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Does Cold Burnishing Gutta-percha Create a Better Apical Seal?

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This study investigated the seal created by cold burnishing the gutta-percha exposed after apical root resection of endodontically treated teeth. Sixty single-rooted extracted human teeth with a single straight canal were divided into four experimental groups of 15 teeth each. In two of the experimental groups the canals were instrumented and obturated well with laterally condensed gutta-percha and sealer. The remaining two groups were instrumented and poorly obturated with laterally condensed gutta-percha and sealer. The apical 2 mm of all the teeth were then resected and the effect of cold burnishing the exposed gutta-percha was investigated using a linear dye penetration technique. Under the condition of this study, cold burnishing gutta-percha after apical root resection of a well-obturated root canal resulted in a poorer apical seal than if no burnishing were performed. Cold burnishing the exposed gutta-percha after apical root resection of poorly obturated root canals improved the apical seal as compared with nonburnished poorly obturated canals.

In endodontically treated teeth that require periapical surgery, every effort is made to ensure that the integrity of the apical seal is adequate. If the apical seal remains questionable after apical curettage and root resection, then a corrective measure such as hot or cold burnishing of the gutta-percha or placing one of a variety of retrofilling materials has been recommended (1–13).

Ingle et al. (14) reported that 63% of all endodontic failures were due to apical percolation as a result of incomplete obturation of the apical root canal space. Weine (1) stated that if there was any chance whatsoever that the apical seal was inadequate, then a reverse filling must be placed. Ideally, the seal created should be fluid-tight to prevent leakage of materials from the root canal system, because such materials may prove to be toxic or irritating to the periapical tissues and thus may delay or prevent healing.

Amalgam has long been advocated as the apical retrofilling material of choice (2–6, 15, 16). The tissue tolerance of amalgam is well established in the dental literature (17–20). However, the seal established by apical amalgams has been questioned by investigators in recent years (7–13, 21). Tanzilli et al. (7), using a scanning electron microscope to determine marginal adaptation, showed that cold-burnished gutta-percha resulted in smaller marginal defects than did amalgam retrofills. Heat-sealed gutta-percha had the largest marginal defects in their study. Moodnik and associates (8) reported marginal defects ranging from 6 to 150 μm between the prepared root surface and the retrograde amalgam filling material.

Barry et al. (9) used a dye penetration method to compare the seal obtained with gutta-percha root canal obturation alone, heat-sealed gutta-percha, retrograde amalgam fillings, and retrograde Durelon filling material. The Durelon group demonstrated the greatest dye penetration. There was a small, but not significant, difference in dye penetration between the other three test groups. Szeremeta-Browar et al. (10), in a ^{45}Ca autoradiographic study, found that amalgam retrofillings leaked throughout the depths of the material. Abdal et al. (11), using a fluorescent dye technique and the scanning electron microscope, found that all amalgams tested produced a poorer seal than did heat-sealed gutta-percha alone. Using bacteria to determine leakage, Kos et al. (12) showed that neither gutta-percha nor amalgam provided an effective seal against the bacteria. It was demonstrated by Tronstad et al. (13) that retrograde amalgams without cavity varnish leaked significantly more than did those placed with a cavity varnish. Kaplan et al. (21) showed that the apical seal produced by retrograde amalgams allowed twice as much dye penetration as did cold-burnished gutta-percha.

The method for creating the best apical seal after periapical surgery is certainly open to debate. Today, the overwhelming majority of endodontically treated teeth are obturated with gutta-percha. Several authors (7, 9, 11–13) have investigated the seal created at the time of apical root resection by manipulating the surgically exposed gutta-percha in various ways. Among the techniques reported were cold burnishing and heat sealing the exposed gutta-percha. Only one report (22) was found in the literature that compared the seal obtained with various techniques and the seal created by apical root resection with no further manipulation of the exposed gutta-percha obturating material. This study reported no significant difference in the seal among root resection alone, retroamalgams, heat-sealed gutta-percha, and cold-burnished gutta-percha. If, in fact, the seal at the time of apical root resection

is adequate or superior to that created by other methods, it would be much easier and quicker, and in the patient's best interest, to forego further manipulation of the exposed apical gutta-percha.

The purpose of this study was to evaluate and compare the seal created by cold burnishing gutta-percha after apical root resection with the seal present when apical root resection was performed and there was no further manipulation of the exposed gutta-percha.

At the time of surgery, teeth that have already had root canal obturation fall into two general, broad categories: those in which the radicular space is well obturated and those in which the radicular space is poorly obturated. Both situations were investigated in this report.

