The position of the mesial root canal orifices in mandibular first molars and its relationship with the canal pattern using an operating microscope

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Introduction

A thorough knowledge of root and root canal morphology, and anticipation of their anatomical variations are important issues in successful root canal treatment. The operating microscope aids in this process by providing increased visualisation and lighting, and allowing better root canal orifice and isthmus detection. However, treated areas, such as radicular configurations in many teeth, cannot be viewed sufficiently even under high magnification. Accordingly, the clinician needs clues or information provided by the pulp chamber floor to determine the anatomy of each tooth.

The mesial root of the mandibular first molar poses a significant challenge: 90% of these teeth have two canals with curvatures that make it even more difficult to view their anatomy. The mesiobuccal (MB) and mesiolingual (ML) canals may have independent or confluent radicular patterns. According to Vertucci’s classification, the most common configurations are type IV (two separate canals all the way to the apex) and type II (two canals that join in the apical third).

Further information on the morphology of the root canals and pulp chamber floor has been provided, with particular reference to the anatomical relationships. This includes those between the occlusal surface and pulp chamber; the variations in colour, junctions, angles, developmental root fusion lines on the pulp chamber floor and canal orifice position; and between the degree of pri-
mary and secondary curvature, the number of root canals, the interorificial distance and root canal configuration. However, to date, no classification has been proposed as a clinical guide regarding canal orifice positions on the pulp chamber floor relative to canal patterns.

Thus, the purpose of this study was to determine and classify the positions of the orifices of the MB and ML canals and investigate their relationship with an independent or confluent radicular pattern in mandibular first molars, by using an operating microscope.

**Material and Methods**

The study examined 110 randomly selected, extracted mandibular first molars with complete root formation and no root canal therapy, obtained from patients of Caucasian origin. All subjects enrolled in this research provided written informed consent, which was approved by the Ethics Committee of the University of Santiago de Compostela, Spain and conformed to the 1995 Declaration of Helsinki (as revised in Tokyo 2004).

The teeth were stored individually in 10% sterile saline. The crowns were sectioned in a mesial-distal direction at the level of the cementoenamel junction (ISOMET 4000; Buehler, Illinois, USA). The teeth were soaked in 5.25% sodium hypochlorite for 30 min, washed under running water, immersed in 17% ethylenediaminetetraacetic acid for 10 min, and washed again. Specimens were stained with methylene blue and dried with pressurised air. An operating microscope (M820 F19; Leica, Wetzlar, Germany) and a digital camera (HDR-CX550VE; Sony, Tokyo, Japan) were used to obtain images of the pulp chamber floor (×10 magnification) and mesial root apex (×25 magnification). Teeth with only one or more than two mesial root canal orifices were discarded. The mesial root canal orifice positions were determined by drawing a distal-mesial line (A) from the centre of the distal root canal orifice across the centre of the pulp chamber floor and equidistant from the MB and ML canal orifices (if two distal orifices were observed, line (A) was drawn equidistant from each one). A second line (B) was drawn joining the MB and ML canal orifices from the centre of each. A symmetric position was determined when the angle between the lines was 90 degrees to a maximum of 100 degrees (Fig 1) and an asymmetric position when it was more than 100 degrees (Fig 2). The interorificial distance was determined from the inner edge of each mesial root canal ori-
The TpsDig2 imaging software (F. James Rohlf, Department of Ecology & Evolution, Stony Brook University, New York, USA) was used for the measurements. Independent or confluent canals were identified by resecting the teeth perpendicular to the long axis, 1 mm from the mesial root apex to the coronal third. Each cut section was then stained and photographed. Using G-Stat statistical software (G-Stat, Letón and Mariño, Department of Biométrics, GlaxoSmithKline, Madrid, Spain), Student’s t and chi-square tests were performed.

### Results

There were 61 (55.5%) mesial roots with an independent pattern and 49 (44.5%) with a confluent radicular pattern. Table 1 provides the interorifice distances of the mesial root of mandibular first molars and the statistically significant differences amongst canal patterns. Three configurations of the mesial canal orifice positions, relative to the pulp chamber floor, were observed. Their characteristics and relationships with the root canal pattern are shown in Fig 3. Statistical analysis of the independent and confluent radicular patterns revealed a significant difference among the configurations (types I, II, and III; \(P < 0.0001\)).

**Table 1** Interorifice distance of the symmetric mesial root canals of mandibular first molars (type I and type II).

<table>
<thead>
<tr>
<th></th>
<th>Distance (mm)</th>
<th>(P)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Minimum</td>
</tr>
<tr>
<td>Confluent Pattern</td>
<td>46</td>
<td>1.15</td>
</tr>
<tr>
<td>Independent Pattern</td>
<td>47</td>
<td>1.34</td>
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### Discussion

Several techniques can be used to ascertain whether root canals are confluent or independent. One method involves placing a gutta-percha point in the buccal or lingual canal and inserting a root canal instrument into the other canal up to the working length. A mark on the gutta-percha after removal...
indicates that the canals are confluent. This method is possible only at the time of canal obturation, because it requires previous mechanical preparation to create space. However, this information is of clinical importance to prevent problems before mechanical preparation: for example, confluent canals have a double curvature in the region of confluence and may have an abrupt curvature. These factors increase the risk of fracture of nickel-titanium rotary instruments.

One method of determining root canal configuration beforehand is based on the insertion of a size 8 or 10 endodontic file up to the working length and by taking two or three radiographs at different angles. Although helpful, this method is limited because it provides a two-dimensional image of three-dimensional features. Additionally, the thinness of the file can cause uncertainty. Compared with the tooth-clearing technique, which is the gold standard for determining root canal anatomy, conventional radiographs do not provide precise information. New imaging technologies such as cone-beam computed tomography are more superior, although this technique is far from routine in most endodontic practices.

Three configurations were obtained on the pulp chamber floor. The classifications (type I, II, and III) were determined by taking into consideration the distances, positions, percentage of samples, and relationship of radicular patterns, in order to visually simplify the large number of measures and reach a more comprehensive understanding of this anatomical issue (Fig 3).

Krasner and Rankow proposed the “law of symmetry”, which suggests that all canal orifices (except those of the maxillary molars) lie on a line perpendicular to a line drawn mesiodistally across the centre of the pulp chamber floor (types I and II in this study). However, there are also many exceptions to this rule (type III). This finding is relevant because asymmetric canal positions possess specific characteristics (mostly independent pattern), and it must be taken into account when locating mesial canal orifices on the pulp chamber floor (Fig 2).

Resecting the teeth perpendicular to the long axis 1 mm from the mesial root apex to identify canal configuration is an older and inferior methodology versus newer techniques, such as Micro Computed Tomography (micro-CT). However, if the goal is to determine only whether the canals present a point of confluence, not the complete radicular configuration, then direct visualisation is safe and appropriate.

### Conclusion

Within the limitations of this study, a significant correlation was seen between the position of the mesial root canal orifices on the pulp chamber floor and an independent or confluent radicular pattern in mandibular first molars. The most predominant appearance was interorificial distances.

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References
