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MicroSeal systems and modified technique

Francesco Maggiore, DDS

Department of Endodontics, School of Dental Medicine, University of Pennsylvania, 240 South 40th Street, Philadelphia, PA 19104-6030, USA

Proper obturation of the root canal system is an essential final step of endodontic therapy. In fact, the endodontic filling has the primary goals of keeping clean the environment achieved by the biomechanical instrumentation, providing a hermetic apical and coronal seal, and eventually obliterating within the obturation material any remnants or debris that the endodontic instruments or solvents are not able to eliminate [1–3].

Technically speaking, the aforementioned objectives can be obtained by an endodontic filling that is able to penetrate the entire root canal system, extend as close as possible to the cementodentinal junction, and have an adequate density necessary for the operator to radiographically evaluate the endodontic procedure [4,5].

The concept that a successful obturation depends very much on proper cleaning and shaping procedures is well accepted by practitioners. Thus, the preparation of the root canal system is crucially important not only for the removal of the organic and inorganic irritants but also for allowing the correct placement of the obturation material.

A key step during the biomechanical instrumentation and for the obturation is the access cavity preparation. The extension of the access cavity has to be a balance between access that is large enough to allow the location of all the canal orifices but conservative enough to prevent any unnecessary loss of coronal dentin. Also, a good access cavity requires the removal of the coronal interferences to insert the endodontic instrument in a straight line path to the apical third. Although additional removal of coronal dentin during the access preparation would facilitate ample access, it would also weaken the root walls and possibly predispose the root to lateral or strip perforations and root fractures during post placement [6].

Nevertheless, most obturation techniques require the placement of the obturation instruments (spreader or plugger) in the apical or middle third of the root to manage the delicate area [7]. Thus, in situations in which

E-mail address: fmaggiore@hotmail.com

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Fig. 1. Components of the MicroSeal system (SybronEndo, Orange, California).

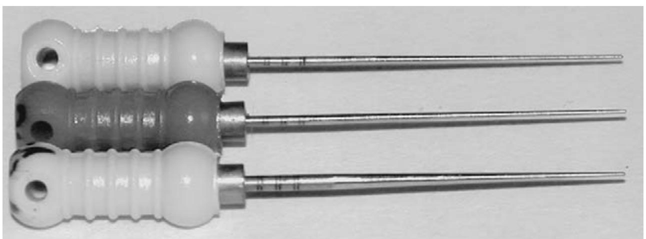


Fig. 2. MicroSeal finger spreaders (size/taper): 20/0.02 (*top*), 25/0.02 (*middle*), 25/0.04 (*bottom*) (SybronEndo).

this placement is not possible because of a canal's narrow dimension, a conservative preparation, or a curved canal, it is often necessary to enlarge the coronal or middle third of the root canal to allow the placement of the instrument to the proper depth [8]. It is obvious that this enlargement is not biologically dictated; rather, it is due to the technical limitation of the obturation method.

One of the obturation techniques more likely suitable for the above cases is the MicroSeal obturation system (SybronEndo, Orange, California)

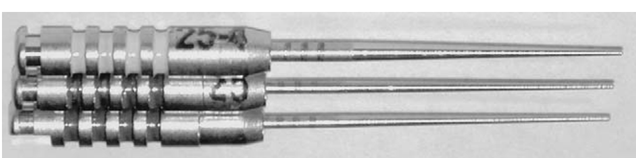


Fig. 3. MicroSeal engine spreaders (size/taper): 25/0.04 (*top*), 25/0.02 (*middle*), 20/0.02 (*bottom*) (SybronEndo).

Fig. 4. MicroSeal condenser size 25, 0.04 taper (SybronEndo).

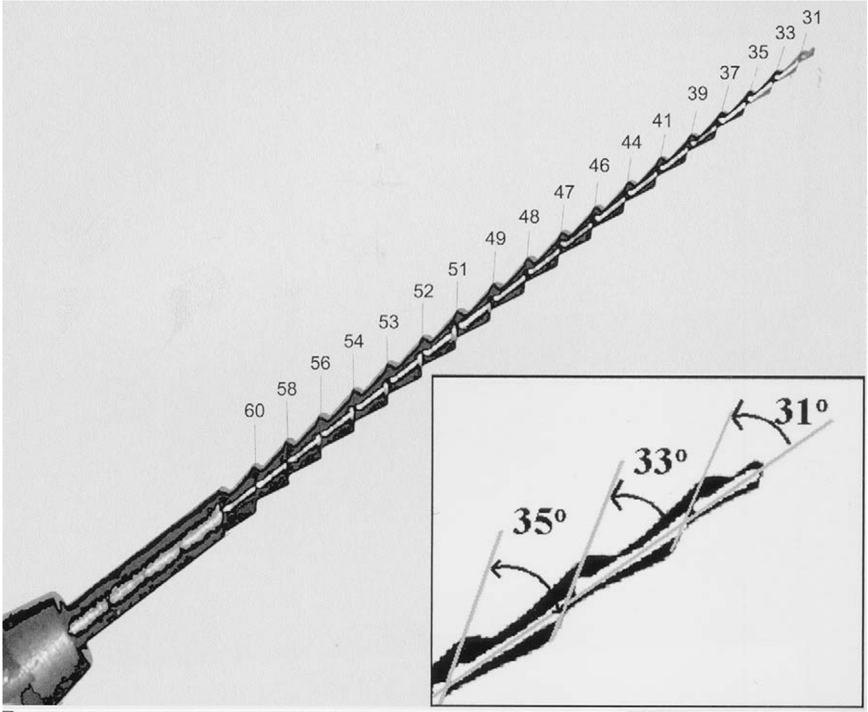


Fig. 5. MicroSeal condenser size 25, 0.04 taper. Measurement of the angle between the blades and the axis of the instrument (SybronEndo).

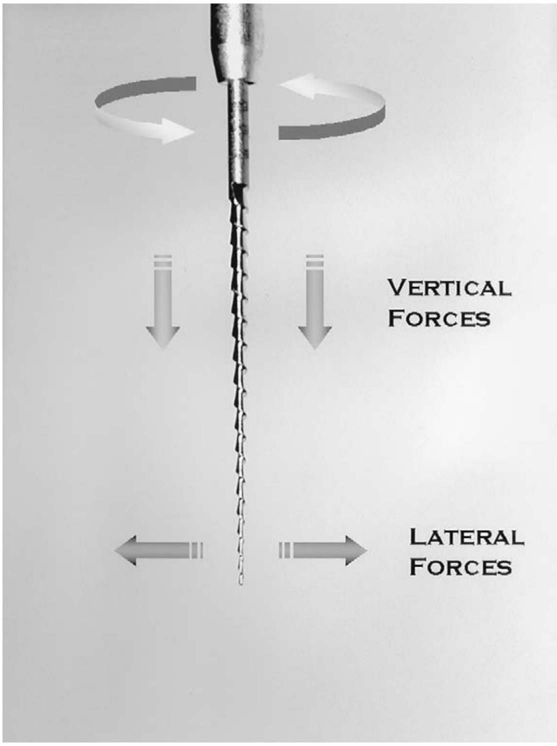


Fig. 6. Vertical and lateral forces generated by the MicroSeal condenser (SybronEndo).

Fig. 7. MicroSeal gutta percha cones (size/taper): 25/0.04 (*far right*), 25/0.02 (*middle right*), 30/0.02 (*middle left*), 35/0.02 (*far left*) (SybronEndo).

Fig. 8. MicroSeal gutta percha heater (SybronEndo).

because it is able to preserve a conservative preparation and provide an adequate penetration by the obturation instruments in the apical third. In this article, different aspects of this technique are discussed.

Description of the system

The MicroSeal technique was introduced in 1996 and can be considered one of the thermomechanical compaction techniques that uses a rotary instrument to plasticize the gutta percha and move it within the root canal apically and laterally. The first thermomechanical compaction technique was introduced by Dr. J.T. McSpadden in 1979 (personal communication, 1979).

The MicroSeal system consists of a series of instruments: the nickel–titanium (NiTi) spreader, the NiTi condenser, the gutta percha heater, the gutta percha syringe, and a special formulation of gutta percha available in cones or in cartridges, called low-fusing gutta percha or ultra–low-fusing gutta percha, respectively (Fig. 1).

MicroSeal nickel–titanium finger and engine spreader

The MicroSeal system provides finger and engine NiTi spreaders. The finger spreaders are available in 0.02 taper in size 20, 25, 30 and in 0.04 taper in size 25 (Fig. 2). They are designed to be used with a continuous rotational motion. The engine spreaders are mounted on a 1:16 reduction handpiece and used at 300 rpm (Fig. 3).

The MicroSeal technique suggests the use of one master cone at the working length. After placement of the master cone at the working length, the spreader compacts the gutta percha cone in the apical third and because of its high flexibility, it can reach the proper depth in the majority of the clinical situations [9].

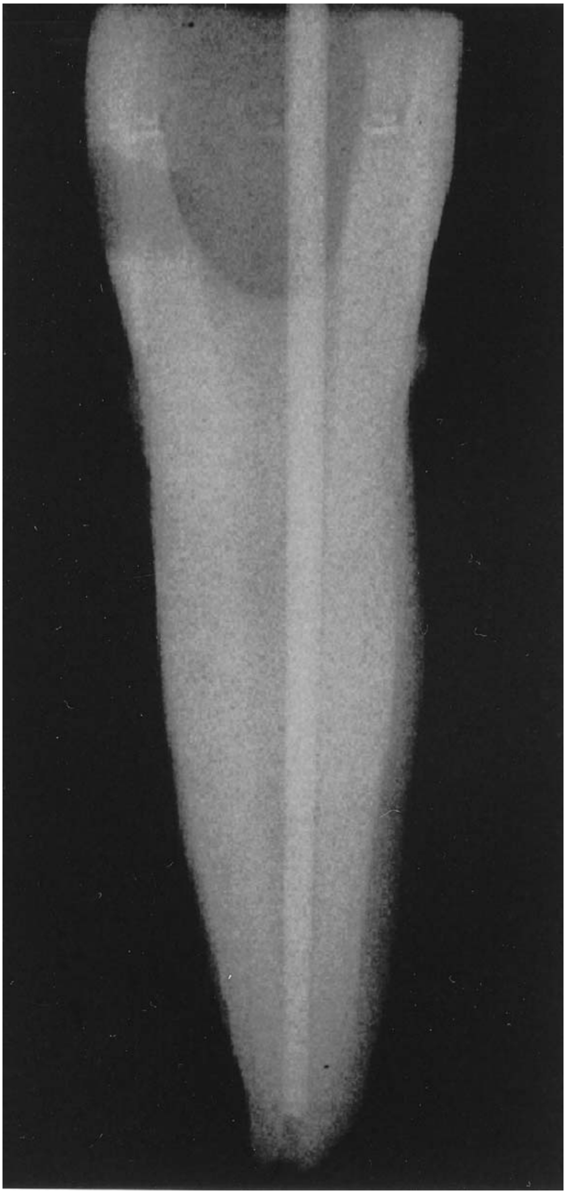


Fig. 9. Radiograph confirming the length of the master cone (MicroSeal, SybronEndo).