The study used an India ink dye penetration and clearing technique for this comparison.

MATERIALS AND METHODS

Sixty extracted single-rooted human teeth were divided into four equal experimental groups of 15 teeth each. All the teeth had straight roots and a single canal. Before instrumentation they were placed into a solution of 5.25% NaOCl to remove any tissue tags attached to the root surface. To facilitate measurement and instrumentation, the crowns of all 60 teeth were removed at the cementoenamel junction with a disc mounted in a high-speed lathe. To ensure apical patency, a #20 K file was passed through the apical foramen before and after completion of root canal preparation.

All 60 teeth were instrumented 1 mm short of the apical foramen to a minimal apical size of 45 using standard K-type files and a step-back technique. Canal flaring was accomplished using Hedstrom files and #2 and #3 Gates Glidden burs. A solution of 5.25% NaOCl was used as a canal irrigant during preparation.

The 15 teeth in group 1 were obturated with laterally condensed gutta-percha and Roth type 801 elite grade root canal sealer (Roth Drug Co., Chicago, IL). A master cone fit with tug back to the apical extent of the canal preparation was coated with freshly mixed sealer and inserted in the canal. Accessory cones were then inserted and condensed laterally using a D-11 spreader placed to within 1 mm of the apical extent of the canal preparation. Excess gutta-percha was removed with a hot instrument and the coronal access was sealed with cavit. No attempt was made to condense the gutta-percha vertically. The sealer was allowed a minimum of 2 wk to set up before further manipulation. All specimens were stored in saline at room temperature.

The apical 2 mm of the root was then resected using a slow-speed air-driven handpiece and a new tapered fissure surgical bur with saline irrigation.

In an effort to ensure that the resections were done in a standard manner, all cuts were made at a right angle to the long axis of the tooth. No further attempt was made to alter the apical seal, and all the specimens were prepared at the same time.

The 15 teeth in group 2 were prepared and treated the same as those in group 1 except that after the apical 2 mm of the root had been resected the exposed gutta-percha was cold burnished with a small-ball burnisher. The teeth in group 3 and group 4 were treated the same as those in group 1 and group 2, respectively, except that during root canal obturation the spreader was only placed to within 5 mm of the apical extent of the canal preparation.

The coronal aspects of all 60 roots were then coated with sticky wax and nail polish was applied to within 1 mm of the exposed gutta-percha at the resected root apex. After allowing the nail polish to dry, all 60 teeth were then submerged in India ink (Pelikan Drawing Ink, Reproducible (Diazo) 17 Black; Gunther Wagner) for 5 days, after which they were rinsed in tap water for 15 min. The wax and nail polish were then removed with a discoid-cleoid hand instrument and the teeth were demineralized for 3 days in 5% HNO_3, dehydrated for 2 days with 100% ethyl alcohol, and then cleared in methyl salicylate so that the extent of ink penetration could be visualized. A stereomicroscope with a Filar micrometer eyepiece was used to measure the length of ink penetration.

To ensure that the experimental model would demonstrate apical leakage, two teeth were prepared as positive controls and two as negative controls. The teeth serving as positive controls were instrumented as described above. They were then obturated with laterally condensed gutta-percha, inserting the spreader to within 1 mm of the apex but using no sealer. Their root surfaces were then coated with wax and nail polish as described above. The teeth serving as negative con-

FIG 1. Example of tooth used as positive control showing gross leakage of India ink.

FIG 2. Example of tooth used as negative control showing no leakage of India ink.

