Residual dentin thickness in mesial roots of mandibular molars prepared with Lightspeed rotary instruments and Gates-Glidden reamers

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Objective. We sought to measure the residual dentin thickness (RDT) in the mesial roots of mandibular molars after instrumentation with Lightspeed and Gates-Glidden rotary instruments.

Study design. Thirty extracted, untreated human mesial roots of mandibular molars were separated from the distal roots and embedded in clear polyester resin. The roots were cut horizontally at 1, 4, and 7 mm short of the anatomic apex. The diameter of each mesiobuccal canal was measured by using a stereo measuring microscope at each level in the buccolingual and mesiodistal directions. The dentin thickness was measured in each level in the mesial, distal, buccal, and lingual directions. Sections were reassembled with a muffle. The canals were enlarged to the working length with Lightspeed rotary instruments, of which the average size used was a No. 50 file. The coronal third was flared with No. 2 Gates-Glidden reamers. Slices were separated again, and the RDT and canal diameters were measured.

Results. The minimal measured RDT after instrumentation at the 1-, 4-, and 7-mm levels was 0.70 ± 0.28 mm, 1.04 ± 0.18 mm, and 1.09 ± 0.19 mm, respectively. The average diameter of the canals after instrumentation at the 1-, 4-, and 7-mm levels was 0.50 ± 0.04 mm, 0.52 ± 0.05 mm, and 0.74 ± 0.08 mm, respectively. The canal diameter did not exceed one third of the root diameter at all levels.

Conclusions. Root canal preparation of mandibular mesial roots with Lightspeed instruments to No. 50 in the apical third and Gates-Glidden reamers to No. 2 in the coronal third does not significantly decrease the RDT.

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Bacteria are the main reason for the failure of root canal treatment.[1] Periradicular inflammation of endodontic origins is best treated and prevented by mechanically removing the bacteria and necrotic tissues with endodontic instruments and irrigation.[2] Intracanal medicaments are additives to the mechanical treatment in inaccessible regions of the root canal system, such as dentinal tubules, the apical delta, accessory canals, and isthmuses.[3]

The average wide diameter in the apical 1 to 2 mm of the mesial canals of mandibular molars is 0.30 to 0.40 mm.[4-7] Therefore, instruments in International Standards Organization (ISO) sizes 45 to 50 should be used in a reaming motion to mechanically remove more bacteria and necrotic tissues in the apical third of these canals.[8,9] Tapered, nonflexible instruments in curved canals limit the ability of the endodontist to prepare the apical third to the proper size without excessive coronal enlargement or iatrogenic procedural errors, or both.[10]

Lightspeed nontapered rotary nickel-titanium instruments (Lightspeed Technology, Inc, San Antonio, Tex) are flexible and can negotiate the apical third with the proper ISO-sized instruments (eg, ISO sizes 45-50 in the mesial canals of mandibular molars), while remaining centered along the original canal path.[11-13] Furthermore, it is not necessary to excessively flare the coronal third, which could reduce the residual dentin thickness (RDT) to critically low values and increase the probability of vertical root fractures.[14-17] Preparation of the apical third to the proper size for bacteria and necrotic tissue removal could also reduce the RDT and weaken the teeth at this root level. This is especially important in roots with an oval cross section (eg, mesial roots of mandibular molars).[18,19] To the best of our knowledge, the RDT after canal instrumentation in the apical third has not been investigated.

The aim of the present study was to measure the RDT and intracanal diameters of mesiobuccal (MB) canals of mesial roots of mandibular molars at 1, 4, and 7 mm from the anatomic apex after instrumen-

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Table I. Residual dentin thickness before and after instrumentation (in mm)

	Before			*After*		
Level/direction	*B*	*M*	*D*	*B*	*M*	*D*
1 mm	1.41 ± 0.47	1.02 ± 0.30	0.75 ± 0.27	1.36 ± 0.46	0.87 ± 0.27	0.70 ± 0.29
4 mm	1.87 ± 0.42	1.20 ± 0.19	1.14 ± 0.17	1.79 ± 0.44	1.06 ± 0.17	1.04 ± 0.18
7 mm	1.93 ± 0.35	1.35 ± 0.21	1.21 ± 0.21	1.85 ± 0.39	1.18 ± 0.21	0.97 ± 0.19

B, Buccal; *M,* mesial; *D,* distal.

tation with Lightspeed and Gates-Glidden rotary instruments.

