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A Comparison between Two Root End Preparation Techniques in Human Cadavers

Gary Wuchenich, DDS, Debra Meadows, DDS, and Mahmoud Torabinejad, DMD, MSD

The purpose of this study was to compare ultrasonic and bur root end cavity preparations with regard to retention, cleanliness, and root canal parallelism. Twenty anterior teeth from human cadavers were instrumented and obturated with gutta-percha and sealer. After raising a full-thickness flap, the apices of the roots were exposed and beveled at a 45-degree angle. Half of the apical cavities were prepared with an appropriate sized Carr alloy tip energized by an Amadent Ultrasonic unit. The other half was prepared with an inverted cone bur in a slow-speed handpiece. The teeth were then extracted, sectioned longitudinally, photographed, and scanning electron micrographs examined. The ultrasonic cavities produced more parallel walls and deeper depths for retention. In addition, the ultrasonic tips followed the direction of the canals more closely than those prepared by burs. Scanning electron microscopic examination of the cavity walls showed presence of cleaner surfaces of root end cavities prepared by ultrasonic tips than those made with burs.

Pulpal and periradicular pathosis may develop when pulp and/or apical tissues are exposed to the oral flora. Removal of irritants, total obturation of the root canal system, and the prevention of recontamination are the main objectives of root canal therapy (1). Inherent in achieving these goals is the fact that the root canal anatomy is highly complex: Lateral canals, accessory canals, and web-like communications between canals exist (2). Straight canals or those free of apical or coronal canaliculi are rare. Davis et al. (3) found anatomical variations in prepared canals quite dissimilar to the design of the instruments used to prepare them. This was particularly evident in the apical third (3). As a result of the complexity of root canal systems and the inadequacy of present cleaning techniques, canal debridement is often insufficient.

The irritants exit the infected root canals, inoculate the periradicular tissues, and a periapical lesion subsequently develops. The significant relationship between the presence of root canal infection and the formation of periapical inflammation has been clearly shown by several investigators (4–6).

The preferred treatment of failing endodontic cases is conventional retreatment. A successful outcome can usually be expected (7). However, because of the complexity of root canal systems, inadequate instrumentation, and presence of physical barriers (anatomical, post and core restoration, separated instruments, etc.), ideal goals are often difficult to achieve with an orthograde approach. Surgical endodontic therapy becomes the first alternative. The procedure involves exposing the involved apex, resecting the root end, preparing a class I cavity, and most often inserting a root end filling material.

According to Arens (8), the class I apical preparation must be parallel to the long axis of the root, 3-mm deep, centered in the root throughout its depth, and should include the entire apical root canal system. To accomplish these goals a significant amount of the apical bone is removed and the roots are resected and beveled toward the operator. A specially designed micro-handpiece or pedodontic handpiece and small, slow- and/or high-speed burs are used to prepare an ideal class I cavity in the apical portion of a root. This procedure is sometimes difficult or even impossible to execute for several reasons: the anatomical complexity of the apical portion of the root canal, root location, the inflexibility of instruments, and the unavailability of enough apical bone or root structures. To circumvent these limitations, vertical and transverse slot preparations, perpendicular to the long axis of the roots, have been recommended (8). The disadvantages to these alternatives include the lack of parallelism between the cavity preparation and the apical root canal system, the need to remove excessive tooth structure, and extensiveness of the apical preparation and restoration.

Most of the restorative root end filling materials are not totally biocompatible. Therefore, they are interfaced with cementum following apical surgery, and do not totally inhibit residual irritant leakage from the root canal system into the periradicular tissues. For these reasons, it is important to keep the root end preparation as small as possible. Reit and Hirsch, (9) following Nygaard-Ostby's recommendation, were able to clean and obturate 77% of 35 cases. They reported a 78% success rate when the root canals were able to be shaped and obturated to within 0.5 mm of the post compared with a 50% when this was not possible. Amagasa et al. (10) performed apicoectomies and retrograde gutta-percha fillings with the use of "new instruments" reporting a success rate of 95.3%.

To perform root end cleaning and shaping when indicated, conventional instrument use is difficult, time consuming, and sometimes ineffective or impossible. In an effort to overcome some of these disadvantages Flath and Hicks (11) reported two apical surgery cases in which root end instrumentation was accomplished with sonic and ultrasonic instruments and the canals were filled with sealer and thermoplasticized gutta-percha.

A specially designed ultrasonic tip has recently been introduced for root end preparations. The manufacturers state that there are several advantages which have not as yet been the subject of published reports. The purpose of this study was to compare the cleanliness and parallelism of root end preparations prepared by ultrasonic tips with those prepared by burs.