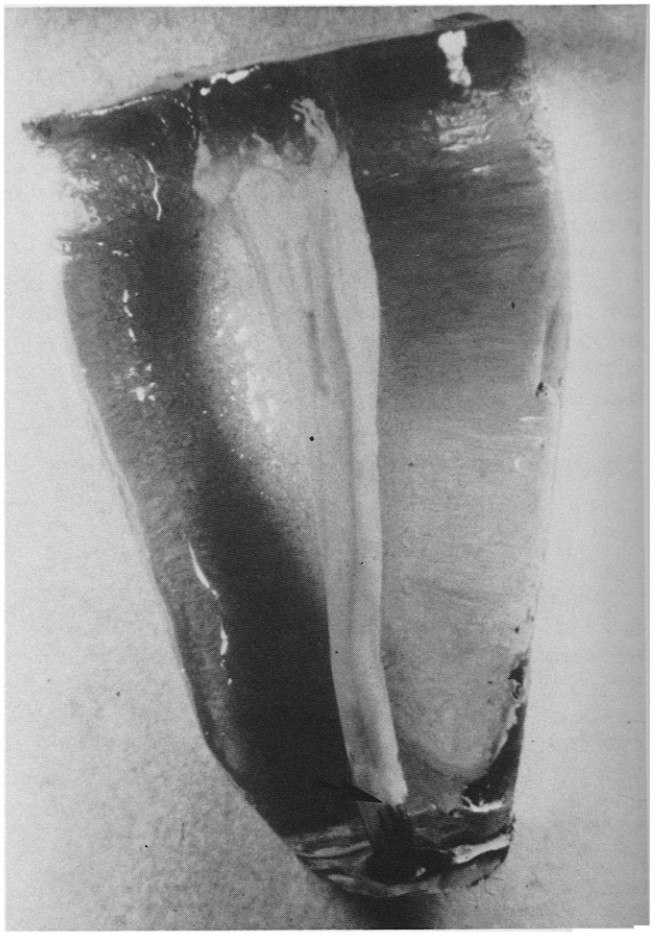

FIG 3. Example of tooth from group 1 in which the canal was well obturated and the gutta-percha was not cold burnished after resecting the root. *Arrow*, extent of ink penetration.

trols were prepared in the same way except that the entire root surfaces were coated with wax and nail polish to include the apical 1 mm. Both control groups were then placed in the ink, cleared, and visualized as with the experimental groups.

RESULTS

Once the specimens had been cleared, it was possible to study the entire circumference of the canal space directly for the presence of India ink, indicating leakage. Gross leakage in excess of 10 mm was observed in the positive control teeth (Fig. 1), whereas no leakage was observed in either of the negative controls (Fig. 2).

Some degree of leakage was observed readily in all four of the experimental groups (Figs. 3–6). Mean apical leakage values and standard deviations for each group are given in Table 1.

Student's *t* test was used to determine whether there were any statistical differences among the groups. Comparisons were made between groups 1 and 2 and between groups 3 and 4 to determine whether cold burnishing had any effect on the apical seal. A comparison was also made between groups 1 and 3 to ensure that filling the canal space with the spreader 5 mm short of the working length did indeed produce a poorly obturated canal. Comparisons and levels of significance are presented in Table 2.

When comparing the difference in apical leakage between groups 1 and 2 it was found that there was a greater penetration of ink in group 2 than in group 1. This was significant at the 0.01 level. In comparing the difference between groups 3 and 4, it was found that group 4 showed less ink penetration than did group 3. The difference was significant at the 0.05 level but not at the 0.01 level. The difference in ink penetration between groups 1 and 3, the groups that were not burnished, was greater in group 3. This was significant at the 0.01 level.

DISCUSSION

The method of examining cleared teeth for ink penetration under a stereomicroscope proved to be a good model for studying apical leakage. The black India ink showed clearly against the pink gutta-percha and linear penetration was easy to measure with the Filar micrometer eyepiece. The fact that extensive ink penetration was demonstrated in the positive control group and no leakage was observed in the negative control group indicates the validity of the experimental design