MicroSeal condenser

Particularly interesting is the MicroSeal condenser (Fig. 4). This instrument is made of NiTi, has a reverse helix design, and is available in 0.02 taper in sizes 25 to 60 and in 0.04 taper in size 25. The condenser is

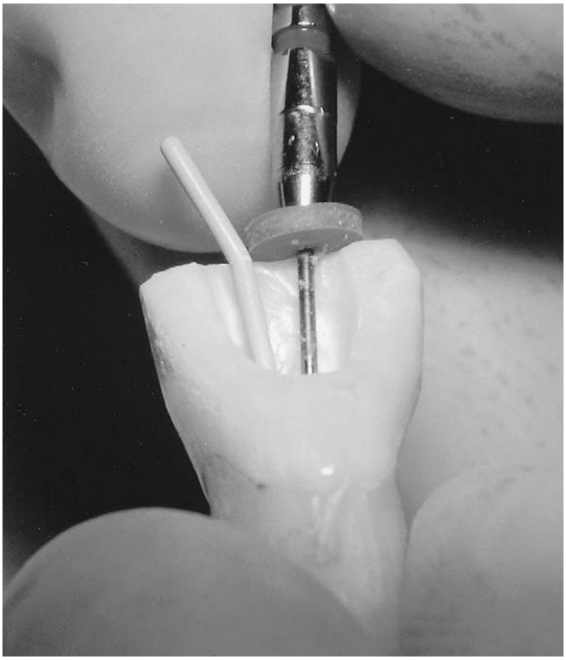


Fig. 10. MicroSeal spreader reaches the proper length alongside of the master cone (SybronEndo).

designed to be used on a 1:1 electric handpiece between 5000 and 7000 rpm.

During its rotation into the root canal, the condenser has the primary goal of generating heat by friction to plasticize the gutta percha cone. Also, the condenser creates centrifuge forces able to press the warm gutta percha

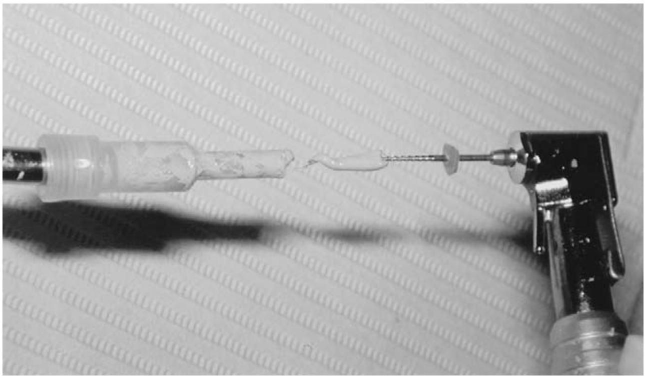


Fig. 11. MicroSeal condenser coated with warm gutta percha from the cartridge (SybronEndo).

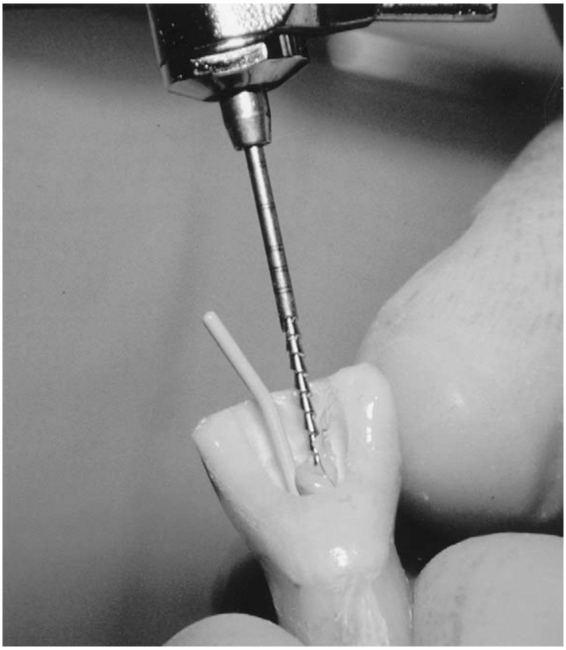


Fig. 12. MicroSeal condenser carries warm gutta percha into the canal (SybronEndo).

into all the spaces within the root canal. Because it is made of NiTi, it is highly flexible and can reach the apical 2 to 3 mm in most cases.

On careful inspection of the angle between the reverse blades of the condenser and the axis of the instrument, a decrease in amplitude from

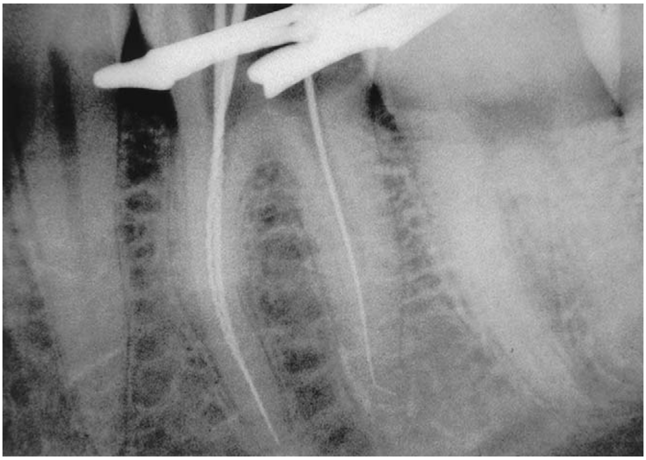


Fig. 13. Tooth No. 19. Apical hook in the distal root.

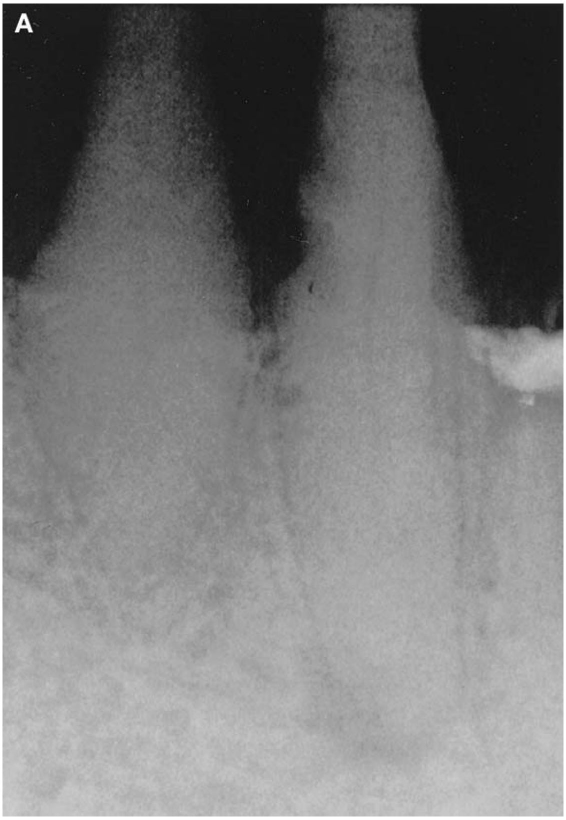


Fig. 14. (*A*) Preoperative radiograph for tooth No. 23 showing an apical bifurcation. The tooth has been prosthetically prepared before the root canal. (*B*) Postoperative radiograph for tooth No. 23. Note the small access cavity to preserve the prosthetic preparation and the management of the apical bifurcation.

the handle to the tip can be noticed; that is, the angle between the blade and the shaft is more open in the coronal part and gradually becomes more closed in the apical part. The author's measurements, using Cad-Cam software, provided an angle varying from 60° to 30° (Fig. 5). This assessment has a very important clinical implication. In fact, the forces generated by the rotating condenser are directed apically mostly in the coronal part of the instrument and laterally at the tip level. This unique design is most likely thought to prevent the possibility of extrusion of the gutta percha beyond the apical constriction. Also, for these reasons, the condenser can be considered to act as a plugger in the coronal part of the root canal and as a spreader in the apical region, generating vertical and lateral forces selectively (Fig. 6).

Fig. 14 (*continued*)

MicroSeal gutta percha cones

According to the manufacturer, the MicroSeal technique requires the use of one master cone at the working length. MicroSeal gutta percha cones are available in 0.02 taper in sizes 25 to 60 and in 0.04 taper in size 25 (Fig. 7). The MicroSeal gutta percha cones are made of low-fusing gutta percha, advertised to be alpha (α) gutta percha at room temperature.

Depending on the temperature, gutta percha is available in two different crystalline forms: the beta (β) phase (37°) and the alpha (α) phase (42°–44°). The β-phase gutta percha is the commonly found gutta percha at room temperature and consists of a high molecular weight polymer. Warming of the β-phase gutta percha will change the crystalline structure into the α-phase gutta percha characterized by low molecular weight due to the

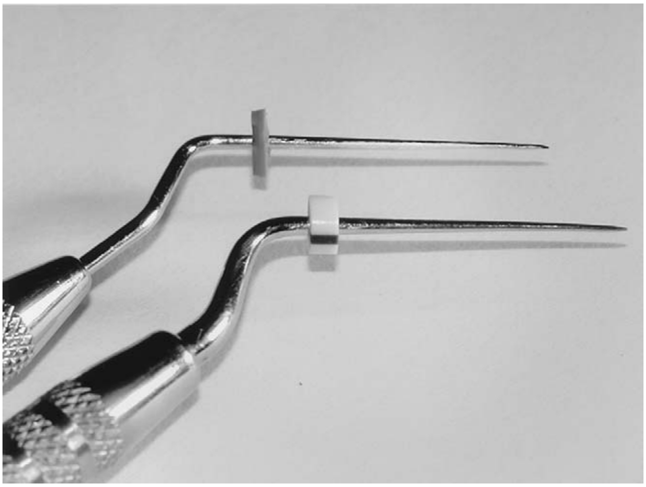


Fig. 15. Spreader D11T (*top*); spreader D11 (*bottom*).

breakage of the chemical links of the polymer. Conversely, cooling of the α-phase gutta percha will produce β-phase gutta percha, and shrinkage occurs during this process. Therefore, to compensate for the undesirable shrinkage of the gutta percha for obturation methods using warm gutta percha, it has been suggested to compact the material while it is cooling with the use of a plugger [10].

Fig. 16. Apical foramen with oval shape.

Fig. 17. Use of accessory cones to create an apical stop for canals with oval foramen.

In the MicroSeal system, the cones are made of α-phase gutta percha at room temperature. In this way, only minimal shrinkage takes place during the cooling phase.

For the same reason, the gutta percha cartridges consist of ultra–low-fusing gutta percha. For infection control purposes, the gutta percha cartridges are made for single-patient use only.

Fig. 18. Radiographic comparison of gutta percha cones size 30, 0.02 taper from the following brands: Hygenic (*far left*), Caulk Densply ISO color (*middle left*), Caulk Densply ISO noncolor (*middle right*), and MicroSeal (*far right*).

Fig. 19. Gutta percha cones tested in the preclinical study: Hygenic, Caulk Densply ISO color, Caulk Densply ISO noncolor, and MicroSeal.