MATERIALS AND METHODS

Twenty anterior teeth of two cadavers were accessed, cleansed, shaped, and obturated with laterally condensed gutta-percha and root canal sealer. A full-thickness flap was raised, the apical bone was removed with a #6 high-speed round bur, and the apical third of each root was resected with a fissure bur under water spray. In group 1, 10 root end cavities were prepared using the Carr ultrasonic surgical tips (CT Retro Tips; Excellence in Endodontics, San Diego, CA) in an Amadent ultrasonic unit (Amadent Co., Cherry Hill, NJ). In group 2, another 10 root end cavities were prepared by a microhead slow-speed handpiece and a #33 ½ inverted cone bur with water irrigation. The teeth were extracted, coded, and sectioned longitudinally with a diamond saw under water spray. To examine dentinal surfaces where no treatment had been performed, one freshly extracted, pulpally extirpated human tooth was also sectioned and used as a control. The sections were then sputter-coated with gold and examined under the scanning electron microscope for cleanliness of the cavities and their directions in relationship to the root canal systems by an electron microscope technician and two of the investigators.

RESULTS

After examination of two or three specimens from each group and because of the nature of our observation, it became apparent that the evaluation of the samples could not be performed in a double blind manner even by the electron microscope technician who was not a dentist and was unaware of the nature of the project. There was a general agreement on the findings of three observers.

The walls of the root end preparations made with ultrasonic tips followed the direction of the root canal system (Fig. 1*A*). In contrast, the root end preparations made by the burs not only did not follow the long axis of the roots but had been prepared at 45 to 60 degrees perpendicular to the long axis of the roots (Fig. 1*B*). The root end preparations made by ultrasonic tips had parallel walls and a minimum depth of 2.5 mm. The root end cavities prepared with burs had short axial walls measuring an average depth of 1 mm and were oblique to the long axis of the root. In some cases the bur almost perforated the lingual root surface (Fig. 2). The surface of dentinal walls of the freshly extracted tooth showed patent dentinal tubules (Fig. 3*A*). In contrast, the dentinal walls of root end preparations made by burs smear layered the tubules with debris (Fig. 3*B*). The dentinal walls of root end cavities prepared by the ultrasonic tips revealed many open dentinal tubules and a minimal debris layer (Fig. 3*C*).

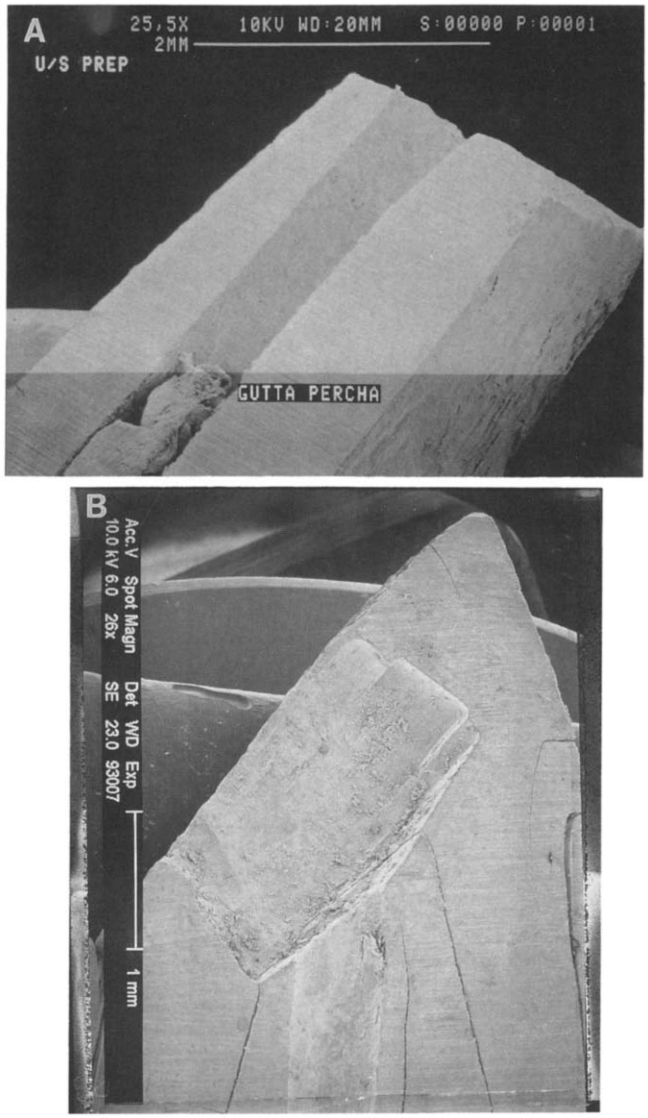

FIG 1. *A*, Scanning electron micrograph of a root end preparation made by ultrasonic tips (original magnification ×25.5). *B*, Scanning electron micrograph of a root end preparation made by slow-speed handpiece and an inverted cone bur (original magnification ×26).

