SCANNING ELECTRON MICROSCOPE EVALUATION OF THE CUT ROOT SURFACE AND ROOT END PREPARATION USING VARIOUS TECHNIQUES

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أجري تحضير الثلث الذروي للجذر في عشرون سنا بشريا مقلوعا ومعالجا لبيان استعمال السرعة العالية، والسرعة المنخفضة، وباستعمال قبضة جراحية مستقيمة ذات سرعة منخفضة، وباستعمال جهاز الموجات القصيرة. وتم تقييم مواصفات سطح الجذور المقطوعة باستعمال المجهر الإلكتروني (سي ي م) بالإضافة إلى ذلك تم فحص البقايا السطحية المتبقية في الحفرة الذروية المحضرة ومقدارها. أظهرت النتائج أن أنعم سطح مقطوع مع أقل كمية من البقايا العاجية تم الحصول عليه باستعمال سنبلة مخروطية ملساء بكلا السرعتين العالية والمنخفضة بينما رأس جهاز الموجات القصيرة أمساء إلى حشوة الكوتابيركا. الغسيل المستمر والمتتالي للحفرة أثناء التحضير أزال كميات أكبر من البقايا.

Root end preparation was performed in the apical third of 20 endodontically treated extracted human teeth using high speed, low speed, straight surgical low speed handpieces and ultrasonic machine. The surface properties of the cut root surface was evaluated using a scanning electron microscope (SEM). In addition, the degree of superficial debris and those retained in the cavity of the retropreparation was also examined. Results showed that the smoothest cut surface with minimal debris was produced by #169 plain tapered fissure bur on both high and low speed handpieces. The ultrasonic tip disturbs the gutta-percha filling. Frequent and continuous irrigation is better used during the cutting procedure to remove a greater amount of debris.

Introduction

Removal of irritants, total obturation of the root canal system, and 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 canal, accessory canal, and web-like communication between canals exist.[2] Straight canals, or those free of apical or coronal canaliculi, are rare. Davis et al[3] found that anatomical variations in prepared canals to be quite dissimilar to the design of the instrument used in its preparation. This was particularly evident in the apical third. As a result of the complexity of the root canal system and the inadequacy of present cleaning techniques, canal debridement is often insufficient. The irritant exits the infected root canal through the apical foramen or lateral canal, 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 for failing endodontic cases is conventional retreatment. A successful outcome can usually be expected.[7] However, due to the complexity of the root canal system, inadequate instrumentation, and presence of physical barriers such as post and core restoration, anatomical vital structure, broken instruments, and ideal goals are often difficult to achieve by the orthograde approach. In such situation, surgical endodontic therapy becomes the first alternative. The procedure involves exposure of the involved tooth apex, resecting the root-end, preparing Class I cavity and, oftenly, inserting a suitable root-end filling material.

Different burs have been recommended for use during the surgical cutting of the root apex.[8-12] In 1956, Richman[12] described an ultrasonic instrument for root resection while Bertrand et al[13] presented a modified cavitron for root-end preparation in 1976. Additionally, Flath and Hicks[14] described the use of a modified ultrasonic and sonic files for retrograde instrumentation. Commercially available ultrasonic instruments for surgical endodontics have just been introduced recently. Specially designed tips for root-end preparation during periapical surgery have been introduced. The tips are purported to provide access to the rootend creating a more conservative preparation in the long axis of the root with greater depth while decreasing the amount of retained debris. Clog, uneven or grooved surface, gouging of the root surface and failure to establish a smooth, flat root surface could occur, which may affect the placement of the retrograde filling.

The purpose of the present investigation was, to evaluate the surface properties of the cut root surface produced by high, low and straight handpieces using the scanning electron microscope (SEM). In addition, the root-end preparation using the above handpieces was compared to one prepared by an ultrasonic retrotip. It was also the objective of this study to examine the degree of superficial debris and those retained in the cavity of the retropreparation.

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Materials and Methods

Twenty extracted human single rooted anterior teeth were used in this study. They were prepared by using the step-back technique and obturated with gutta percha and zinc-oxide eugenol cement using lateral condensation technique. Excess filling material was removed, then the access opening was sealed with cavit and radiograph was taken.

