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Thickness of Cementum/Dentin in Mesial Roots of Mandibular First Molars

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The mesial roots of 15 human first lower molars, along with the corresponding half of the tooth crown, were studied to determine the thickness of dentin-cementum. A device was developed whereby these could be embedded in resin with a precisely known orientation in space. The roots were radiographed in mesiodistal and vestibular-lingual projections, then sectioned perpendicular to the canal axis in the coronal third. Thickness of dentin-cementum was compared on sections and radiograms; results showed that the amount of hard tissue is effectively about one fifth less than that appearing on the radiogram.

At present, flared root canal preparations are thought to be the most suitable, in that they permit more effective cleaning of the canal system and at the same time facilitate complete obturation (1, 2).

In mandibular molars, the flared preparation may result in strip perforations if great care is not taken in the preparation of the "danger zone" in the mesial canals (3). The danger zone has been described as 4 to 6 mm below the canal chamber orifice (4).

The aim of this research was to obtain precise measurements of the thickness of dentin and cementum available for instrumentation in the mesial roots of mandibular molars and to correlate these measurements to corresponding radiographs.

MATERIALS AND METHODS

Fifteen human lower first permanent molars were chosen for this study. The mean length of the teeth in the sample was 22.1 mm (range, 18 to 23 mm), with a mean length from bifurcation to apex of 9.5 mm. Mean root curvature was 20 degrees (range, 15 to 30 degrees). The degree of curvature of the root was determined by Schneider's technique (5).

The teeth were conserved in a 10% solution of formalin. Residues of calculus and alveolar bone were removed ultrasonically; the teeth were immersed in 5% sodium hypochlorite to eliminate remaining organic residues. A standard access cavity was made. The two roots were separated through the bifurcation. The sample studied consisted of the mesial root in combination with the corresponding tooth crown.

The study analyzed the coronal third of the mesial root of the lower first molar; the reference axis used was the mean axis of this part of the canal.

The roots were embedded in resin blocks. A positioning device was used to orient the root correctly (Fig. 1) through successive radiograms from the buccal and the proximal. Using a radiographic device (Fig. 2), the reference axis was placed perfectly parallel to the long axis of a bushing used to transfer the positioned root to the embedding system (Figs. 3 and 4). The roots were then embedded in rectangular resin blocks with the reference axis perfectly parallel to the long axis of the block.

Sections were cut with the Tronconeuse P 100 machine (Pressi, Grenoble, France) equipped with a diamond disc (101 mm in diameter, 0.31-mm thickness). The resin block was

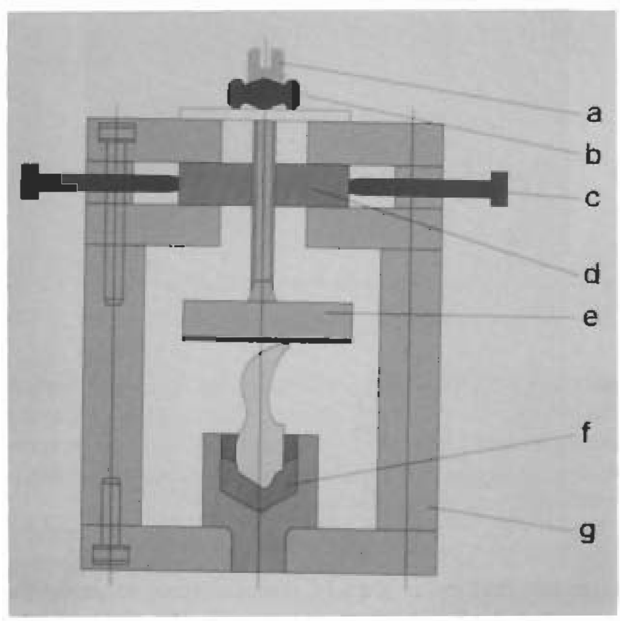

FIG 1. Positioning device. *a*, threaded pin; *b*, fixing nut; *c*, threaded pins to regulate the piston *e*; *d*, mobile plate which can be displaced transversely; *e*, piston; *f*, bushing; and *g*, spacing bars for mounting the positioner and fixing the X-ray films.