DISCUSSION

The purpose of apical access, root resection, and curettage is to remove irritants from the root canal system inaccessible to the operator via a coronal entry. Preparing a root end cavity and filling it with an adequate restorative material prevents any remaining irritants from migrating into the periradicular tissues. As stated by Kaplan et al. (12), "the clinical success of retrograde amalgam, in spite of its leakage, can be attributed to the fact that (1) apicoectomy removes the lateral canals and the uncleaned portion of the canal, (2) the apical preparation cleans the canal, and (3) the apical curettage stimulates the healing process." Harrison and Todd (13)

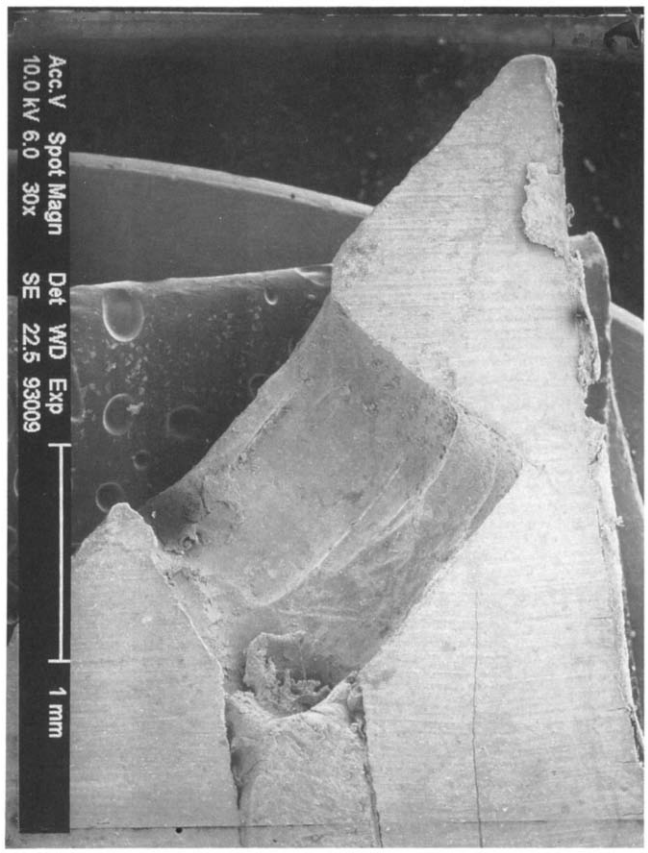

FIG 2. Scanning electron micrograph photograph of a root end preparation made with bur showing short axial walls and oblique preparation in relationship to the long axis of tooth (original magnification ×30).

have demonstrated that root resections performed with rotary instruments do not affect the seal of previously condensed gutta-percha and sealer. They recommend placement of a root end filling material when doubt exists about the adequacy of the apical seal. Because clinical and radiographic evaluations of the apical seal of obturated canals are judgmental, and the presence of coronal leakage cannot be detected during clinical examinations, making a root end preparation and filling it with a restorative material as a routine has been recommended by some investigators (14).

The effects of different clinical factors on success or failure of surgical endodontic therapy have been studied by a number of clinical investigators (15–20). The inconsistencies in these investigations can be attributed to the lack of standardization in operation technique and healing assessment following surgical endodontic therapy. The main variables include diversified methods of cleaning, shaping, and obturating root canals prior to apical surgery; presence or absence and type of final restoration; coronal leakage; root canal anatomy and its accessibility; extent and angle of root resection; type and depth of root end preparations; and selection of root end filling materials. Most of these variances can be standardized in in vitro studies by using uncomplicated, single-rooted, extracted teeth. However, in vivo surgical procedures involving root resection, root end preparation, and root end filling involve other more difficult to control factors than the type of filling materials that can affect the final prognosis. Consequently,

