Dimension, Anatomy and Morphology of the Mesiobuccal Root Canal System in Maxillary Molars

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Abstract

Introduction: To increase our understanding of the root canal system, we examined the mesiobuccal (MB) roots of maxillary first and second molars, which are considered to be one of the most complex root canal systems. **Methods:** Uninstrumented MB roots from 153 teeth were imbedded, sectioned, and observed at 8× using a stereomicroscope for main canal numbers, isthmus presence, and dimensional size of canals and dentin walls. **Results:** The number of canals observed in maxillary first and second molars was 20% and 38.1% for one canal, 79.8% and 60.3% for two canals, and 1.1% and 1.6% for three canals, respectively. The buccal canal was larger than lingual or middle canals at all levels of the root. The average distance between the two main canals was 1.2 ± 0.6 mm in first molars and 1.78 ± 0.6 mm in second molars. Isthmus tissue increased greatly at 3.6 mm from the apex, suggesting optimal root resection at this level. Little differences in thickness between mesial and distal canal walls were seen until reaching the coronal sections of the root where the average canal wall thickness was found to be thinner (33%) on the distal, suggesting a "danger zone" for maxillary molars at a level where the root joins the crown of the tooth. **Conclusions:** The observations made here provide a more precise understanding of the maxillary MB root system. Orthograde and retrograde root canal therapy might be improved with a comprehensive understanding of pulpal morphology throughout the entire MB root. *(J Endod 2010;36:985–989)*

Key Words

Canal anatomy, danger zone, isthmus

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A classic study by Hess (1) showed pulp spaces to be complex systems. Numerous studies since then have continued to help define the anatomy, morphology, and dimension of the human dentition, with the common denominator being that certain root systems are more complex than others. One such system is found in the mesiobuccal (MB) root of maxillary molars (2–4).

Once entered, the MB canal space can vary from a simple, single canal to multiple canals with anastomoses or isthmus areas woven throughout the length of the root. These complexities make it difficult to achieve the endodontic treatment goals of thorough cleaning, shaping, and subsequent three-dimensional obturation of the entire canal system (5, 6). A solid understanding of the dimension of the anatomy and morphology of the tissues treated is fundamental (2, 4, 7, 8). Although tooth anatomy and morphology have been previously investigated rather thoroughly, no study was found to have completely measured the mesial to distal position of the MB canal system with respect to the root thickness.

A number of studies that focused on the MB roots of maxillary molars have been previously completed using pulp casting, dyes with tooth clearing or grinding, radiographs, and microscopes (4, 9–14). A ramification of the pulp tissue that has become a contemporary topic is the isthmus. Currently, the isthmus (anastomosis) is defined as a pulpal passageway connecting two or more canals in the same root (15). The reported incidence of isthmus in the mesiobuccal root of maxillary molars is variable, from 4.9% to 52% (8, 16). When a partial isthmus is included, the incidence is 100% in roots with multiple canals at certain distances from the apex in the MB root of maxillary molars (17, 18). Although not discussed directly, the emphasis on thorough cleaning and shaping of the entire pulp space implies the importance of including the isthmus areas during endodontic therapy (5, 6).

The purpose of this study was to develop a dimensional understanding of the MB root canal system in maxillary first and second molars, to document the number and location of main canals in each root, and to classify the pulpal space according to location and isthmus. The observations made here will provide a more precise understanding of the MB root system.

Methods and Materials

One hundred fifty-three teeth were selected (90 maxillary first molars and 63 maxillary second molars). Extracted teeth from dental patients in Minneapolis, MN, were collected and stored in water with Thymol (Fisher Scientific, Fair Lawn, NJ). Only those teeth with a free MB root system were used (ie, no teeth with webbed or fused root systems were used.

Distobuccal and palatal roots along with corresponding portions of the crown were removed using a diamond disc. Specimens were embedded in acrylic resin using a 4.5-mL clear plastic spectrometer cuvette (Fisher Scientific, Springfield, NJ). A digital caliper was used to measure from this cut to the base of the cuvette and, subsequently, to the cut surface after each cut was made.

Slabs were cut using a 5-in diameter, 0.4-mm-thick diamond disc (Star Diamond Industries, Carson, CA) mounted on a "L'il Trimmer" lapidary saw (Lapcraft, Powell, OH). A jig was made and functioned as an end stop to facilitate consistency of slabs approximately 1-mm thick. Each slab was appropriately labeled on the apical end in the same area before being cut free from the cuvette to facilitate consistent orientation when viewed under the microscope.

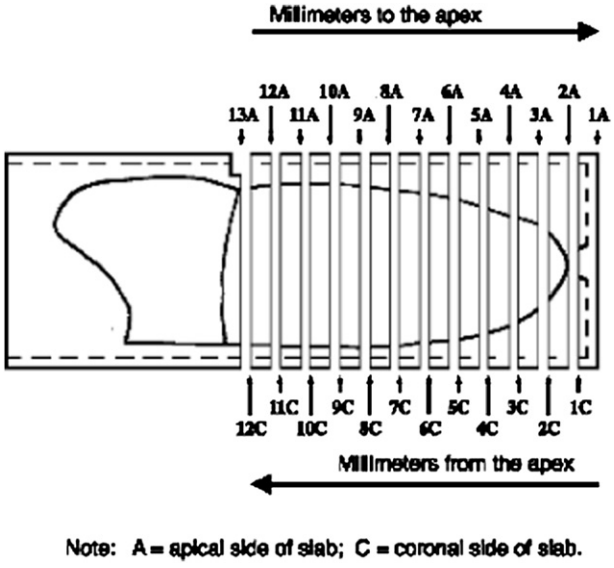


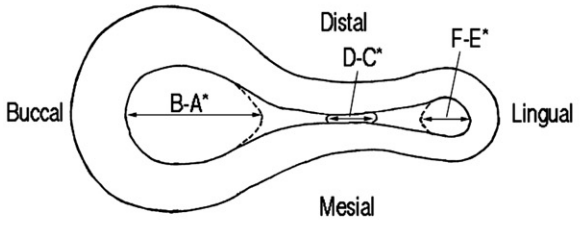
Figure 1. Sectioning of the MB root of a maxillary molar.