MATERIAL AND METHODS

For this study, 30 extracted, untreated human mandibular molars with fully formed apices and no root resorption were used. Teeth were stored in 10% buffered formalin solution. An endodontic access cavity was prepared, and the distal roots were removed. A patency No. 10 K-file was passively introduced into the MB canals until visible at the apical foramen. Radiographs of the roots were taken from the buccal and mesial aspects with E-speed film (Eastman Kodak, Rochester, NY) to determine working length and canal curvature. The angle of the curvature was measured according to the method used by Schneider,[20] by projecting the processed radiographs onto a piece of white paper and tracing the file and root outline with a permanent marker. Canals with a curvature greater than 30° were excluded.

The teeth were embedded in clear polyester resin (Fiberplast LTD, Haifa, Israel) by using small cylindrical investment molds. The tooth crown protruded to the level of the cementoenamel junction, and the roots were oriented parallel to the long axis of the mold and stabilized with blue dental wax (Hygenic, Akron, Ohio). The apical foramen was also sealed with a small piece of blue dental wax . Clear polyester resin (Fiberplast LTD) was poured around the tooth until flush with the root tip. After the resin was completely set, it was released from the mold. Three holes 0.3 mm in diameter and 120° apart were drilled parallel to the long axis of the block for placement of bolts at a later stage. A 2-mm-deep orientation groove was prepared with a low-speed round bur, ISO size 21, along the surface of the resin block facing the MB canal. The embedded roots were cut horizontally at 1, 4, and 7 mm short of the anatomic apex with a 0.30-mm-thick blade mounted on a precision saw (Isomet Plus; Buehler, Lake Bluff, Ill). Dentin thickness was measured at each level in the mesial, distal, buccal, and lingual directions by using a Toolmaker measuring microscope (Mitutoyo, Tokyo, Japan). The diameters of all MB root canals were determined at each level in the buccolingual and mesiodistal directions. Clear polyester resin disks, 0.5-mm-thick, were prepared to compensate for the length loss caused by the vibrating effect of the rotating saw during the preparation of the slices. The sections and disks were correctly reassembled according to the orientation grooves, and three 0.3-mm bolts were inserted in the predrilled holes and secured by compatible nuts.

The MB canals were then prepared by a single trained and experienced operator (O.Z.) with Lightspeed rotary instruments (Lightspeed Technology, Inc) and Gates-Glidden reamers (VDW, Munich, Germany) according to the manufacturer's instructions included with the Lightspeed rotary instruments. Coronal flaring was prepared up to 6 mm short of the working length with Gates-Glidden reamers (Nos. 1 and 2). The apical preparation to the working length was carried out with Lightspeed instruments to an average ISO size 50. Slices were separated, and the RDT and canal diameters were determined as previously described. Two evaluators (A.K., Z.F.) who were not involved with canal preparation carried out all measurements. The measurement was repeated when the discrepancy was greater than 0.05 mm. The average measurement by the 2 evaluators was calculated and recorded. The *t* test for paired samples (95% CI) was used to determine the differences in intracanal diameters before and after instrumentation at each root level.

RESULTS

The mean (±SD) RDT of the buccal canal before and after instrumentation in different directions and levels along the root is presented in Table I. The RDT of the buccal canals before and after instrumentation at the buccal, mesial, and distal directions is presented in Figure 1, *A-C*. The values of the lingual aspect of RDT of the buccal canal included the diameter of the lingual canal and isthmuses that were not instrumented and therefore were excluded from the results. No significant change was found between the RDT before and after preparation for the buccal, mesial, and distal directions ($P > .05$).

The average (±SD) diameter of the root canals before and after instrumentation is presented in Table II. The values are related to the root level and the bucco-