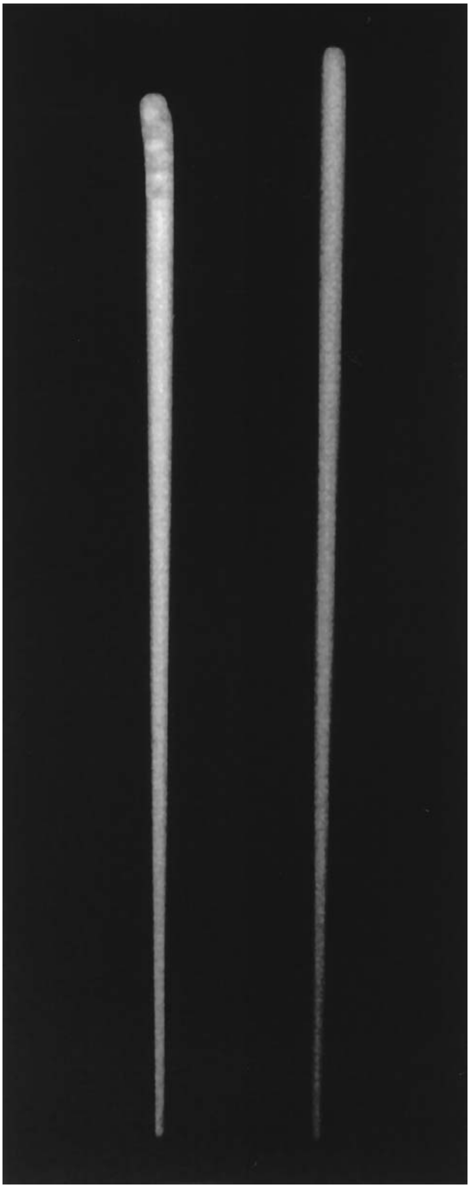


Fig. 20. Radiographic comparison of gutta percha cones size 30, 0.02 taper from Caulk Densply ISO noncolor (*left*) and MicroSeal (*right*).

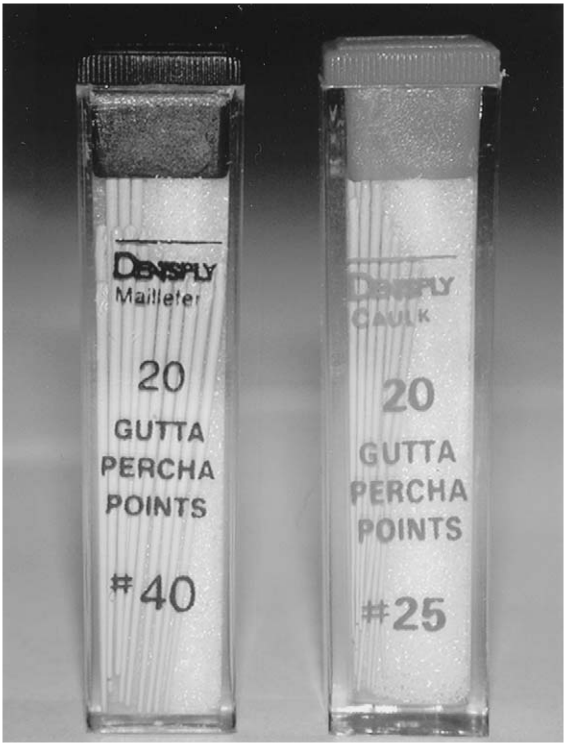


Fig. 21. Gutta percha cones from Caulk Densply ISO noncolor used in the preclinical test.

MicroSeal gutta percha heater

To warm the gutta percha in the cartridge, the MicroSeal heater can be used (Fig. 8). This machine is very easy to handle and after the heater is turned on, the working temperature is reached within 45 seconds. As soon as the gutta percha in the cartridge becomes plasticized, it is ready to be used.

Description of the technique

When the canal is ready to be filled, the selection of the master cone is the first step of the procedure. Proper tug back 0.5 to 1 mm short of the working length is the criteria for the selection of the master cone. According to the manufacturer, large canals require a 0.04 taper master cone, whereas the 0.02 taper is indicated for narrow canals.

It is advisable to confirm the length of the master cone radiographically (Fig. 9).

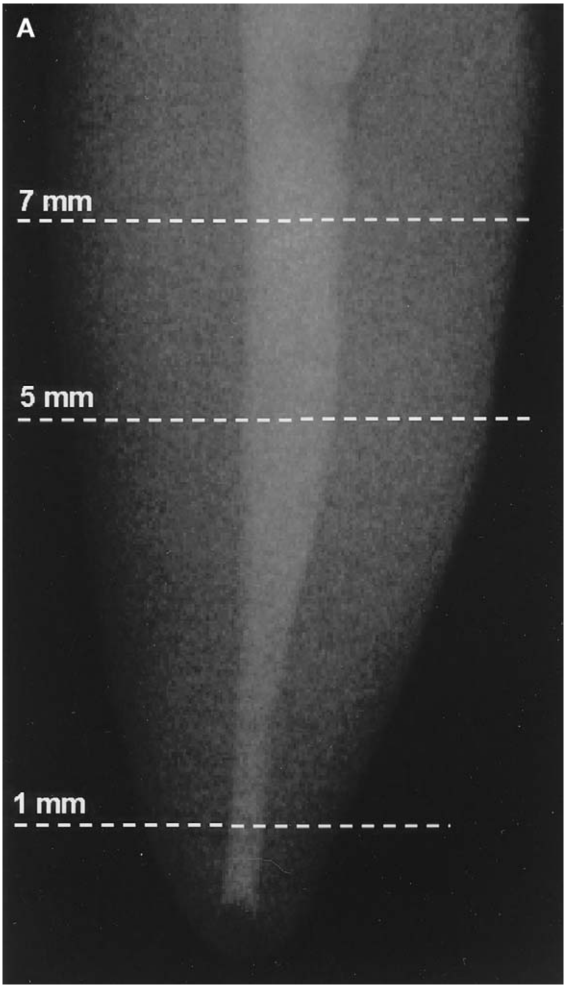


Fig. 22. Group 1, n = 8. Radiographs in clinical (*A*) and proximal (*B*) view. Cross-sections at the 1 mm (*C*), 5 mm (*D*), and 7 mm (*E*) levels.

After dipping the tip of the selected master cone into endodontic sealer, it is introduced into the canal. The NiTi MicroSeal spreader is advanced to within 1 to 2 mm from the working length and is rotated (Fig. 10). The spreader is then removed from the canal; space has been created between the master cone and the canal walls.

Next, the gutta percha cartridge is heated and the condenser is introduced into the cartridge and gently removed to cover 5 to 6 mm of the instrument with warm gutta percha (Fig. 11). The coated condenser can now be introduced into the canal space created by the spreader (Fig. 12).

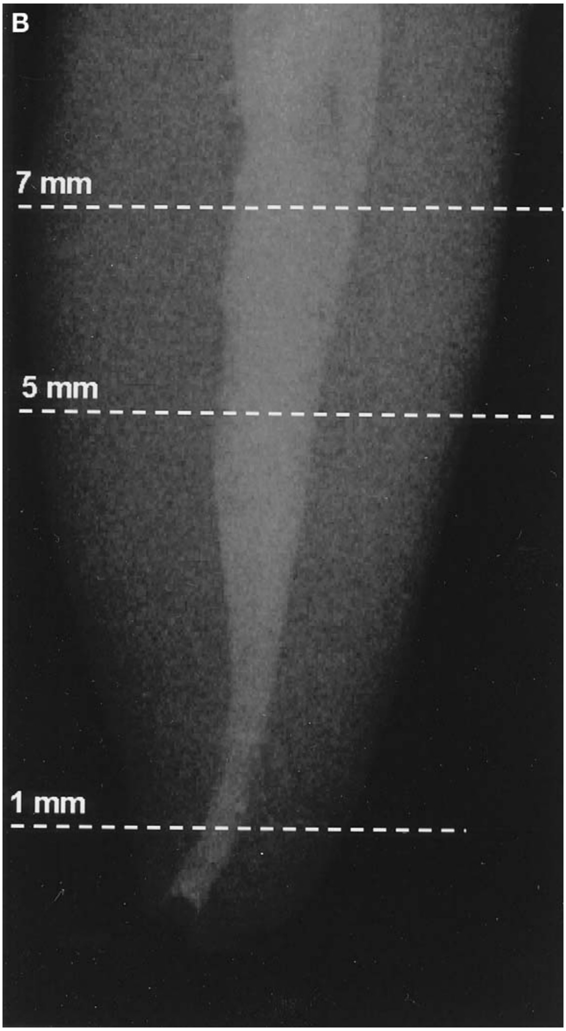


Fig. 22 (*continued*)

Generally, it is advisable to select a 0.04 taper condenser when a 0.02 taper master cone has been used and to select a 0.02 taper condenser when a 0.04 taper master cone has been used. The selection of the condenser strictly depends on the clinical situation.

It is important to place the condenser as close as possible to the working length and not to rotate the instrument while inserting. After it is seated, the rotation of the condenser can begin. In the very first moment of the spin, the generated force promotes a tendency to withdraw the condenser from the canal. This force has to be countered by firmly keeping

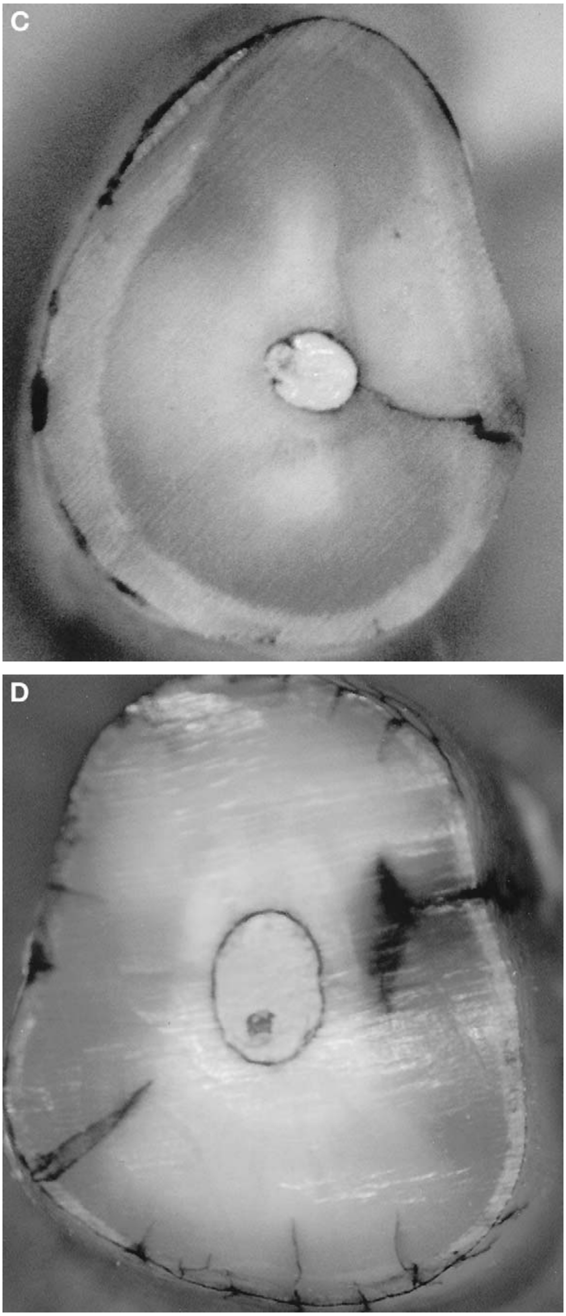


Fig. 22 (*continued*)

Fig. 22 (*continued*)

the instrument in place for 1 or 2 seconds. The condenser is then removed while rotating with a gentle stroking motion against the canal walls. The whole procedure requires no more then 6 seconds. If the first spin does not fill the canal completely, then the condenser can be coated with new gutta percha and a second spin can carry additional gutta percha into the canal.

Modifications

The technique just described is the one recommended by the manufacturer. To improve some of the aspects of the technique, the following suggestions are made by the author.