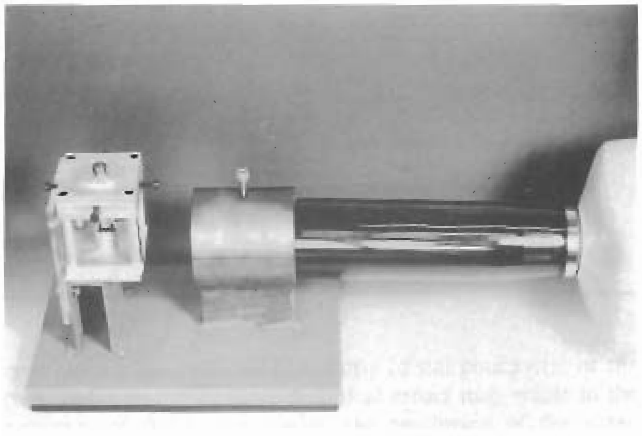

FIG 2. Correct positioning of the radiographic device.

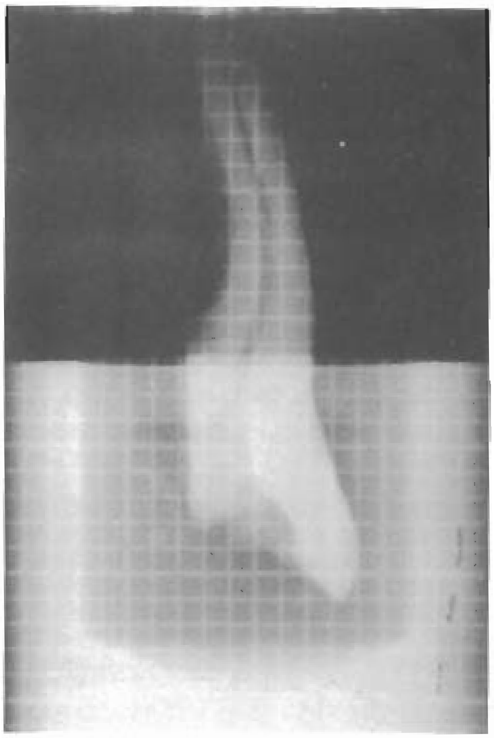

FIG 3. Vestibular-lingual radiogram.

fixed to the arm of the saw, with the long axis of the rectangular block perpendicular to the cutting disc. The first cut was made immediately below the bifurcation. A micrometer screw was turned to obtain six successive sections perpendicular to the reference axis as indicated in (Fig. 5).

The 90 sections were photographed under the stereomicroscope, as was a precision millimeter rule to enable successive conversion into millimeters of measurements made by the computer in pixel. Enlargement was ×12. The camera factor was ×0.25 (Stereomicroscope SR with photographic system MC63A; Carl Zeiss, Oberkochen, Germany).

The slides of the sections and that of the precision millimeter rule, and the corresponding radiographs in the vestibular projection, were photographed with a Fotovix telecamera

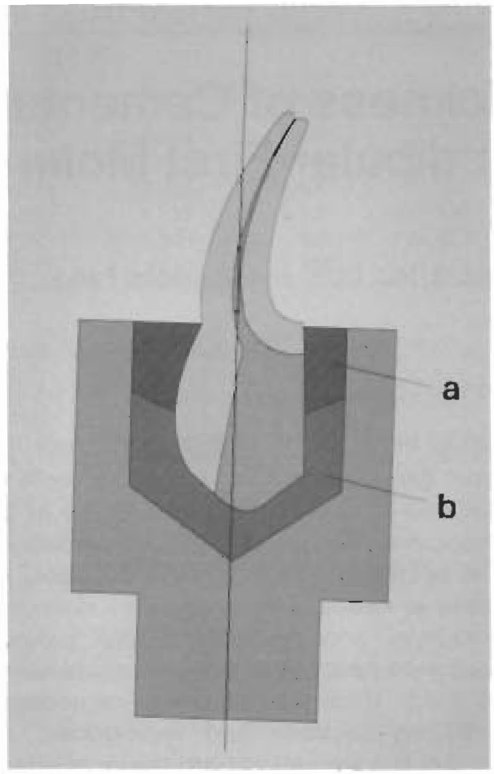

FIG 4. Tooth in position in bushing. *a*, sticky wax and *b*, inert wax.

