and also the extraction reasons were not recorded. No difference was made between central and lateral incisors.

Tooth selection criteria for this study were the following:
• Lower incisor with enough coronal substance to ensure it is such a tooth;
• Intact root;
• Unmodified endodontic configuration.

In this study, we used the Weine’s classification for endodontic configurations [3]:
• Type I: one canal, one apical foramen;
• Type II: two canals, one apical foramen;
• Type III: two different canals, two different apical foramina;
• Type IV: one canal that divides two apical foramina.

Radiographs were taken using an X-Mind™ device from SATELEC; the sensor was scanned using a Digora® scanner and the Digora® for Windows software. The teeth were placed on the sensor on a proximal side, no matter which, to ensure exposure of proximal incidence. This incidence is optimal to capture cases where there are two canals, one buccal and the other lingual, as well as their direction. Given the lower incisors mesio-distal flattened morphology, there was no problem keeping them on the sensor. Radiological conditions were the same for all the teeth. The studied teeth had one or two canals and endodontic configurations Weine Type I, II, III, and IV. To analyze the data, we centralized them in a table created
in Microsoft Excel. We also investigated the possible existing correlations between crown and root bucco-lingual maximum diameter and the number of root canals that could be found.

Results

Of the 575 lower incisors examined by this research, 464 or 81% had one canal and 111, respectively 19%, had two canals (Table 1, Figure 1).

![Figure 1 – Percentage of canals in this study.](image1)

<table>
<thead>
<tr>
<th>Study results</th>
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<tbody>
<tr>
<td>No. of canals</td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Total</td>
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<tr>
<td>One canal</td>
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<tr>
<td>Type I</td>
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<tr>
<td>Type III</td>
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<tr>
<td>No. of teeth</td>
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<tr>
<td>111</td>
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<td>8</td>
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<tr>
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Figure 2 – Percentage of canals in this study according to Weine classification.

An isthmus could be radiologically identified in 32% of the lower incisors with two root canals.

Our study also revealed that the number of root canals of mandibular incisors is in direct correlation with their bucco-lingual dimension of both crowns and roots. The figures are slightly different when compared with similar studies [4], but are pointing in the same direction. Two distinct canals were only found at the incisors having the bucco-lingual dimension of at least 6.5 mm and one canal at those with at most 5.9 mm. This observation may lead to a clinical guidance concerning the number of root canals that one can expect to find when lower incisors have to be endodontically approached.

Discussion

Over time, numerous studies investigating lower incisors endodontic anatomy have been published (Table 2).

![Figure 2](image2)

A variety of techniques had been used to study the root canal morphology of these teeth, such as sectioning [12], decalcification and coloring [7], or radiological examination [15]. As per Nallapati S, the present day in vitro methods used to study the root canal anatomy include: direct observation, microscopic observation, macroscopic sectioning, microscopic sectioning, dyes, filling and decalcification, filling and clearing, radiography, contrasting media and cone beam tomography [16]. We opted for the radiological study, because we could not find in the Romanian endodontic literature a similar research of endodontic morphology of lower incisors ever being conducted and the method had successfully been used in many studies of reference.

The specialty literature shows that 11.5–56% of mandibular incisors have two canals (Table 2). The lowest value, 11.5% of cases with two canals, is present in Madeira MC and Hetem S study in 1973 [5]. Ezoddini F
et al. (2006) showed a frequency of 55.9% configurations with two canals on Iranian population studies [13], one of the highest published to date. In the classical research led by Rankine-Wilson RW and Henry P, the lower incisors had two canals in 40% of cases, with different configurations [2]. Our study showed a second canal in lower incisors in 19% of cases.

In terms of number of canals, the closest value to our study was obtained by de Oliveira SH et al., in 2009 [15], in a similar radiological in vitro study on 200 lower incisors from a Brazilian population – which represents 20% of cases with two canals [7].

When existing, the second canal is very hard to be seen on regular radiographs or even during endodontic treatment and may be in some cases identified only on extracted, decalcified and cleared teeth [17]. An isthmus interconnecting these two canals may be present, at up to 55% of the lower incisors having two root canals [18].