First, the use of the NiTi spreader is of great advantage, especially in the case of curved canals, because it guaranties that the instrument reaches the proper depth of 1 mm from the working length [9,11]. Alternately, in certain clinical circumstances, as with a sharp apical hook (Fig. 13), the NiTi spreader can be bent under pressure and may not transmit its compacting force to the gutta percha cone. Also, there are root canal anatomies such as apical bifurcations (Fig. 14) that require management by a prebent spreader,

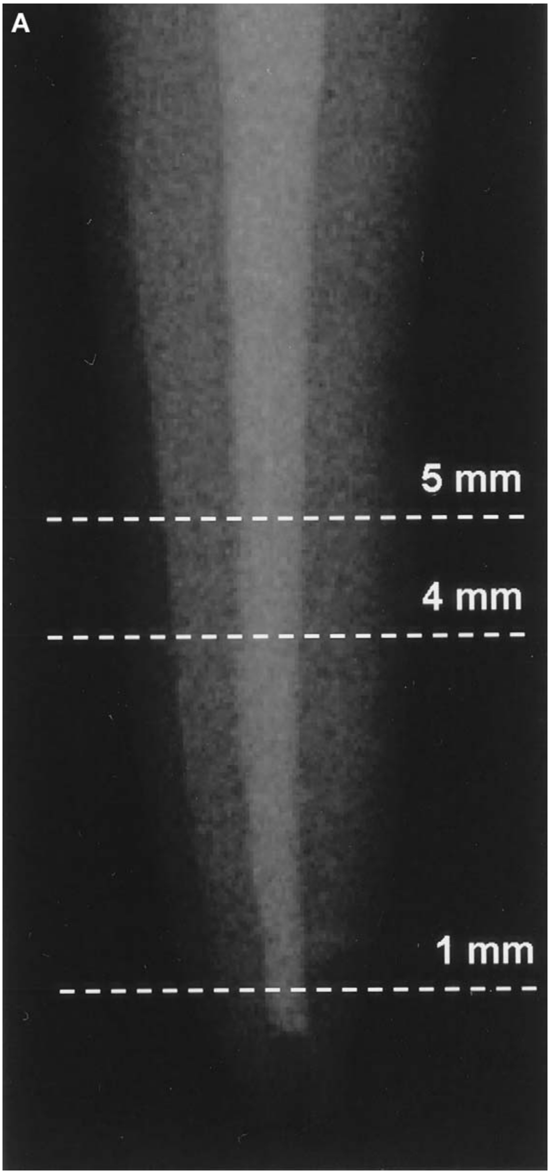


Fig. 23. Group 2, n = 2. Radiographs in clinical (*A*) and proximal (*B*) view. Cross-sections at the 1 mm (*C*), 4 mm (*D*), and 5 mm (*E*) levels.

and the NiTi spreader cannot be precurved [12]. Thus, the use of the stainless steel spreader D11T can replace the NiTi finger spreader for the apical compaction of the master cone where indicated (Fig. 15). In addition to the apical compaction of the master cone, the author finds the use of

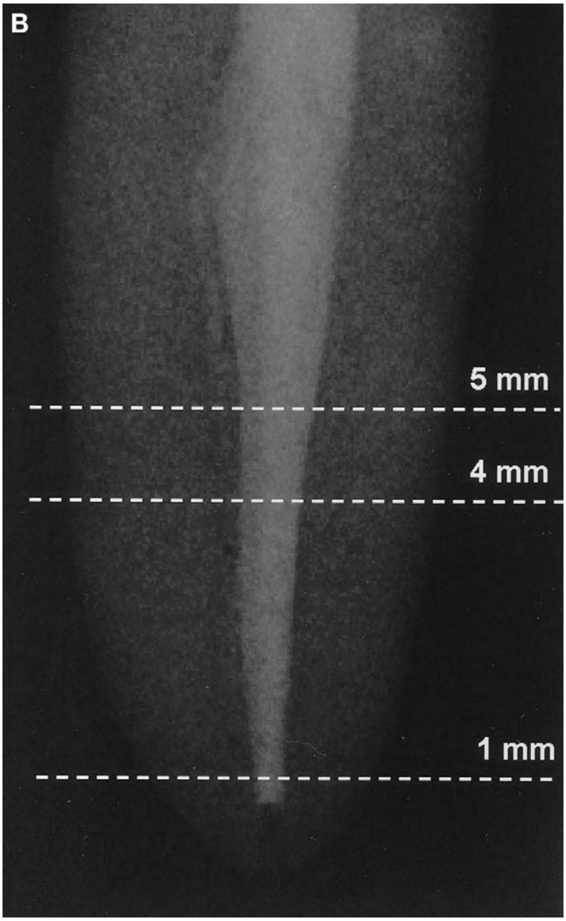


Fig. 23 (*continued*)

a more tapered spreader such as the D11 helpful to create more space, specifically in the coronal part of the canal (see Fig. 15). In this way, the subsequent introduction of the condenser becomes easier and faster. For this purpose, the D11 spreader is not supposed to reach the apical area because its main action occurs at the orifice level. It is very important that the spreader D11 is not forced but is gently guided as far as it will go into the root canal.

Second, the use of the master cone has the primary objective of creating an apical stop. In this way, further use of the condenser coated with warm gutta percha is prevented from pushing any filling material beyond the apical constriction. Because there is a high variation in size and shape of the apical anatomy, there are situations in which the master cone alone does not

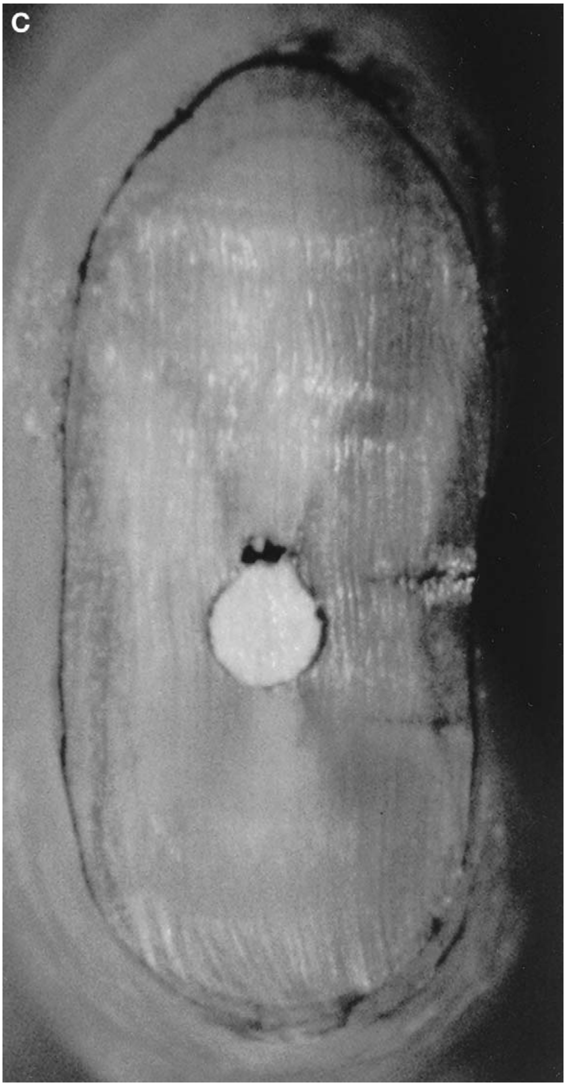


Fig. 23 (*continued*)

completely seal the apex. In these situations, the apical foramen is oval in shape (Fig. 16) or is ribbon shaped due to the confluence of two canals in the same apical exit [13]. In such situations, in addition to the master cone, the use of one or two accessory cones (generally 0.02 taper, size 25) may provide a more secure apical stop against which the rotating condenser can be safely pushed (Fig. 17). In fact, the use of one master cone in all cases could result in some undesired overfilling or underfilling.

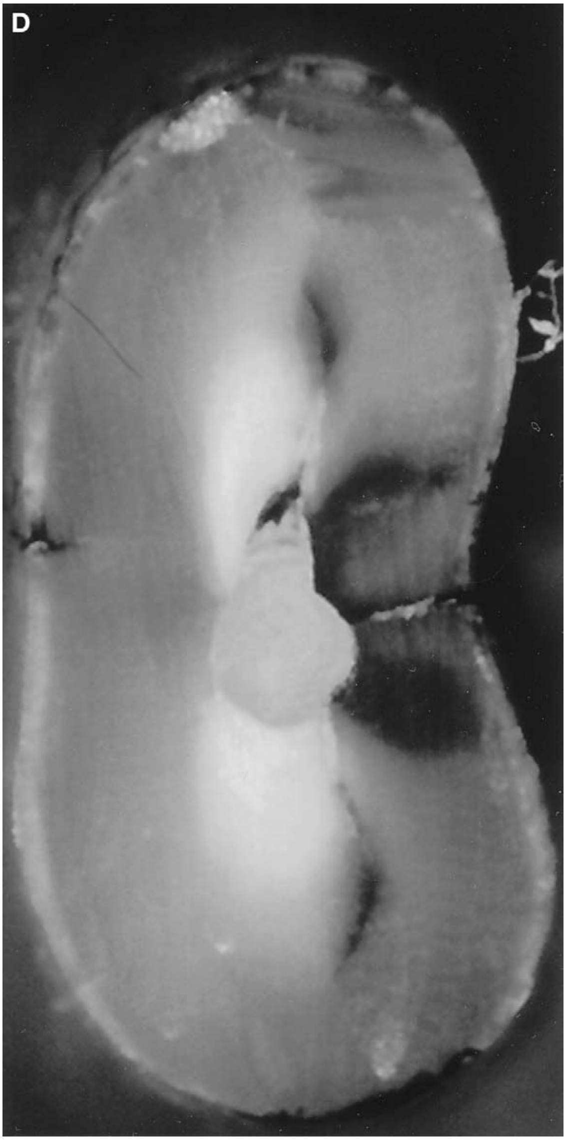


Fig. 23 (*continued*)

Third, according to the manufacturer, the selected master cone can be a 0.04 taper or a 0.02 taper. Other than the fact that the 0.04 taper gutta percha cones are available only in size 25—with the obvious limitation that this represents—the author would like to emphasize how important it is to have a good tug back in the apical 1 mm of the canal. A less tapered cone

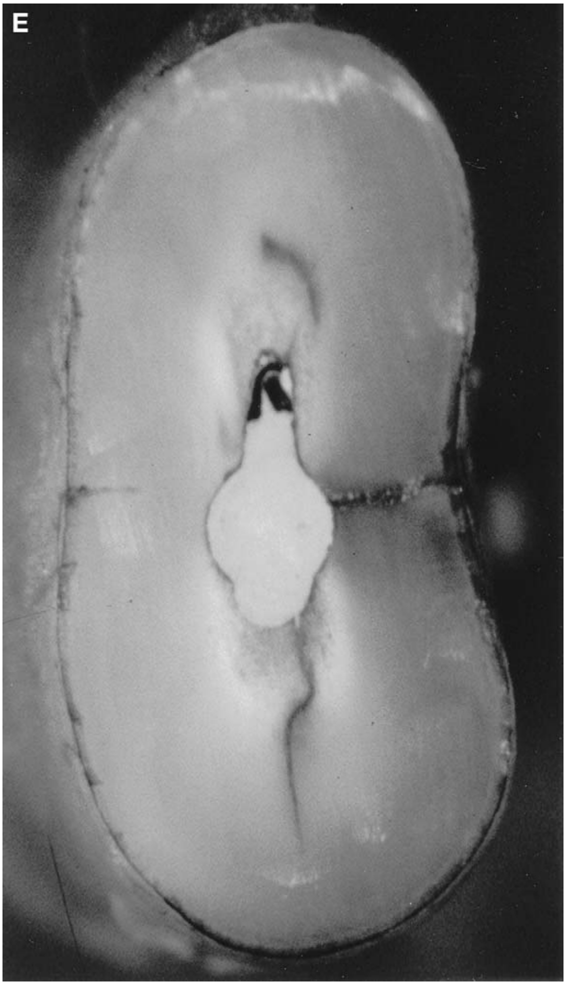


Fig. 23 (*continued*)

can achieve this result more predictably. Also, if one considers that the use of one or two accessory cones in addition to the master cone is frequently indicated, the selection of a 0.04 taper master cone would risk creating a bulk of gutta percha at the orifice level. This bulk would interfere with further insertion of the condenser coated with warm gutta percha. Thus, the 0.02 taper master cone is the one more likely indicated in the majority of the cases.

