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Effect of retrograde cavity preparations on root apexes

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Abstract – Ultrasonic cavity preparations in endodontic surgery has become a popular procedure with several advantages noted: Smaller cavities, deeper and cleaner preparations, less removal of surrounding bone needed for instrumentation and less removal of root apex dentin. Concern has been raised that lines of infraction have appeared in some instances when the ultrasonic instruments have been used. We wished to examine the result of cavity preparations in root apexes using five different methods: high and slow speed handpieces, sonic instruments, and ultrasonic instruments at two power settings, medium and high levels, respectively. The results showed that all the methods produced some infractions; the high power ultrasonics produced the most infractions while the fewest numbers were associated with the slow speed handpiece and ultrasonic instruments at the medium power setting.

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Endodontic surgery includes root resection and retrograde cavity preparation. The usual technique has been to resect the root tip with either a high or slow speed carbide or diamond bur, in order to obtain a beveled apical surface, followed by an apical cavity preparation with either a small round or inverted cone bur (1).

Recently, sonic and ultrasonic instruments have been introduced for the purpose of preparing apical cavities (1–4). Several advantages have been mentioned. For instance, beveled resections are not necessary, smaller and cleaner cavity preparations can be made, and one may extend cavity preparations several millimeters coronally from the apical orifice. The latter may be particularly advantageous if the canals were not adequately cleaned previously.

No disadvantages have been clearly identified in the use of ultrasonic energy in retropreparations. The mechanism by which an apical cavity is made using ultrasonic instruments is presumably through the acoustic power emitted by these instruments (5). It is not known if such action is detrimental to the integrity of the surrounding dentin. One may speculate, however, about the possible effect the energy may have on dentin; is it likely to initiate fracture lines or worsen present root infractions? The purpose of this study was to examine the effect of sonic, ultrasonic, high-speed, and slow-speed root-end preparations on the development of root infractions.

Material and method

Sixty roots of extracted teeth were used in this experiment. The apical 2-3 mm of each root was resected using a diamond stone in a high speed handpiece with constant water spray.

The resected roots were grouped according to shape (round, oblong, concave) and measured for their narrowest diameter (<3mm; 3.0-3.5mm; >3.5mm), and distributed into six experimental categories (Table 1). Each category had a similar distribution of shape and diameter samples. The experimental groups (2 to 6) had nine roots each while the control group (I) consisted of 15 roots. Prior to making apical cavity preparations, the re-

Table 1. Experimental groups

Group I	Resected root tips - no retropreparations	15 roots
Group 2	High speed (#1 round bur)	9 roots
Group 3	Slow speed (#1 round bur)	9 roots
Group 4	Sonic retrotip	9 roots
Group 5	Ultrasonic at medium setting of 5	9 roots
Group 6	Ultrasonic at high setting of 10	9 roots
	Total	60 roots

sected root tips were stained with 2% methylene blue to check for any existing fracture lines, using a clinical microscope[1] at 16X magnification; none were present. Retropreparations were made in Groups 2 to 6; group I served as control and received no preparation other than root tip resection. In Group 2 the cavities were made using a #1 round bur in a high speed handpiece with a water coolant spray, while Group 3 was prepared with a slow speed handpiece, a #1 round bur, but not water coolant. Group 4 was prepared with a sonic handpiece with a #25 retrotip (Micromega 1500[2]) with water coolant. Groups 5 and 6 were prepared with ultrasonic handpieces fitted with retrotips[3] and used with a water coolant; the differences between the two groups was in the power settings: Group 5 was set at a medium level of 5 and Group 6 at a high level of 10. After cavity preparations the root tips were again stained and examined closely by photographing the resected surfaces at 10X magnification with a video enhanced measuring microscope[4] and projecting the slides on a screen. Three examiners viewed the slides and looked for presence or absence of fracture lines. In those instances where there was lack of total agreement, the slides were re-evaluated. Only those roots in which all three examiners agreed on the presence of lines were counted as having infractions.

Results

An infraction is a hard tissue fracture in which the parts have not separated (6). In our study, the infractions showed as methylene blue lines extending from the cavity preparations to the external surfaces of the roots (Fig 1). None of the 15 roots in Group 1, in which cavity preparations were not made, showed lines of infractions. Of the

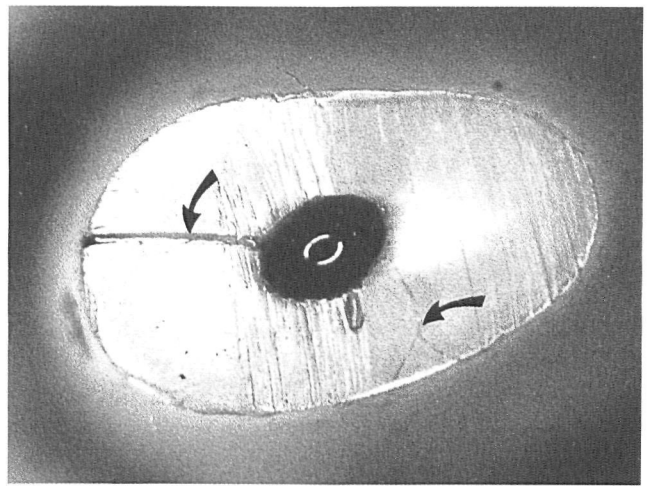

Figure 1. Resected root surface after apical cavity preparation. Note small and large infractions (arrows).

remaining 45 roots in the other five groups, 12 showed lines interpreted as infractions. Table 2 shows the distribution of infractions among the groups.