(640 × 516 resolution and six tonalities of gray) (Tamron Co. Ltd., Tokyo, Japan). The images obtained were transferred directly into a personal computer (Commodore Amiga 500, coupled with a Newtek Videon II digitalizer) and elaborated using the Deluxe Paint III program (Electronic Arts, San Mateo, CA).

For each section, the following measurements were made (Fig. 6): A: maximum distance between the tangent to the canals (distal side) and the parallel tangent at the most distal point of the section; B1: minimum distance between the mesiovestibular canal and the distal side of the section; and B2: minimum distance between the mesiolingual canal and the corresponding distal side of the section. The distance between the distal wall of the canal and the distal surface of the root (C) was measured on the radiograms, in correspondence with the sections cut through the roots (Fig. 7).

RESULTS

Measurements on the computerized video images of the sections and of the radiographs in vestibular-lingual projection were made in pixels. A conversion factor calculated on the video image of the precision millimeter rule, previously photographed under the stereomicroscope, was used to convert them into millimeters: 1 pixel = 0.01282 mm for the sections and 1 pixel = 0.03846 mm for the radiograms.

The distances A-B1-B2 (Fig. 6) and C (Fig. 7) are given in 10^{-1} mm. Data were elaborated as follows: (a) mean values of A, B1, B2, and C for each section and (b) median values of A, B1, B2, and C for each section.

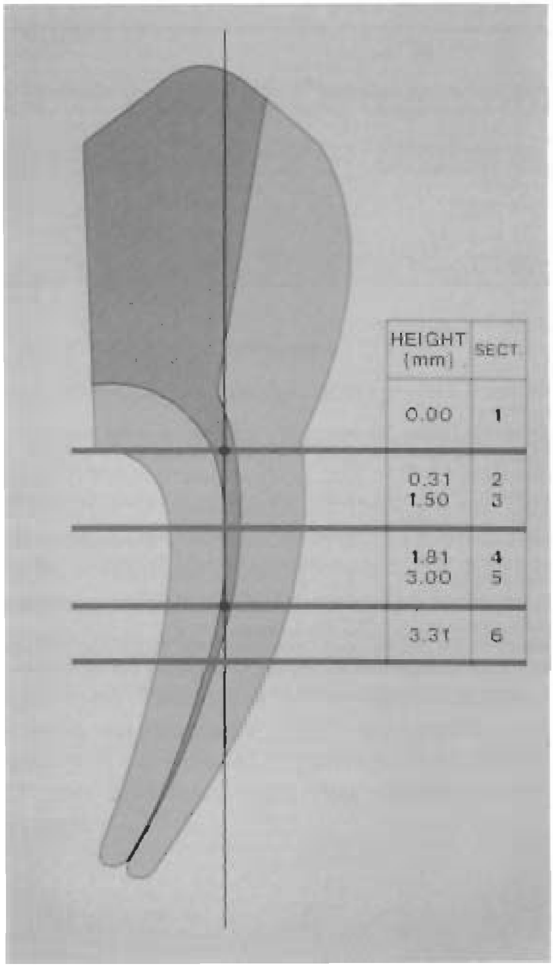

FIG 5. Diagram of cuts of the root embedded in the resin block.

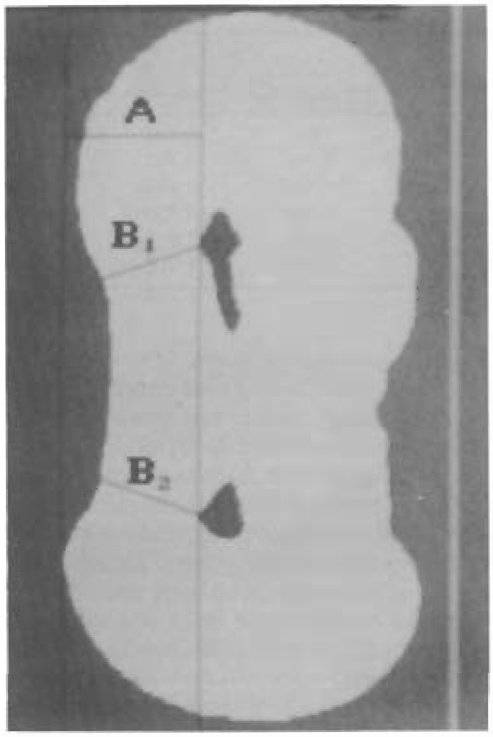

FIG 6. Video images of the distances measured on the sections.