A fourth consideration is the use of the plugger at the end of each compaction. It is true that the ultra–low-flow gutta percha from the MicroSeal system undergoes less shrinkage, but it is also true that after the

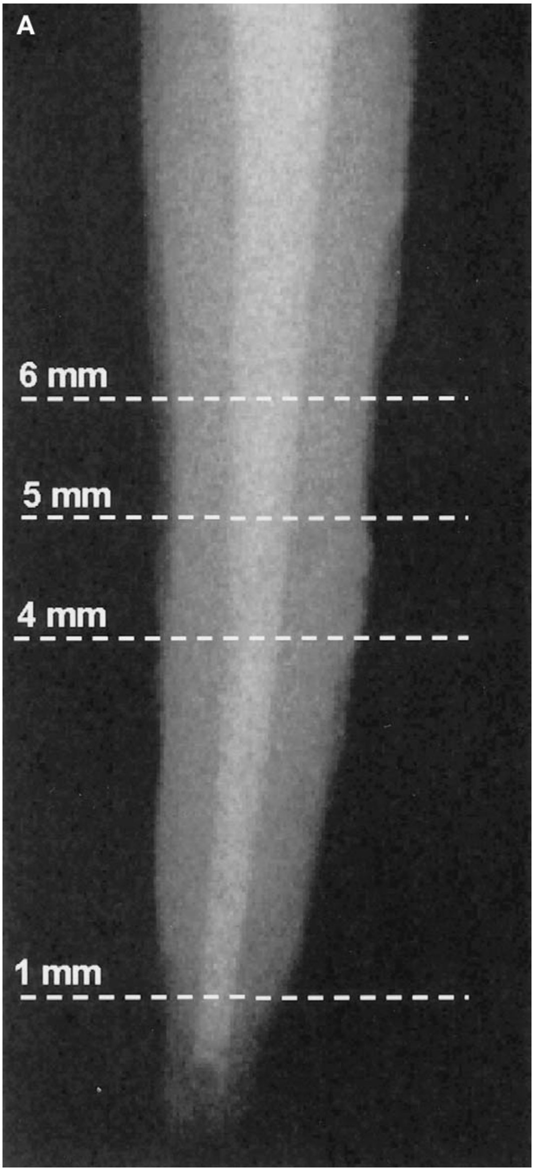


Fig. 24. Group 3, n = 1. Radiographs in clinical (*A*) and proximal (*B*) view. Cross-sections at the 1 mm (*C*), 2 mm (*D*), 4 mm (*E*), 5 mm (*F*), 6 mm (*G*), and 6.5 mm (*H*) levels.

use of the condenser, an amorphous mass of gutta percha fills the canal. To better adapt the melted filling material to the canal walls, the use of the plugger is of great benefit. The author believes that the obturation does not end with the rotation of the condenser; the coronal compaction using

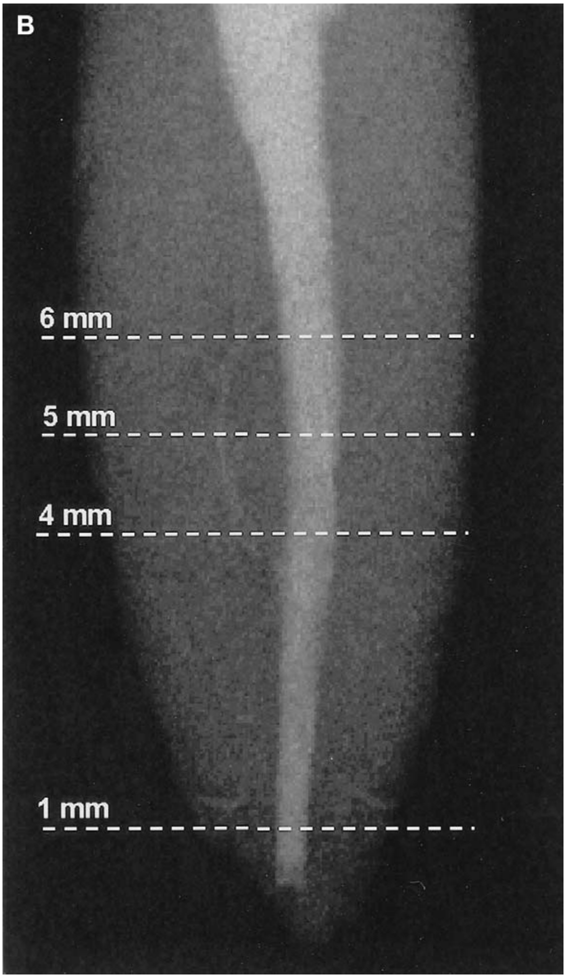
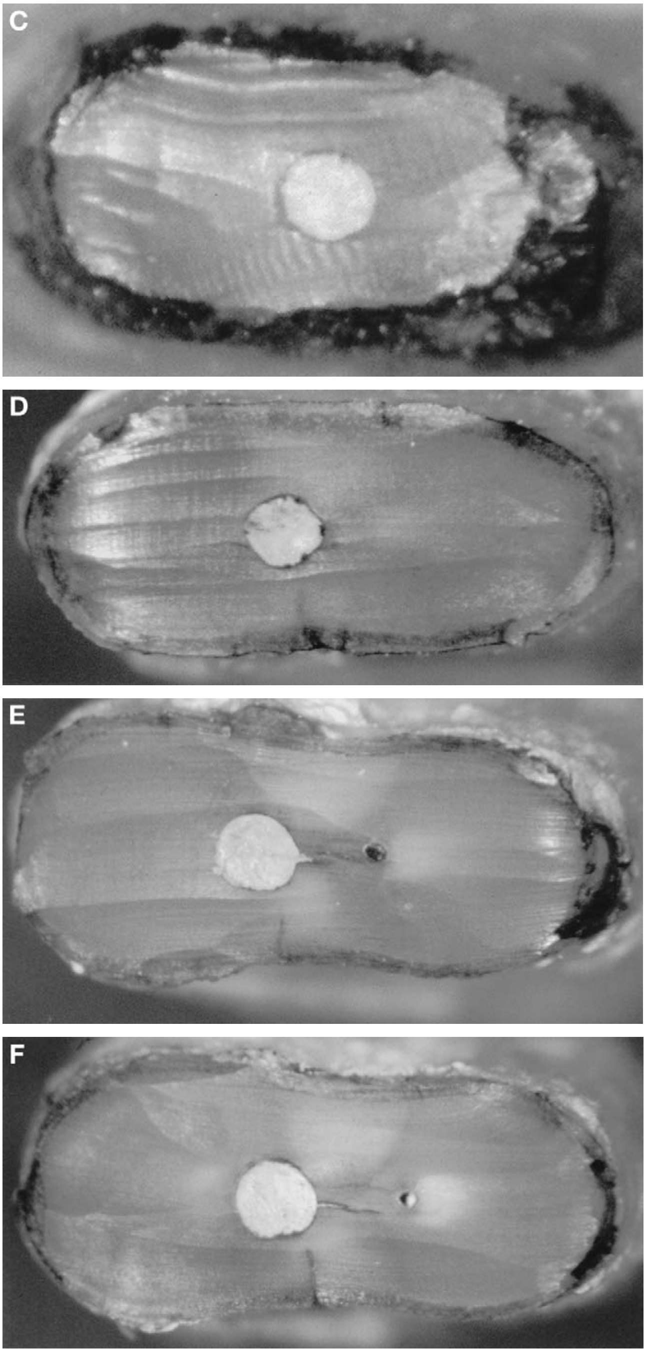


Fig. 24 (*continued*)

a plugger of proper size greatly increases the adaptation of the gutta percha to the root canal system, prevents formation of voids, and ultimately provides a more dense and homogeneous obturation.

Fifth, one of the main differences between the MicroSeal gutta percha cones and other brands of gutta percha cones is the radiopacity. The author compared the radiopacity of the MicroSeal gutta percha cone with other gutta percha cones on the market. The MicroSeal gutta percha cones appear to be less radiopaque (Fig. 18), which may present a disadvantage because the evaluation of the root canal filling is clinically done on the basis of its radiographic density [4].



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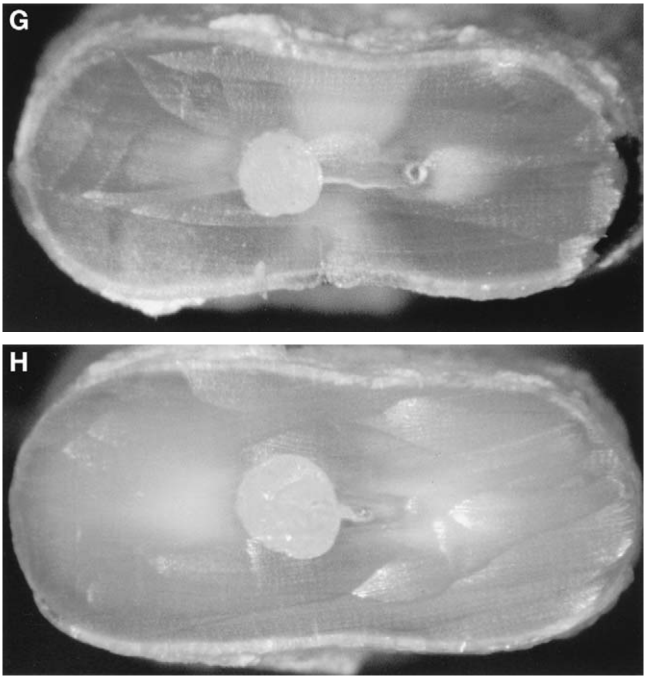

Fig. 24 (*continued*)

A preclinical test was done to explore the possibility of using a more radiopaque brand of gutta percha cones for the MicroSeal technique and for using one or two accessory cones and a plugger. In a preliminary stage of the study on extracted teeth, different brands of gutta percha cones were substituted for the MicroSeal cones using the MicroSeal technique.

Gutta percha cones (Hygenic, Caulk Densply International Standards Organization [ISO] noncolor, Caulk Densply ISO color, and MicroSeal) were tested (Fig. 19). Among the different brands, the cones manufactured by Caulk Densply (ISO noncolor) were the most similar to the MicroSeal cones in handling and obturation characteristics. They also showed a higher radiographic density (Fig. 20). Therefore, the author decided to use the MicroSeal gutta percha cones and the Caulk Densply (ISO noncolor) gutta percha cones in the preclinical test (Fig. 21).