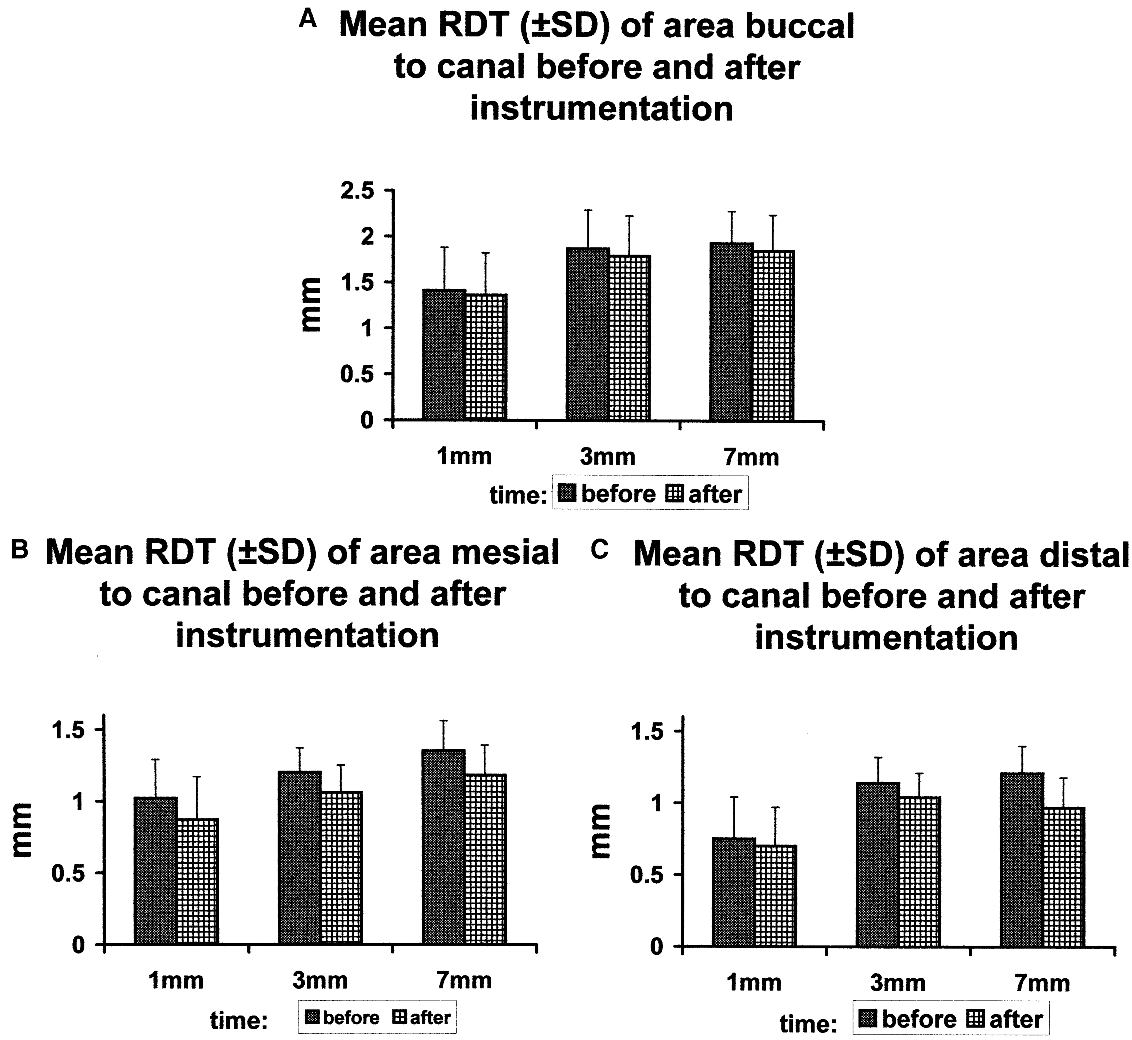

Fig 1. Three graphs showing the mean residual dentin thickness of the buccal (**A**), mesial (**B**), and distal (**C**) directions in terms of the root level before and after instrumentation.

Table II. Canal diameter before and after instrumentation (in mm)

Level/ direction	*Before*		*After*	
	BL	*MD*	*BL*	*MD*
1 mm	0.32 ± 0.07	0.28 ± 0.05	0.48 ± 0.05	0.51 ± 0.08
4 mm	0.42 ± 0.12	0.32 ± 0.08	0.52 ± 0.07	0.51 ± 0.07
7 mm	0.52 ± 0.17	0.36 ± 0.07	0.76 ± 0.07	0.72 ± 0.04

BL, Buccolingual; *MD*, mesiodistal.

lingual and mesiodistal directions. Reduction of dentin width as manifested by evaluating the change in canal diameter was significant in each direction and in all levels ($P < .01$).

Photographs of 1 representative mesial root before and after instrumentation of the MB canal are presented in Figure 2, *A* and *B*.