The teeth were then randomly divided into 4 groups of 5 teeth each (four experimental and one control with resection of the root-end and no apical preparation). In each group, the teeth were mounted upside down using acrylic and plaster, exposing about 8 mm of the root-end. The experimental groups were divided into the following combination of burs and handpieces:

Group 1 : A high speed handpiece was used for apical root resection and root-end preparation (#169 plain tapered carbide fissure bur for resection, and #330 inverted cone carbide bur for apical preparation).

Group 2 : A low speed handpiece was used for apical root resection and root-end preparation (#169 plain tapered carbide fissure bur was used for resection, and #330 inverted cone carbide bur was used for apical preparation).

Group 3 : A straight surgical low speed handpiece was used for apical root resection and root-end preparation (surgical length cross-cut fissure bur was used for resection and inverted cone was used for apical preparation).

Group 4 : A high speed handpiece, with #169 plain tapered carbide fissure bur, was used for apical root resection and the root-end prepared using an ultrasonic retrotip mounted on Neosonic unit*.

The apical 3 mm of each root was resected in all groups at a 90 degree angle to the long axis of the root. A 90 degree angle was selected to provide better continuity from one specimen to the next and to facilitate the preparation of the specimens for the scanning electron microscopic (SEM) examination. A new bur was used for every tooth and an attempt was made to produce the smoothest possible surface in all specimens. During the cutting procedure, each specimen was irrigated with saline to keep the root surface moist and to flush away any accumulated debris. Irrigant was suctioned with endo suction tip at high volume. At the end of the procedure, all roots were cut horizontally about 5 mm coronal to the preparation, dried, mounted on a single copper stud, and sputter coated with gold (Gold coater, fine coat, IoN sputter JFC-1100) for SEM (Jeol Model, JSM 840A) examination. A minimum of four photomicrographs for each specimen were taken at 10 Kvp to compare the general topography of the surfaces and the presence of debris in the cut surfaces and the root-end preparation. The photomicrographs were evaluated by two calibrated examiners at a magnification of X300 and X500 for the assessment of the root surface debris; a magnification of X35 and X50 for the assessment of the root surface; a magnification of XI00 to XI50 for the assessment of the root-end preparation and, a magnification of XI000 and XI500 for the assessment of debris on the root-end preparation. These levels of viewing were chosen because they showed the best details required to make accurate evaluation while maintaining the field as large as possible. The criteria for evaluating the debris are shown in Table **1**.

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Results

Representative examples of the characteristic surface properties produced by each handpiece and bur are shown in Figure 1. The smoothest cut surface was produced by the high-speed handpiece and #169 plain tapered carbide fissure bur, followed by the low-speed handpiece; while the straight handpiece, with cross-cut fissure bur, produced the roughest surface. The surface debris were less in all groups except Group 3, which showed moderate amount of debris [Fig. 2B]. Ultrasonic preparation proved to be the smallest on the average followed by those prepared with high and low speed handpieces; while those produced by straight handpiece were large with a tendency to gouge the canal wall in the thinnest area of the root [Fig. 1]. Ditching was noticed near the wall of the root end preparation in Groups 1, 2, and 3. The dentinal walls of the root-end cavities prepared by the ultrasonic tips and straight handpiece showed minimal amount of debris [Fig. 3B].

In Group 4, one specimen, prepared with the ultrasonic tip, appeared to have incomplete removal of gutta percha during the preparation [Fig. 4]. Gutta percha appeared to be pulled and smeared in the control group [Fig. 5].

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. It is assumed that cleanliness and the absence of debris are highly desirable in root-end preparation. This was achieved by frequent and continuous irrigation during the cutting procedure. This will help in removing a greater amount of debris that might carry microorganisms, thereby improving the prognosis.

The results from this study indicate that the smoothest cut surface, with minimal debris, was produced by #169 plain carbide fissure bur in both high and low-speed resections. The

Table 1. Scoring of debris on cut root surface and root-end preparation.