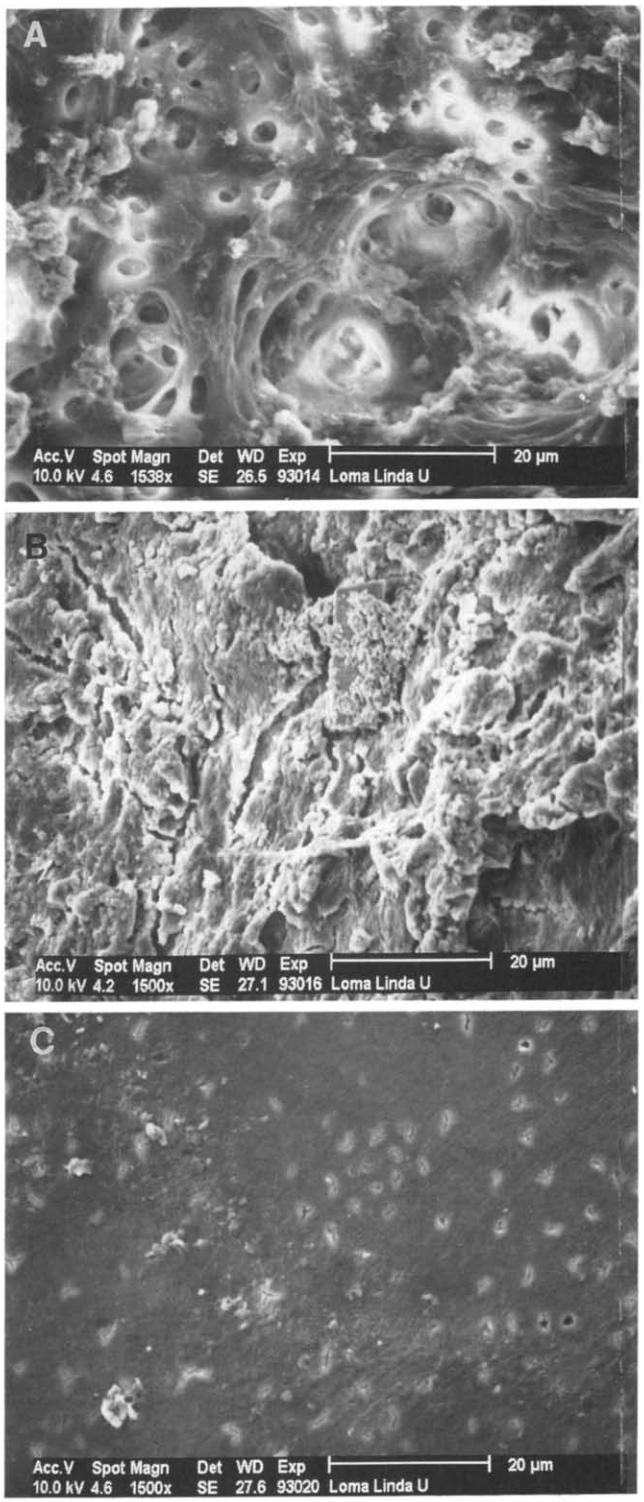

FIG 3. *A*, Scanning electron micrograph showing patent dentinal tubules of a freshly extracted human anterior tooth (original magnification ×1538). *B*, Scanning electron micrograph of a root end preparation made with a bur, covered with debris (original magnification ×1500). *C*, Scanning electron micrograph of a root end preparation made with ultrasonic tips showing dentinal tubules and minimal debris (original magnification ×1500).

most clinical studies that compare various root end filling materials fail to standardize the clinical factors which might affect their results. Subsequently, their conclusions regarding the efficacy of various root end filling materials may be questionable.

Comparisons between success rates of surgical and nonsurgical root canal therapy have shown that nonsurgical therapy is more successful (approximately 20%) (15, 18, 19). This is usually attributed to incomplete debridement of the root canal and egress of irritants into the periapical tissues. Since the success of nonsurgical root canal therapy is considered to be dependent upon the complete removal of irritants and total obturation of the root canal system, it is reasonable to assume that the same principles apply to teeth requiring surgical endodontic therapy. In order to gain straight-line access into the root canal system from the apical end, the operator has been forced to remove extensive amounts of periradicular bone and root structure or bend conventional, sonic, or ultrasonic files. To achieve these goals with previously available instruments was difficult to impossible. The newly designed ultrasonic tips appear to offer direct access to the root ends, with minimal bone loss.

Our results showed that the root end cavities prepared with a conventional handpiece and slow-speed burs were more shallow in the apico-coronal direction, were not parallel with the long axis of the root, and contained more debris than those prepared with ultrasonic tips. Ultrasonic tips improved our ability to prepare cleaner, deeper root end preparations. This improved technique appears most beneficial and could contribute to a higher success rate in surgical root canal therapy. Standardized clinical procedures and long-term follow-up studies are needed to compare the ultimate effectiveness of these tips.

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Dr. Wuchenich is a graduate student, Department of Endodontics, School of Dentistry, Loma Linda University, Loma Linda, CA. Dr. Meadows is a graduate student, Department of Endodontics, School of Dentistry, Loma Linda University. Dr. Torabinejad is professor of endodontics, Director of Graduate Endodontics, School of Dentistry, Loma Linda University.

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The Way It Was

In the annals of quackery, Grove's Tasteless Chill Tonic may stand supreme for its persuasive advertising slogan—"Makes Children and Adults as Fat as Pigs."

Well, they had one thing right—it sure was tasteless.

William Cornelius