DISCUSSION

A simple and accurate modified Bramante muffle system was used for this study.[21,22] The frequent inaccuracy generally encountered in these horizontal-sectioning systems is related to the space created among the slices during sectioning. The compensating disks prepared in the current model overcame this shortcoming and maintained the original root length after sectioning. The amount of space lost during sectioning is related to blade thickness and amplitude of its vibration. Therefore, it is essential to carry out a preliminary evaluation of length loss before initial intracanal instrumentation. After preparing the desired num-

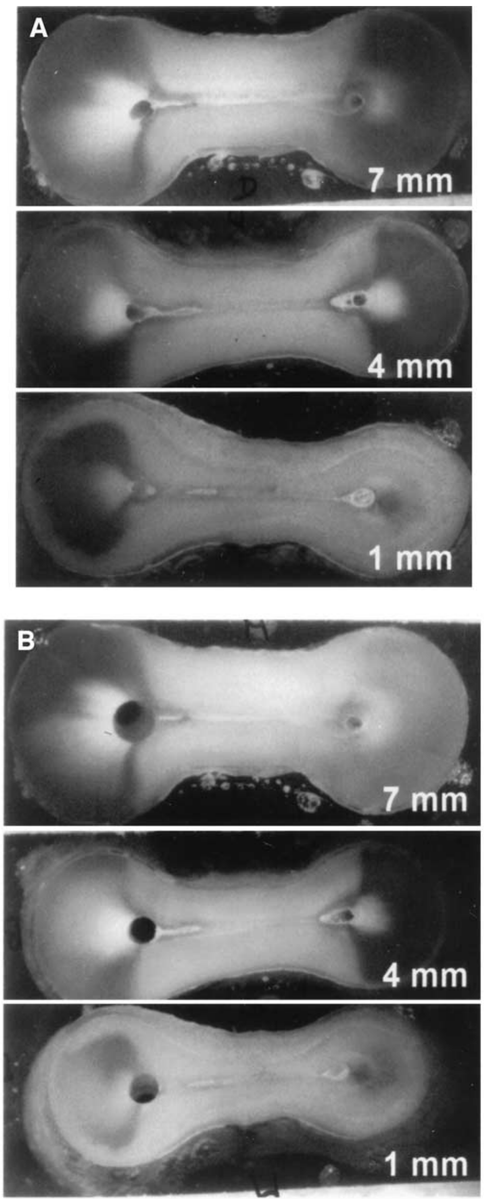

Fig 2. Photographs showing 3 slices of representative mesial root before instrumentation (**A**) and after instrumentation (**B**).

ber of sections, the lengths of the reassembled sections are measured. The widths of the disks are calculated by dividing the length loss by the number of spaces created after sectioning. In this study, the average space lost in each section—and, consequently, the disk thickness—was 0.5 mm.

The RDT and diameters of the root canals were evaluated. These values indicate the mechanical limits of instrumentation to enlarge the diameter of the root canal to approximately predetermined values that would not significantly weaken the dentinal walls. The initial diameter of the root canal indicates to what extent such instrumentation should be carried out to achieve thorough debridement and cleanliness. The change in canal diameter was significant in each direction, indicating that Lightspeed rotary instruments cut all surfaces evenly, thus preventing the phenomena of cutting 1 surface and leaving other surfaces more or less untouched.

The RDT of root canals in the coronal segment has already been examined.[23-29] It has been suggested that one of the criteria for post space diameter is that the RDT should not exceed one third of the root width, which minimizes deterioration of the mechanical properties of the root.[23-29] When the same criteria are applied to the apical preparation, the results of the present study indicate that the canal diameter after instrumentation with Lightspeed to No. 50 in the apical area and Gates-Glidden No. 2 reamers in the coronal area did not exceed one third of the root diameter in all levels, thus preserving its mechanical integrity.

The diameter of the apical third of root canals was 0.3 to 0.4 mm, which is in accord with the results of previous studies[5,7] and matches ISO instrument sizes 30 to 40. The difficulties encountered when trying to initiate instrumentation in the apical third with these instrument sizes and not with the smaller sizes are related to their tapered design. In addition, the coronal zone in many root canals is constricted, creating further difficulties. This necessitates flaring of the coronal zone before negotiating the apical third (known as the *crown-apical approach*). The advantage of flexible nontapered instruments such as Lightspeed, which are recommended for conservative preparation of the apical third to proper sizes, is that excessive flaring of the coronal segment of the canal is not necessary. Effective mechanical removal of bacteria in the apical third is achieved without significantly reducing the RDT.

CONCLUSION

Root canal preparation of mandibular mesial roots with Lightspeed instruments to No. 50 in the apical one third and Gates-Glidden reamers to No. 2 in the coronal third does not significantly decrease the RDT.

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