Score	Criteria
Minimal	Covering up to 30% of the specimen
Moderate	Covering between 30 and 70% of the specimen
Heavy	Covering above 70% of the specimen

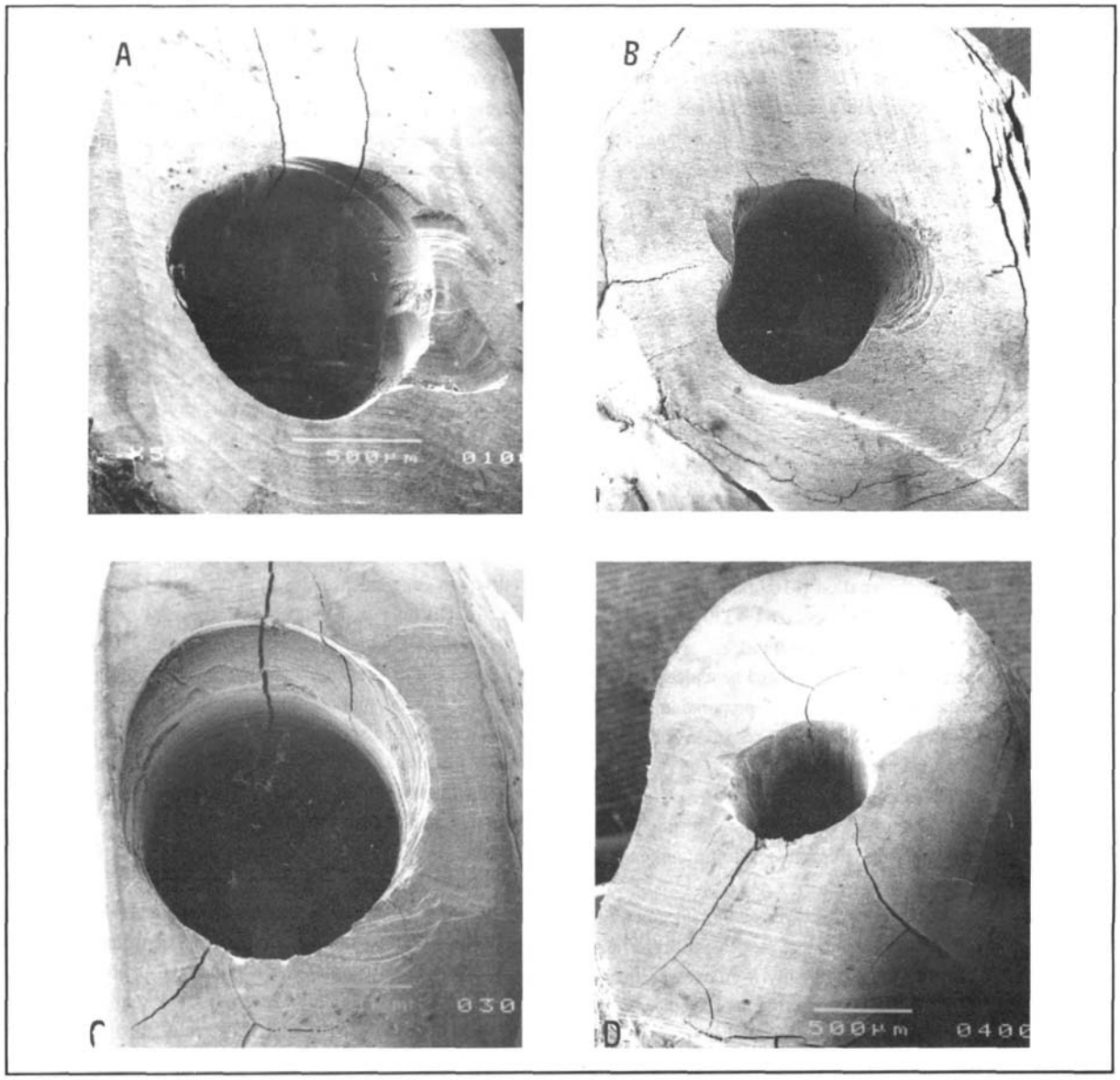

Figure 1. Scanning electron micrograph (X35) of the root surface characteristics: (A) Group 1; (B) Group 2; (C) Group 3 and (D) Group 4. Notice the ditching near the dentinal wall of the root end preparation in Groups 1, 2, and 3.