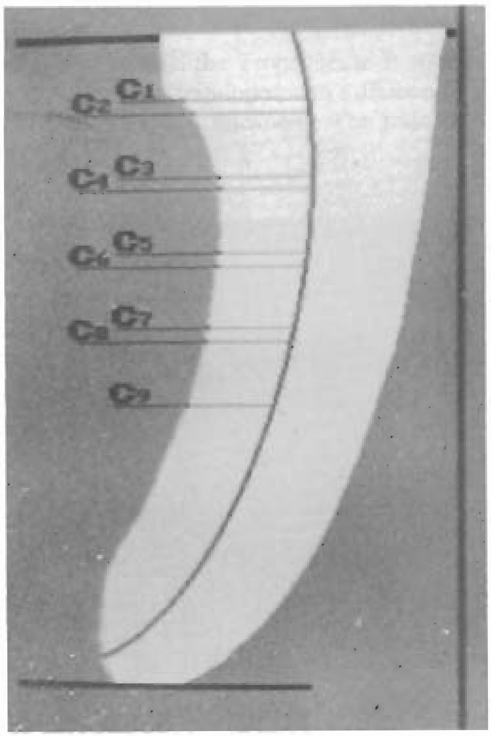

FIG 7. Video images of the distances measured on a radiogram of a root in the vestibular lingual projection.

Table 1 gives the mean and median values. The median values are less influenced by an asymmetrical distribution of data and provide data more closely corresponding to reality.

DISCUSSION

This study confirmed that the distal surface of the mesial root of the first permanent mandibular molar is concave. The figure eight shape of the root explains the fact that measurement A is significantly greater than either B1 or B2 for all sections (Table 1). From the clinical point of view, during instrumentation, the thickness of dentin and cementum available to the dentist in the direction of the distal surface of the root is less than is usually thought.

At 1.5 mm below bifurcation (section 3) the real thickness of dentin is the least (1.2 to 1.3 mm); thus, this is the zone of greatest risk. Even differences of tenths or hundredths of a millimeter can be critical in avoiding stripping to this part of the canal. The mesiovestibular canal is closer to the distal surface of the root. In our opinion the mesiolingual canal should be instrumented before the mesiovestibular canal, considering that in 30.77% of cases, the two canals join into a common apical part (6). The mesiovestibular canal will thus have its apex at the level of confluence with the mesiolingual canal, and will thus be shorter inside the root and so less instrumented.

The correlation between the anatomical survey and the corresponding radiographic analysis showed a minimal difference between A and C. This difference is due to technical

TABLE 1. Mean and median of measurements A, B1, B2, and C

Section	A		B1		B2		C	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1	1.841	1.782	1.419	1.372	1.449	1.449	1.774	1.769
2	1.813	1.782	1.358	1.295	1.390	1.346	1.684	1.692
3	1.754	1.769	1.241	1.192	1.291	1.256	1.495	1.539
4	1.741	1.731	1.247	1.282	1.262	1.333	1.469	1.538
5	1.700	1.628	1.221	1.307	1.243	1.346	1.395	1.423
6	1.661	1.705	1.210	1.384	1.227	1.410	1.366	1.423

errors or to the particular anatomy (distal concavity) of the root under study. Possible technical errors may relate to the accuracy of the image reader, the resolution of the video system, or the use of standard X-ray films which give poor resolution of outlines. It should, however, be remembered that differences between A and C are not clinically relevant.

From the clinical standpoint, the study shows that there is a big discrepancy between the apparent and the real thickness of dentin. In radiographic evaluations, pre- and intraoperatively, it is wise to reduce the measurements given by the radiograms by about one fifth, as can be seen from the analysis of the median values.

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