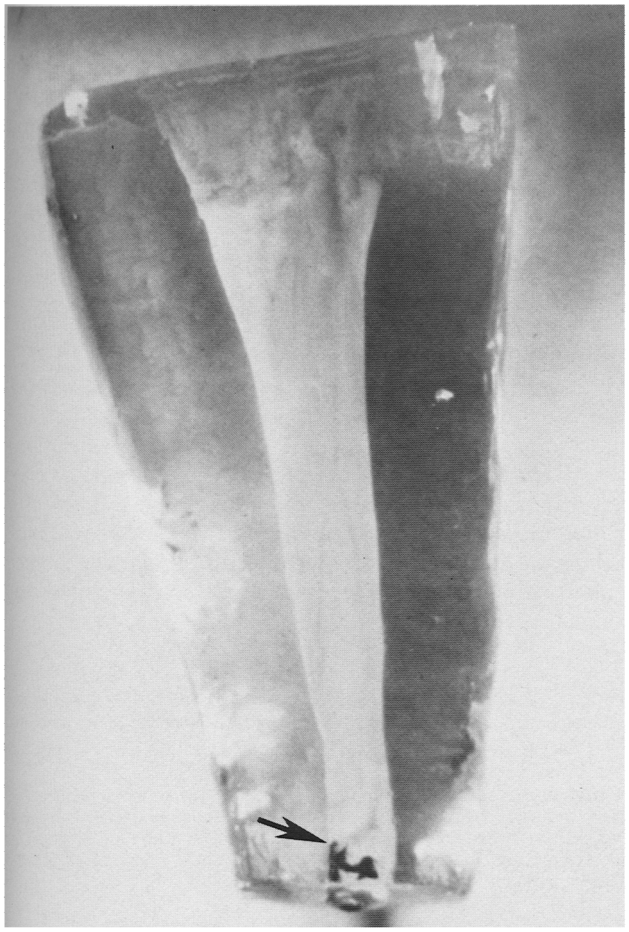

FIG 4. Example of tooth from group 2 in which the canal was well obturated and the gutta-percha was cold burnished after resecting the root. *Arrow*, extent of ink penetration.

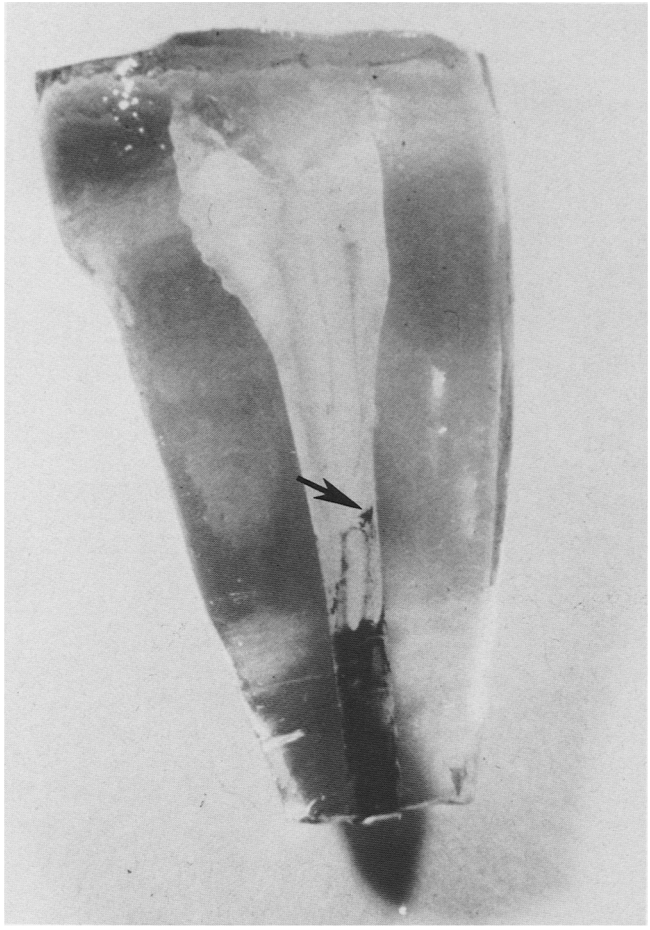

FIG 5. Example of tooth from group 3 in which the canal was poorly obturated and the gutta-percha was not cold burnished after resecting the root. *Arrow*, extent of ink penetration.

to demonstrate leakage around the exposed apical gutta-percha into the root canal system.

Two hypotheses were investigated in this paper. Stated as null hypotheses they are as follows: (a) with well-obturated canals the seal present after apical root resection alone is the same as the seal after apical root resection and cold burnishing the exposed gutta-percha, and (b) with poorly obturated canals the seal present after apical root resection alone is the same as the seal after apical root resection and cold burnishing the exposed gutta-percha.

The depth of spreader penetration was controlled at the time of canal obturation to create a good or poor apical seal. Allison et al. (23) showed in a study of apical leakage that when the spreader tip could be inserted to within 1 mm of the prepared length there was significantly less leakage than when the distance between the spreader tip and prepared length was greater than 1 mm. Groups 1 and 2 were obturated with the spreader tip inserted to within 1 mm of the prepared length, whereas the spreader was inserted 5 mm short in groups 3 and 4. The extent of ink penetration in group 3 was significantly greater than that measured in group 1, indicating poorer apical root canal obturation in groups 3 and 4.

In comparing the results between groups 1 and 2, a significantly greater amount of linear ink penetration was observed in group 2, indicating that cold burnishing the exposed gutta-percha in a well-obturated root canal system resulted in greater leakage than when no cold burnishing was performed. In comparing group 3 with group 4, a significantly smaller amount of linear ink penetration was measured. With a poorly obturated canal, burnishing the gutta-percha exposed after apical root resection improved the seal. Both of the null hypotheses were rejected.