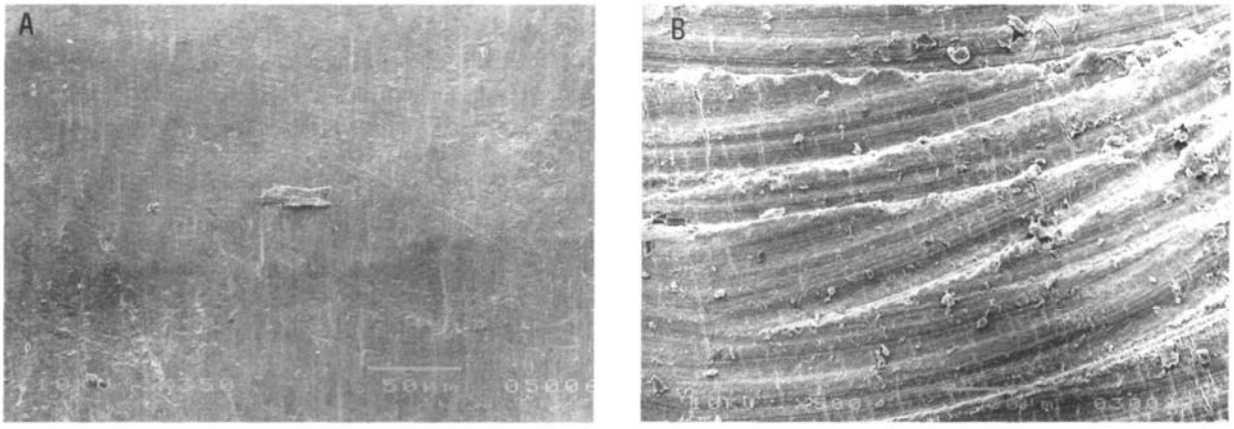

Figure 2. Scanning elctron micrograph of the surface debris produced by: (A) Group 1 (X350) minimal, (B) Group 3 (X500) was moderate.

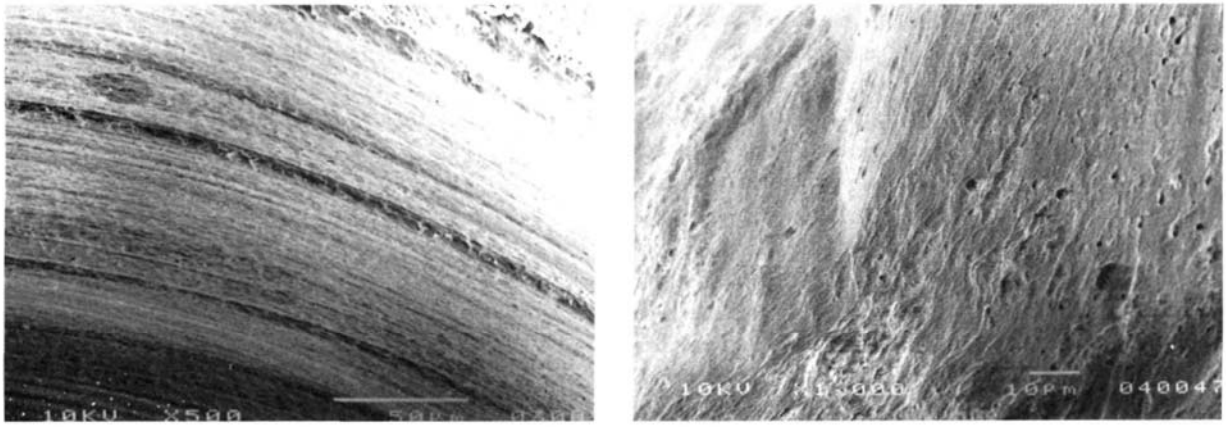

Figure 3. Scanning elctron micrograph of the dentinal wall of the root-end cavity prepared with: (A) Group 3 minimal amount of debris; (B) Group 4 showed a minimal amount of debris.

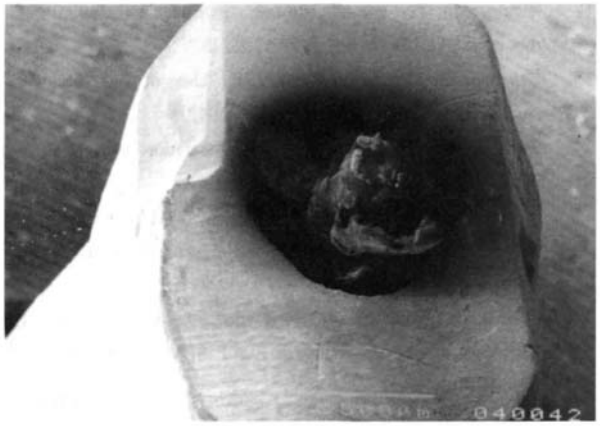

Figure 4. Micrograph showing incompletely removed gutta-percha disturbed during the preparation with ultrasonic tip (X50).