In Group 2, in which the cavity preparations were made with a high speed handpiece, infractions occurred in 3 of 9 roots, while only one infraction occurred when a slow speed handpiece was used (Group 3). The sonic group (4) had 2 infractions. In the ultrasonic groups (5 and 6) one infraction was found when the power setting was at a medium level while five infractions occurred at the highest setting.

Table 3 shows the distribution of infractions based on size and shape of the resected root surface. Teeth with the narrowest external root surface diameter , <3 mm, showed a frequent incidence of infraction, 6 of 15 (40%). Roots with biconcave root morphology developed infractions apparently unrelated to root diameter. The chi square test showed that while there is no significant difference in the distribution of infractions based on root morphology (X^2=3.5; df=2; p=0.17) and root thickness, (X^2=1.5; df=2; p=0.47), it does suggest a trend in occurrence of fractures in roots which are biconcave (7 of 15) and less than 3 mm in diameter, (6 of 15). Further analysis of the incidence of infractions (12 of 45 test teeth) showed a risk of generating infractions that varies from a high of 55%, (5 of 9), for ultrasonic retropreparations at high settings, to a low of 11%, (1 of 9), for ultrasonic at medium settings, and for those done with a slow-speed handpiece. The confidence interval which reflects the possible range of values for the true value of the percentage of teeth having infractions, independent of the method used, can,

[1] Storz-Urban, St Louis, Missouri
[2] Micromega 1500, Medidentia International, Inc., Woodside, New York, USA
[3] Excellence in Endodontics, San Diego, California, USA
[4] Mitutoyo microscope Tokyo, Japan

Table 2. Incidence of infractions*

Group I No apical cavity	Group 2 High Speed	Group 3 Slow Speed	Group 4 Sonic	Group 5 Ultrasonic Medium	Group 6 Ultrasonic High	Totals
0	3	1	2	1	5	12

* Each experimental group consisted of 9 roots; the control group (I) had 15 roots.

therefore, be determined at the 95% level and found to be 0.138 to 0.396. This means that based on these data, the percentage of teeth having infractions could be as high as 40% and unlikely to be less than 14%.

Discussion

Innovations in techniques and instruments have contributed to the progress made in recent years in endodontics, and endodontic surgery has perhaps benefitted most. Surgical treatment of teeth with endodontic problems has become increasingly common since the 1972 publication on the histological, radiographic and clinical study of endodontic surgery by Rud et al. (7).

Recent advances in surgical techniques have included the introduction of surgical microscopes and the use of ultrasonic instruments for apical cavity preparations (8, 9). Wuchenich et al. (4) showed that ultrasonically prepared cavities can be made that have smaller diameters, are deeper and more retentive, and are cleaner than those made with slow speed inverted cone burs. Other possible improvements were reported by Mehlhaff et al. (10) who pointed out that the bony crypt size for apical access could be decreased and that less apical tooth structure needed to be removed in making apical cavity preparations. The question about possible problems in using ultrasonic devices on root tips has been raised in three recent research reports. Layton et al. (11) and Abedi et al. (12) linked an increase in apical fracture lines to the use of ultrasonic instruments, while Marderosian & Glickman (13) found no correlation.

In the present study we compared four methods of preparing apical cavities in the development of dentin infractions. Our observation was that all four methods were associated with lines of infraction, but that some factors appeared more prominent than others.

Table 3. Incidence of infraction related to combinations of shape and diameter

	< 3 mm	3.0 - 3.5mm	> 3.5 mm
Round	2		
Oblong	2		1
Biconcave	2	3	2
Totals	6	3	3

As one would expect, the morphology of the root was important. More infractions occurred in those roots classified as biconcave. This was true regardless of the size of the root diameter. The thin dentin walls associated with the root concavities probably predispose these roots to fracture.

Dentin thickness, in and of itself, appears to play a role in the development of infractions; the small diameter roots (<3mm) developed more lines, regardless of the morphology, than the larger diameter roots.

With respect to the methods for preparing the apical cavities, ultrasonic devices at high power settings resulted in lines of infractions in over half of the samples (5/9), while low ultrasonic power settings and slow speed handpieces generated only one infraction each. Ultrasonic energy can be a very powerful force on dentin and other hard tissues. Heat can be generated - though coolant water sprays are used - and vibration is very noticeable. Both the heat and the vibration may contribute to the development of infractions.

In the high speed handpiece group, three of nine samples developed lines. Heat and vibration may be factors, but to a lesser extent than with high power ultrasonics.

The sonic instrument was not comfortable to use and created several gouges on the surrounding dentin. Infractions occurred in 2 of 9 samples, possibly related to the inadvertent gouging due to the difficulty in controlling the instrument. The least number of infraction lines resulted from the use of slow speed handpieces and ultrasonic instruments set at a medium power level. The gentler manipulation of dentin appeared to prevent infractions.

The fact that there is a risk of generating infraction lines regardless of the method used to prepare apical cavities should not be ignored. Granted, one cannot equate infractions with subsequent root fractures, but the potential for later fractures must be considered. The risk for devel-

oping infractions, at the 95% confidence level, indicates a range of 0.138 to 0.396, meaning that there exists a risk of about 14% of developing infractions when using slow- speed handpieces or low-power ultrasonics and up to about 40% risk when high power ultrasonics are used. It remains to be determined what the risk may be for infractions to proceed to true fractures.

If apical cavity preparations are associated with risks of infractions one may wish to consider alternative methods for accomplishing the goal of apical root end fillings: the sealing of the root canal apex. The reports by Rud et al. (14) and others (15) suggest that apical cavity preparations may be avoided by the use of bonded composites covering the resected root surface. The composite seals both the root canal orifice and surrounding dentinal tubules. Only root resection is necessary in such a technique and in our study we found no infractions associated with the resection step.

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