The need for a good apical seal, either before or after root resection, is not at question. A good apical seal is always the ultimate goal. Beatty and Zakariasen (24) state that, although the exact importance of leakage is not known, until it is known it would seem prudent to use techniques that provide the most effective seal. Linear measurement of dye penetration has been traditionally used to assess leakage (9, 11, 21), and it should be pointed out that a wide range of dye penetration was observed in all four groups. The clinical significance of the extent of penetration of fluids into the apical canal space still remains questionable. Additional research to investigate this area is suggested.

Surgery may be indicated in selected cases in which the obturation to the point of resection can be considered good. This may occur in cases in which the need for surgery was created by a separated instrument in the apical root canal

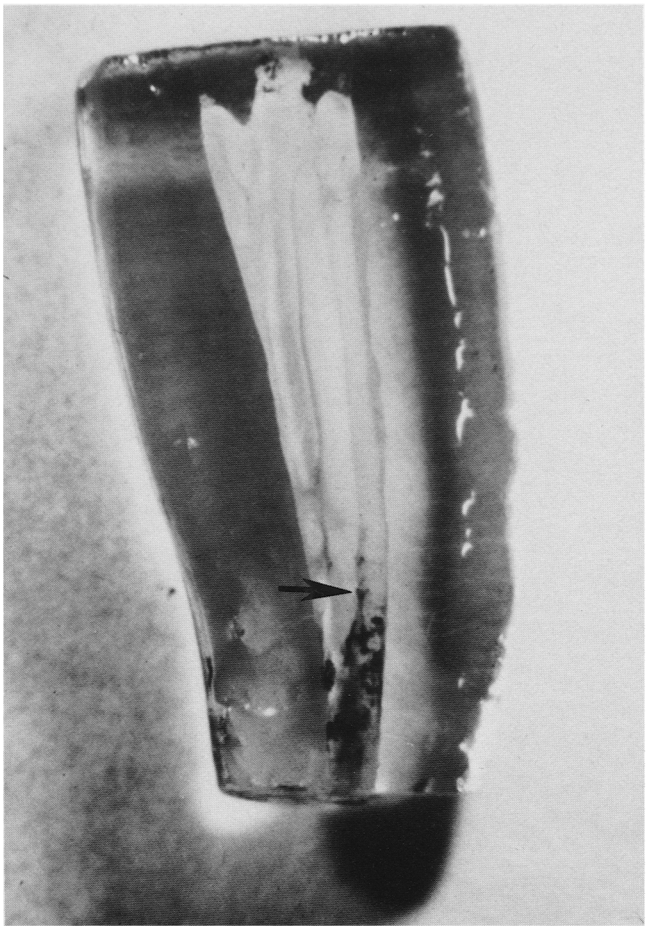

FIG 6. Example of tooth from group 4 in which the canal was poorly obturated and the gutta-percha was cold burnished after resecting the root. *Arrow*, extent of ink penetration.

TABLE 1. Linear ink penetration in each group

Group	Linear Ink Penetration (mm)*
1	0.568 ± 0.488
2	1.144 ± 0.422
3	1.412 ± 0.927
4	0.553 ± 0.857

* Mean ± SD.

TABLE 2. Statistical significance between experimental groups

Group Comparison	Significance Level
1 versus 2	$0.001 < p < 0.01$
3 versus 4	$0.02 < p < 0.05$
1 versus 3	$0.001 < p < 0.01$

space or in cases in which the apical portion of the root canal system cannot be properly prepared and obturated, resulting in persistent symptoms. The canal space coronal to the point of root resection may be instrumented and obturated well. If the decision is made not to place an apical restoration after root resection then the operator must decide how to handle the exposed gutta-percha. The results of this study would indicate that if the canal had been well obturated originally and no apical restoration was planned then the gutta-percha exposed after the root was resected should not be cold burnished. On the other hand, if the quality of the original obturation was poor or questionable then cold burnishing the exposed gutta-percha or placing a reverse filling may be the treatment of choice (7).

CONCLUSIONS

The effect of cold burnishing gutta-percha exposed after apical root resection was investigated using an in vitro clearing technique that allowed linear ink penetration measurements.

Based on the results of this study, the following conclusions were made: (a) cold burnishing the gutta-percha exposed after apical root resection of a well-obturated canal resulted in a poorer apical seal than did no burnishing; and (b) cold burnishing the gutta-percha exposed after apical root resection of a poorly obturated canal resulted in an improved apical seal compared with no burnishing.

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or Department of Defense.

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