In the preclinical study, an interesting observation was that the ISO color and the ISO noncolor gutta percha cones by Caulk Densply, despite having the same manufacturer, showed a very different clinical behavior.

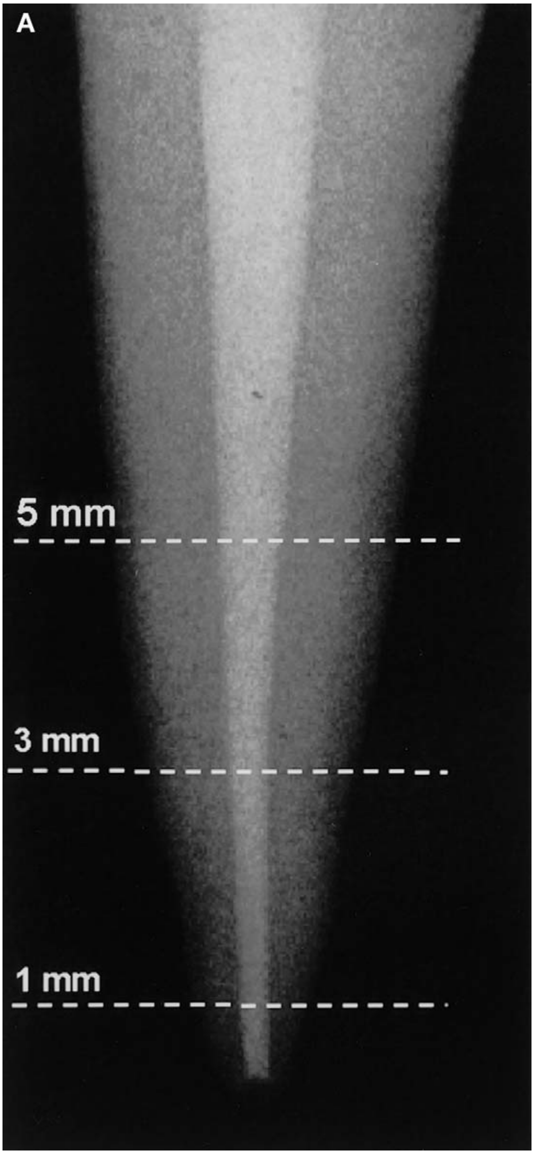

Fig. 25. Group 3, n = 6. Radiographs in clinical (*A*) and proximal (*B*) view. Cross-sections at the 1 mm (*C*), 3 mm (*D*), and 5 mm (*E*) levels.

Preclinical test

Sixteen straight single-rooted teeth were divided into four groups of 4 teeth each, with each group consisting of two narrow canals and two large canals. All canals were instrumented using the same instrumentation

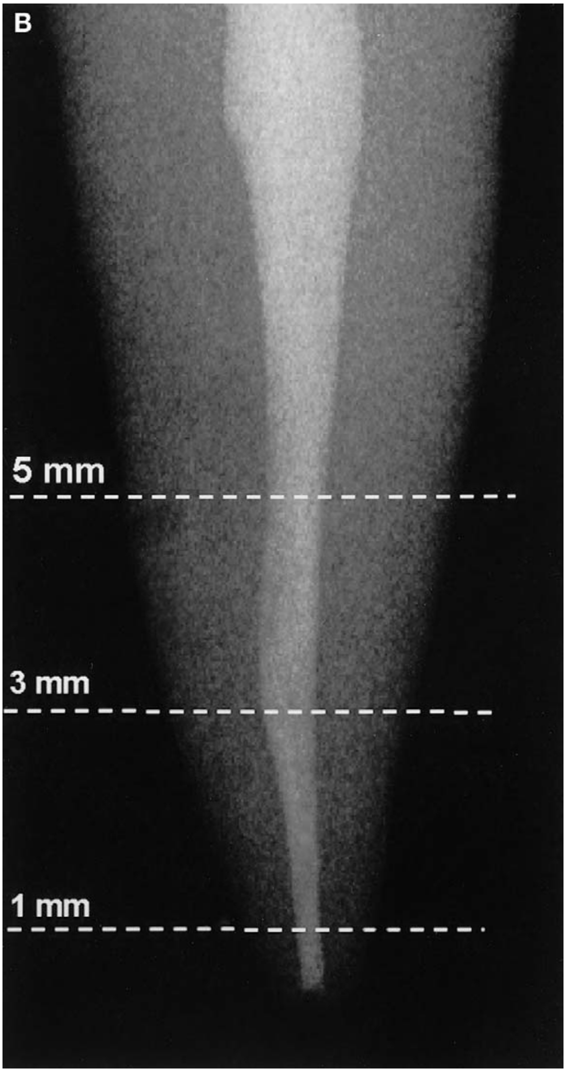

Fig. 25 (*continued*)

technique. After access was made, the preflaring was accomplished using Gates–Glidden instruments in sizes 2, 3, and 4. The canals were prepared using the Profiles 0.06 taper. Canals were prepared up to size 35 or 45 depending on the initial apical size and were irrigated with sodium hypochlorite and EDTA, alternating after each instrument. For the

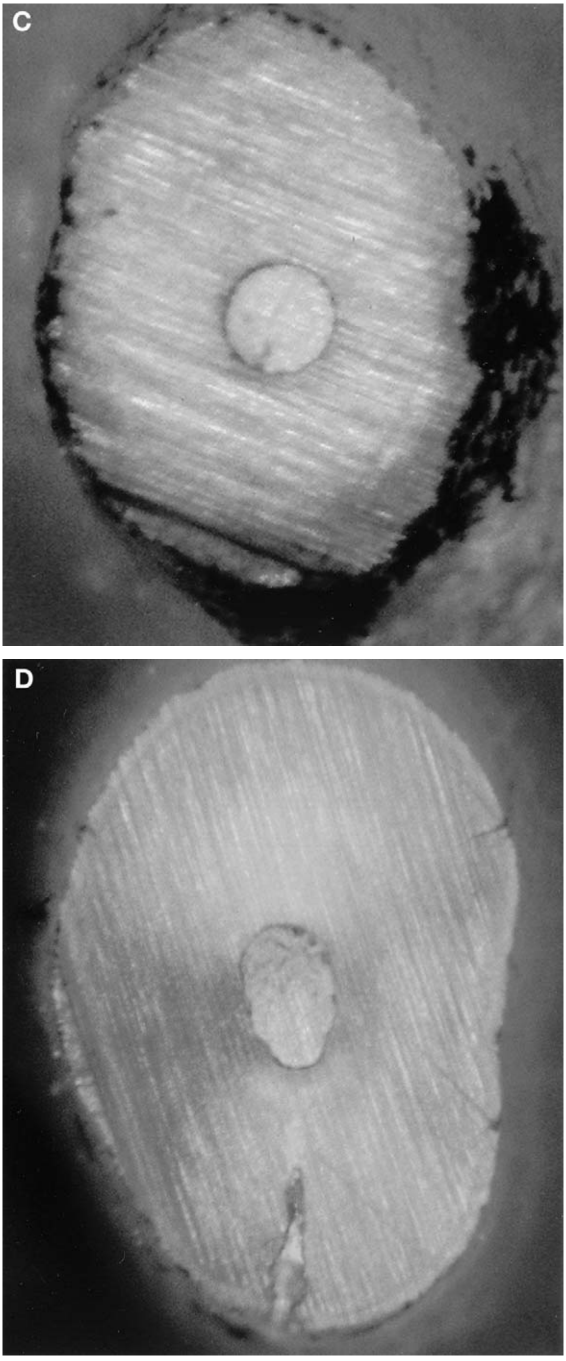

Fig. 25 (*continued*)

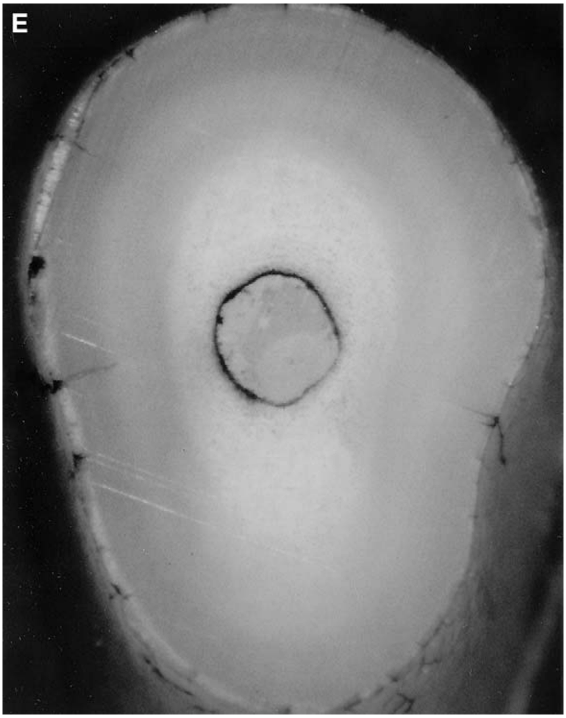

Fig. 25 (*continued*)

obturations, the gutta percha cones were dipped in Grossman sealer in all cases.

In group 1, the canals were obturated using one MicroSeal gutta percha master cone, and no plugger was used after the condenser rotation.

In group 2, the canals were obturated using one MicroSeal master cone plus one or two accessory MicroSeal cones of 0.02 taper and size 25; the plugger was used consistently after the condenser rotation.

In group 3, the canals were obturated using one master cone manufactured by Caulk-Densply. No plugger was used after the condenser rotation.

In group 4, the canals were obturated using one master cone plus one or two accessory cones of 0.02 taper and size 25 manufactured by Caulk-Densply, and the plugger was used consistently after the condenser rotation.

After all the samples were prepared, they were sectioned at increments of 1 mm using a sectioning saw (Beuhler LTD, Lake Bluff, Illinois) under cool

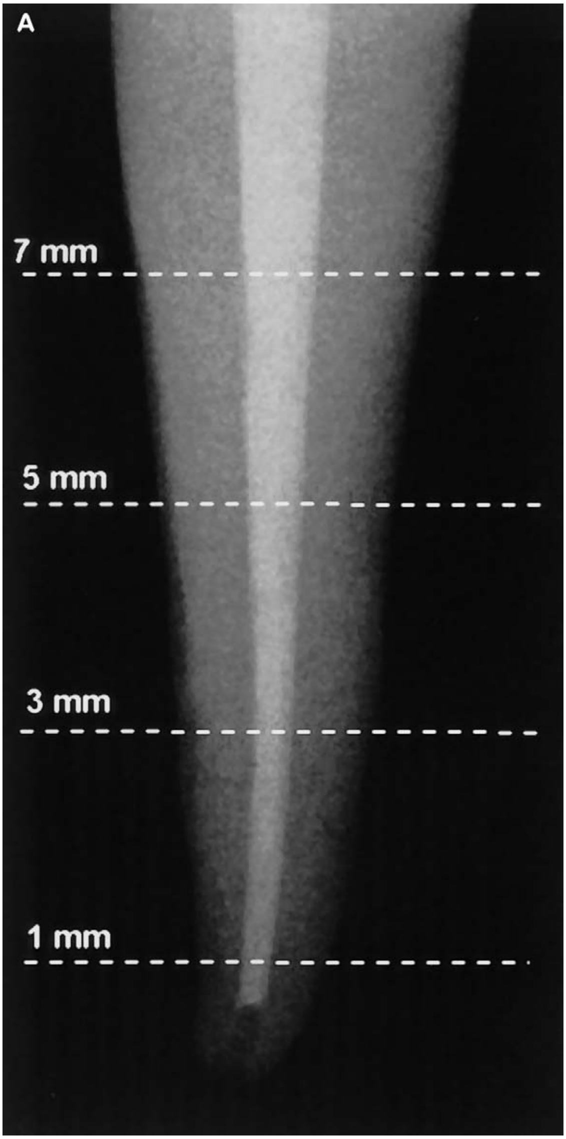

Fig. 26. Group 4, sample n = 6. Radiographs in clinical (*A*) and proximal (*B*) view. Cross-sections at the 1 mm (*C*), 3 mm (*D*), 5 mm (*E*), and 7 mm (*F*) levels.

water. The sections were then stained with methylene blue and examined under the operation microscope at 20× magnification.