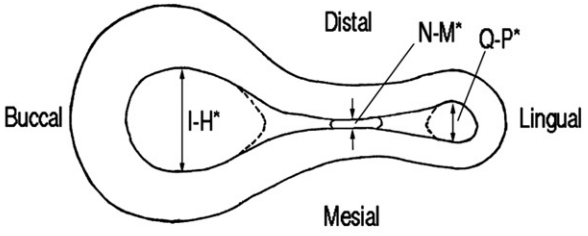
Each side of a slab was designated as a section, and each section was identified by the numeric order in which it was cut free from the cuvette and by whether the surface of the section was in the apical or coronal position (Fig. 1). The reference for measurement was a notch on the side of the cuvette over the CEJ, and the distance of each section (ie, the A and C distance from the apex) was determined.

Before viewing with the microscope, slabs were stained with "To Dye For" (Roydent Dental Products, Rochester Hills, MI). Both sides of each slab, section A and section C, were observed at 8× using a dissecting stereomicroscope fitted with a 100-unit eyepiece reticule (Carl Zeiss Jenna, Germany). At an 8× setting, 100 reticule units measured 6.3 mm. Therefore, one reticle unit equals 0.063 mm. Canal types and numbers were recorded for each specimen. Main canals were designated as canals that had a minimal dimension of 1.5 reticle units and that followed the long axis of the root from the chamber to the apical foramen.

Each section of each specimen was designated with an isthmus classification. The isthmus types observed are defined as follows:

1. Type I: one, two, or three round, slightly oblong, or ovoid main canals but no tear drop shape and no sign of pulp ramifications between the canals.
2. Type II: two main well-rounded canals. The dentinal walls in the thin portion of the root appeared to have been squeezed together to the point of approximation but not fusion. This condition is also called an incomplete or partial isthmus.
3. Type III: similar to type II except that a third canal existed or appeared to be entrapped in the thin area of the root.





Section	Distance from apex	1st Molars B-A	D-C	F-E	I-H	N-M	Q-P	2nd Molars B-A	D-C	F-E	I-H	N-M	Q-P
2A	0.64 mm	0.29	0.26	0.35	0.29	0.17	0.20	0.35	0.17	0.21	0.28	0.22	0.20
2C	1.62 mm	0.39	0.30	0.27	0.29	0.17	0.19	0.46	0.25	0.33	0.31	0.11	0.17
3A	2.15 mm	0.39	0.26	0.37	0.28	0.13	0.20	0.48	0.18	0.38	0.32	0.13	0.18
3C	3.12 mm	0.47	0.35	0.37	0.30	0.14	0.15	0.47	0.33	0.32	0.32	0.15	0.16
4A	3.64 mm	0.48	0.28	0.41	0.29	0.14	0.16	0.52	0.16	0.37	0.36	0.16	0.18
4C	4.58 mm	0.50	0.28	0.45	0.32	0.15	0.15	0.59	0.14	0.42	0.35	0.13	0.17
5A	5.10 mm	0.54	0.20	0.50	0.33	0.15	0.15	0.65	0.27	0.44	0.36	0.15	0.18
5C	6.10 mm	0.56	0.43	0.57	0.36	0.15	0.16	0.62	0.29	0.46	0.36	0.14	0.17
6A	6.61 mm	0.61	0.46	0.68	0.37	0.15	0.17	0.68	0.44	0.48	0.38	0.14	0.18
6C	7.59 mm	0.68	0.26	0.75	0.40	0.16	0.17	0.68	0.25	0.37	0.41	0.15	0.18
7A	8.09 mm	0.70	0.26	0.79	0.42	0.16	0.15	0.74	0.35	0.35	0.41	0.15	0.17
7C	9.07 mm	0.84	0.37	0.72	0.48	0.15	0.19	0.72	0.42	0.54	0.46	0.16	0.18
8A	9.57 mm	0.84	0.29	0.72	0.50	0.16	0.19	0.83	0.24	0.57	0.46	0.15	0.17
8C	10.57 mm	1.11	0.26	0.73	0.66	0.21	0.23	0.70	0.30	0.36	0.53	0.14	0.18
9A	11.05 mm	1.03	0.46	0.61	0.70	0.20	0.19	0.78	0.25	0.43	0.54	0.21	0.19
9C	12.04 mm	1.14	0.21	0.69	0.81	0.21	0.24	0.95	0.19	0.35	0.62	0.24	0.23

Figure 2. Pulp canal dimensions throughout the MB root (mm). Buccal to lingual (B-A for MB; F-E for ML; D-C for middle canal) and mesial to distal (i-H for MB; Q-P for ML; N-M for middle canal) dimensions of canals were measured in each section. Mesial to distal pulp dimensions are more restricted compared to buccal to lingual dimensions. The buccal canal increased in size from apex to coronal sections, while the dimensions of the lingual and middle canal changed very little from apex to the coronal area.