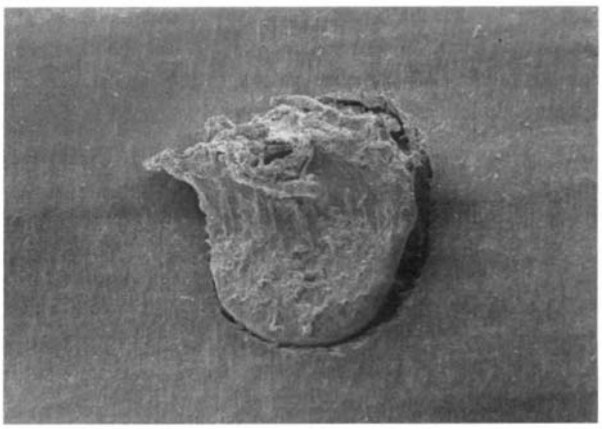

Figure 5. Micrograph showing the shredding and smearing of gutta-percha produced by the high speed handpiece and #169 plain tapered fissure bur (X200).

roughest and most irregular surface, with moderate amounts of debris, was produced by the cross-cut fissure bur in straight low-speed resection. This result was also observed by Nedderman et al[1] . Cross-cut fissure burs are commonly used for rapid removal of both bone and tooth structure in oral surgery and operative dentistry. Their availability and rapid cutting characteristics are probably among the reasons why they have been commonly recommended for use in apical root resection, while little thought was given to the surface characteristics they produced. The ditching that was observed near the wall of the root-end preparation in Groups 1, 2, and 3 may be due to the lack of control when using conventional burs.

Ultrasonic instrumentation has been commercially available for retrograde endodontic therapy since the introduction of the Cavi-Endo system. There has, however, been a lack of instruments specially designed for surgical endodontic therapy. This has resulted in a number of attempts to adapt existing instruments to surgical application. Wuchenich et al[15] showed that ultrasonically created cavities had more parallel walls and depth for retention. In addition, the ultrasonic tip followed the direction of the canal more closely than those prepared by burs. SEM examination of the cavity walls showed the presence of cleaner surfaces of root-end cavities prepared by ultrasonic tips than those made with burs. Gutmann et al[16] showed that root-end preparation with a bur produced a heavy smear layer at all levels of the preparation. This layer was partially removed during ultrasonic preparation in the apical two thirds. Although the ultrasonic tip provides superior control and the root-end preparation proved to be the smallest on the average, it causes a disturbance of the gutta-percha seal at the prepared site. This was also observed by Engle and Steiman[17]. The gouging that results with straight handpiece may increase the risk for perforation. All techniques utilized in this study produced residual debris in the root-end preparation which is in agreement with the results observed by Gormann et al[18]. Baker et al[19] reported that the removal of debris and microorganisms from the root canal system seemed to be a function of the quantity of irrigating solution rather than the type of solution used. The flushing action of the solution seemed to be the significant factor. Shredding and pulling of the gutta-percha was observed in the control samples with high

speed and #169 plain tapered fissure bur. Same observation was reported by Nedderman et al and Cunningham[20] with a low-speed fissure bur. Tazilli et al[21] also reported similar findings with the use of #700 high speed carbide bur and water spray observed under SEM. Although water spray was used, they concluded that the heat of the bur was responsible for the bulling and blistering of the gutta-percha. Some practitioners assumed that the apical seal is adversely affected by the root resection procedure and routinely attempted to improve the seal by placing a retrofilling material. An autoradiographic leakage study by Harrison and Todd[22] concluded that root resections performed with rotary instruments do not affect the seal of previously condensed gutta-percha and sealer. The bur utilized in their study was not specified. They recommended 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, rootend preparation and placement of a retrofilling material is recommended.[23]

Conclusion

Based on the results of this study, following conclusions can be drawn:

1. The smoothest cut surface with minimal debris was produced by #169 plain tapered fissure bur using either high or low speed handpieces.
2. Ultrasonic tip produced a conservative preparation but it disturbs the gutta-percha filling.

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