Each sample was evaluated regarding the (1) adaptation of the gutta percha to the canal walls, (2) presence of voids in the obturation, (3)

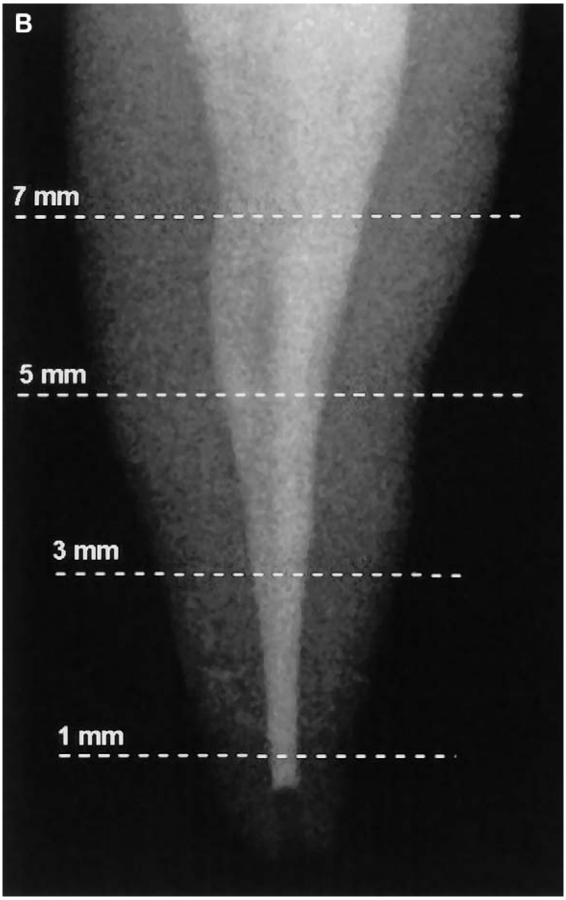

Fig. 26 (*continued*)

radiographic density, and (4) ability of the gutta percha to fill irregularities and lateral canals.

Each category was scored as poor, acceptable, good, or very good. Three different operators carefully analyzed the results of the study.

In group 1, opposite results were observed. In fact, the cross-sections of narrow canals (ie, lower anterior teeth) showed a satisfying adaptation of the gutta percha to the canal walls, and the filling material looked homogeneous for the full length of the canal. The cross-sections of large canals (ie, canines and lower bicuspids), however, showed voids in the obturation material and poor adaptation to the dentinal walls in some of the samples. The radiographic density was generally evaluated as poor (Fig. 22).

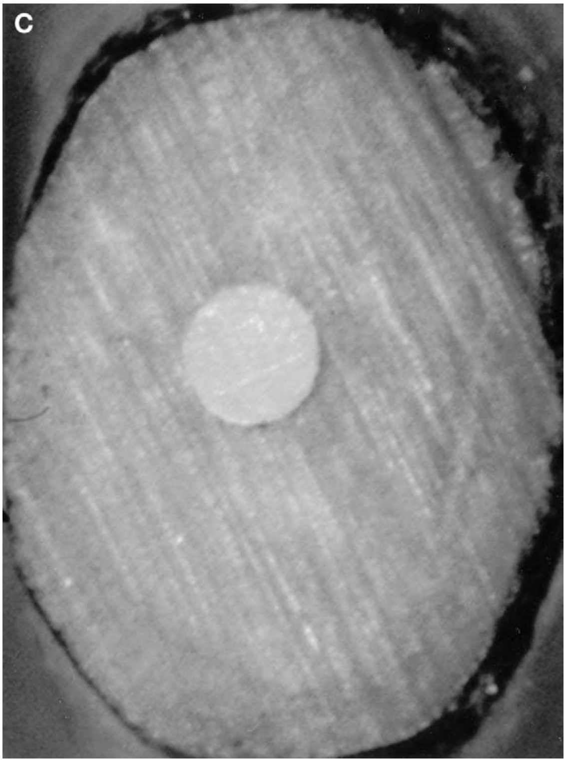

Fig. 26 (*continued*)

In group 2, regardless of the canal size, the adaptation of the gutta percha to the canal walls was generally good. Voids were not observed in any of the samples. Flowing of the gutta percha in lateral canals was observed in some of the sections. The radiographic density was also evaluated as poor in this group (Fig. 23).

In group 3, the adaptation of the gutta percha was considered good in narrow canals and inconsistent in most of the large canals. The cross-sections documented an unusual anastomosis in a lower anterior partially filled with gutta percha (Fig. 24). The radiographic density was considered satisfactory (Fig. 25).

In group 4, the adaptation of the filling material to the canal walls was consistently good or very good, both in narrow and large canals. The filling material was homogeneous and able to flow into the intricacies of the root canal system and to adapt to different types of anatomy. The radiographic appearance showed good contrast and was considered superior compared with the other groups (Fig. 26).

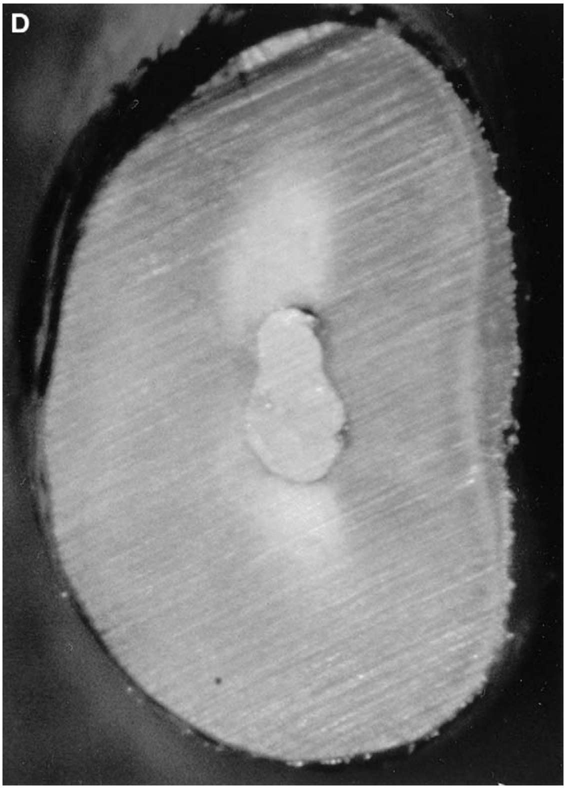

Fig. 26 (*continued*)

The following conclusions were made:

- The MicroSeal technique, with or without the use of the plugger, gave good results in narrow canals with MicroSeal and Caulk-Densply gutta percha cones using one master cone or using accessory cones. The radiographic appearance of the MicroSeal cone obturations, however, had less contrast compared with the obturations done with the Caulk-Densply cones.
- In large canals, the MicroSeal technique resulted in inadequate wall adaptation when one master cone alone was placed and no plugger was used. In these cases, the use of accessory cones and a plugger is advised.
- The use of one or two accessory cones improved the obturation only for large canals.
- Technically, there was no difference in the handling of the MicroSeal or Caulk-Densply gutta percha.

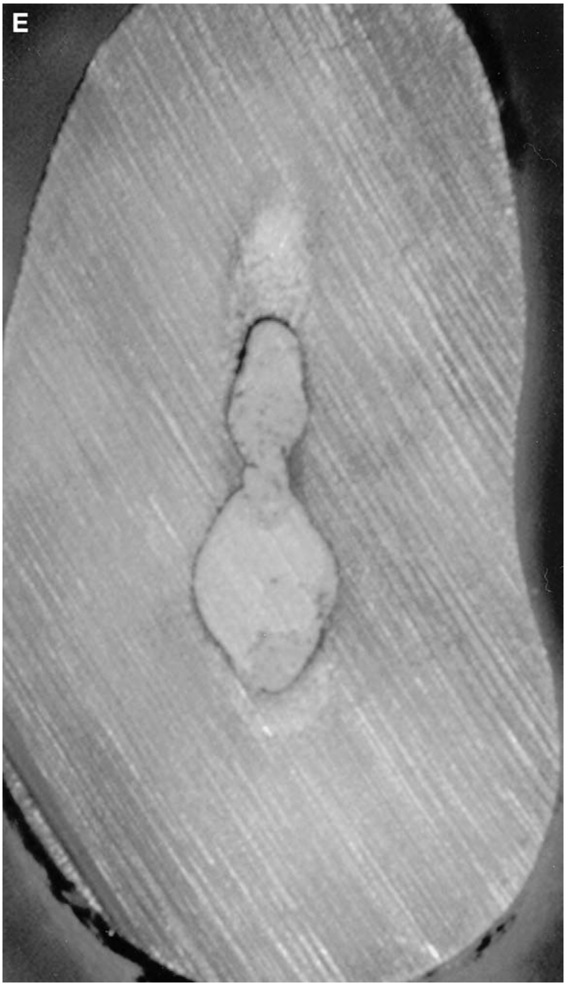

Fig. 26 (*continued*)

- The MicroSeal technique using MicroSeal or Caulk-Densply gutta percha cones proved very effective for obturating lateral canals and irregularities.

Discussion

From this study, it appears that from the technical point of view, there is no difference between the use of the MicroSeal and the use of

Fig. 26 (*continued*)

Caulk-Densply gutta percha cones. They melt at the same rpm of the condenser after the instrument, coated with warm gutta percha, is introduced into the canal. The cones, when melted, provide gutta percha that is homogeneously integrated with the MicroSeal gutta percha from the cartridge. The only difference appears to be the slightly better radiopacity of the Caulk-Dentsply cones compared with the MicroSeal cones.

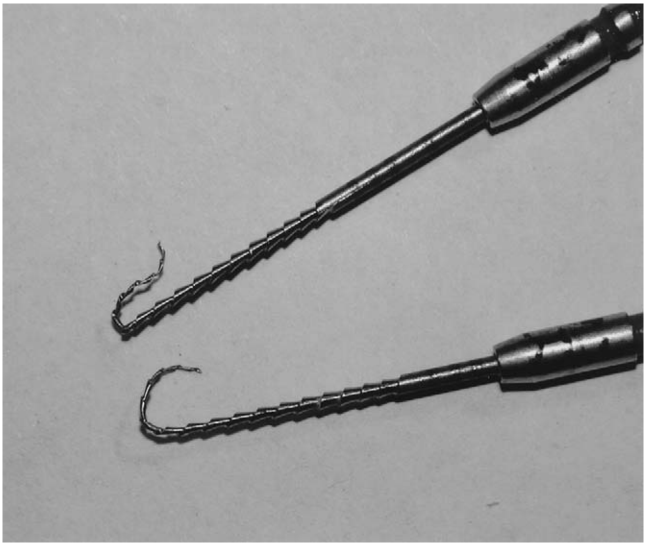

Fig. 27. MicroSeal condenser undergoing very high torsional stress before reaching the breaking point (SybronEndo).