Besides the number of root canals, their endodontic configuration plays a crucial clinical role in lower incisors therapy. By endodontic configuration, we not only mean the direction, fusion and/or bifurcation of root canals, but also the number of apical foramina; correctly sealing them leads to success of the endodontic treatment.

In our study, most of the lower incisors, respectively 98%, present one apical foramen, the remaining 2% present two foramina. Teeth with one apical foramen had endodontic systems Weine Type I (81% of total, respectively 464 teeth) and Weine Type II (17% of all studied incisors, respectively 95 teeth) and of those with two apical foramina, eight teeth fit Weine Type III (1% of total) and eight teeth Type IV (1% of total).

Results somewhat similar to these were discovered by Madeira MC and Hetem S [5] and Vertucci FJ [7], noting that Type IV configurations were not found in any of these studies. It should also be noted that the percentage of Type III configurations found by us, standing at 1%, is close to that of other studies in endodontic literature, such as those carried out by Madeira MC and Hetem S [5], Benjamin KA and Dowson J [6], Vertucci FJ [7], Gencoglu N [11], Uma Ch et al. [12], incisors with two separate foramina being relatively rare. The present study showed Weine Type IV configurations – one root canal which bifurcates and opens on root surface through two different apical foramina – on lower incisors in 1% of cases, fact not mentioned than by Al-Qudah AA and Awawdeh LA [14], who in his 2006 research on Jordanian population found 3.6% of studied lower incisors with this configuration. The bifurcation on canals studied by us occurs in medium or apical third. These are among the most complicated endodontic cases, taking into account the very small size of the canals, the place where bifurcation occurs and the difficulty of their instrumentation. The most hard to clean and shape is in these circumstances the lingual canal. As specified in other studies [15], the inappropriate approach of this canal or completely missing it inevitably leads to failure of the entire root canal treatment for that incisor.

The different results concerning the investigation of the endodontic morphology of lower incisors these studies are showing may be due to the variability existing between different populational groups.

It can be concluded that the results obtained through this study are within the existing literature findings.

From the clinical point of view, the cleaning, shaping and obturation of Weine Type I and III endodontic systems is relatively easy, because each canal of these configurations is independent and distinct from the emergence orifice to the apical foramen (Figures 3 and 5). Shaping and obturation of Weine configurations Type II canals (Figure 4) do not pose so many problems, because each root canal has its own emergence orifice from the pulp chamber floor, allowing visualization and facilitating access.

![Figure 3 – Weine Type I.](image3)

![Figure 4 – Weine Type II.](image4)

![Figure 5 – Weine Type III.](image5)

Instead, negotiation and filling of Weine Type IV configurations and of those teeth with one canal which divides and the two emerging canals fusion and open through one apical foramen, presents a high degree of difficulty, because the canals have common areas and bifurcations. In these cases, the canal after bifurcation, which is a continuation of the main canal, is more accessible and we manage to shape it quite easily, while
the other canal proves to be extremely difficult. To be successful, therapy in these cases must be individualized.

Although most of lower incisors have one apical foramen, the presumption that by obturating one canal the foramen would be sealed is not always right and we do not recommend such a therapeutic attitude. Residual pulp on the other canal will turn into necrosis and release compounds that can reach through lateral canals in the marginal periodontium [10, 14]. Vertucci FJ considers the presence of lateral canals to be 20% for the lower central incisor and 18% for the lateral lower incisor [8]. Additionally, canals usually merge very close to the apex and if the root canal is underobturated, for example up to the fusion point, the second canal will communicate with the periapical tissues, and thus, compromising the endodontic treatment.

Conclusions

Variations in endodontic system morphology in lower incisors in the Romanian population are quite significant. Not considering this opens the way towards treatment failures. Our study showed that 19% of lower incisors coming from this population, or in other words almost one out of five teeth, had two canals. In these cases, most had single apical foramina, but sometimes two apical foramina were found, including the rare situation when a canal divided apically and opened through two different apical foramina. When endodontically approaching lower incisors, thorough clinical and multi-incidence radiological and even CBCT examinations are required in order to maximize chances to provide a successful customized endodontic treatment.

References


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