The cones from Hygenic and from Caulk Densply (ISO color) had very different behavior compared with the MicroSeal and Caulk Densply ISO noncolor cones in this preclinical study. In fact, the Hygenic cones and the Caulk Densply ISO color cones seemed to be more elastic and required a higher speed and more time for the condenser to start the

Fig. 28. Cross-section showing a fragment of MicroSeal condenser incorporated into the filling material. (Courtesy of Dr. SH Baek, South Korea.)

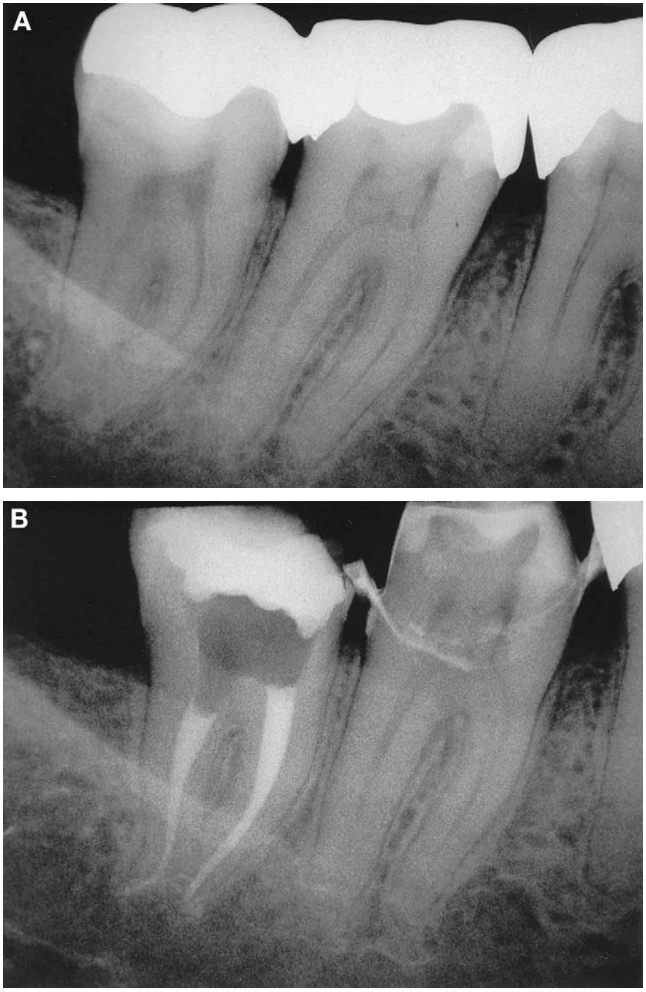

Fig. 29. Tooth No. 32. (*A*) Preoperative radiograph. (*B*) Postoperative radiograph.

melting process. Also, it seemed that the gutta percha from these brands (after melting) did not integrate homogeneously with the MicroSeal gutta percha from the cartridge and, therefore, provided an unpredictable obturation.

These observations are only clinical. Further research is needed to investigate the molecular and physical properties of the MicroSeal gutta percha cones compared with other brands.

The author's clinical observations suggest that the benefit of accessory cones really depends on the size of the canal and its apical shape. Lower

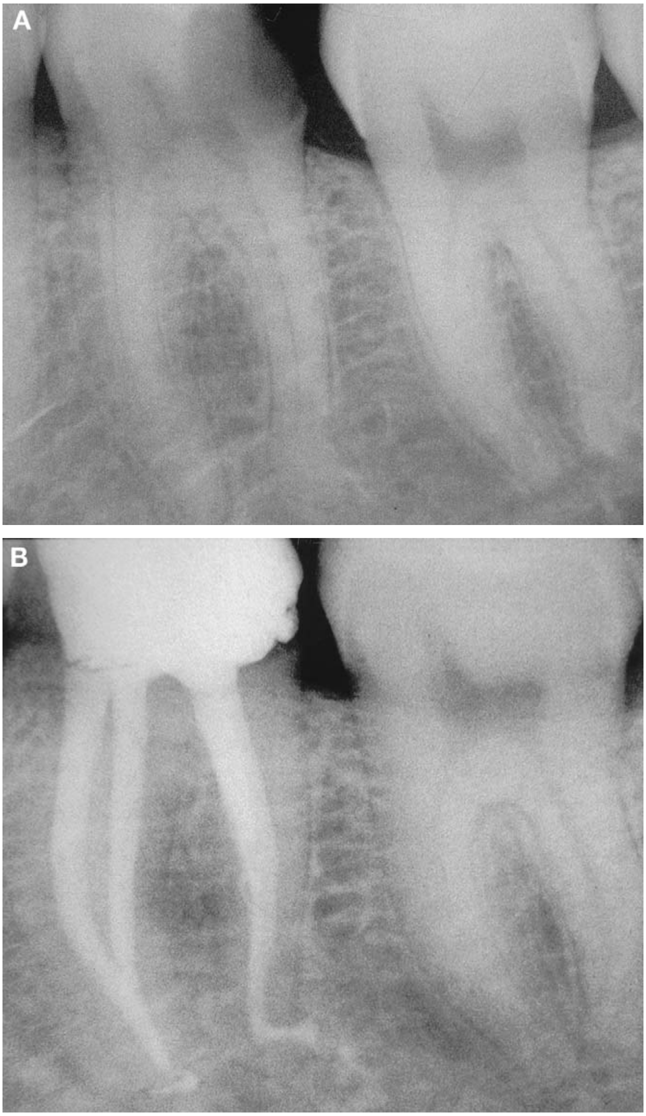

Fig. 30. Tooth No. 19 showing 90° apical curve. (*A*) Preoperative radiograph. (*B*) Postoperative radiograph.

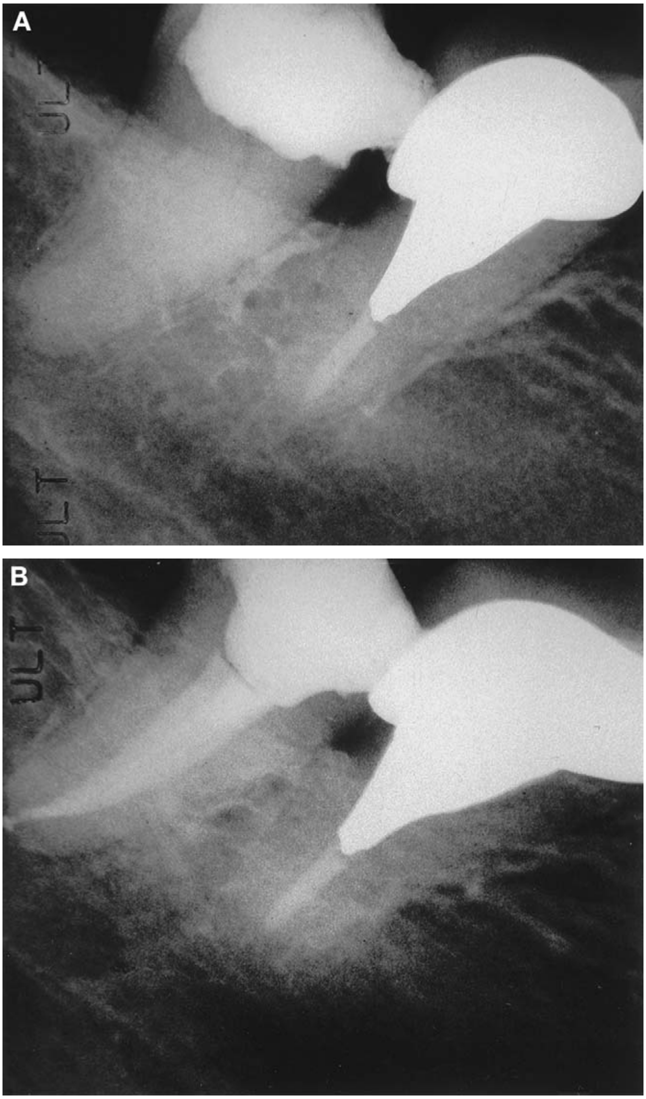

Fig. 31. Tooth No. 31 with C-shaped canal. (*A*) Preoperative radiograph. (*B*) Postoperative radiograph.

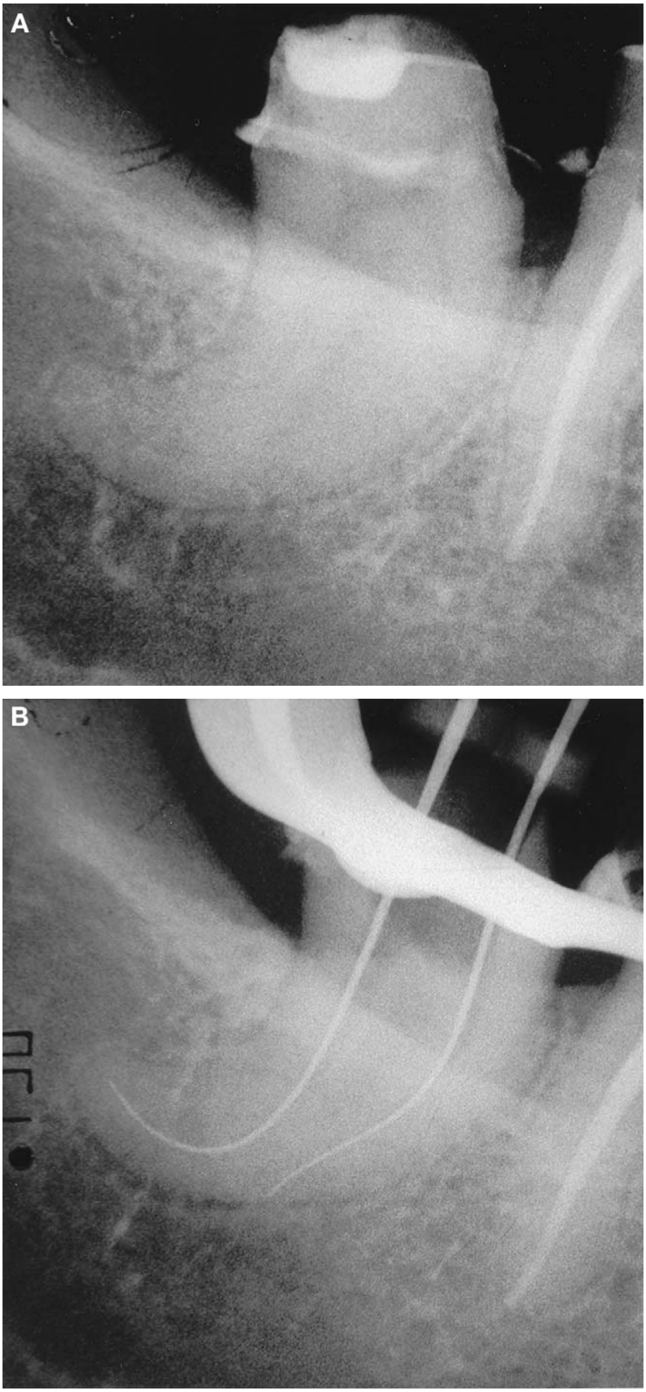

Fig. 32. Tooth No. 32 with severe canal curvature. (*A*) Preoperative radiograph. (*B*) Working length radiograph. (*C*) Postoperative radiograph.

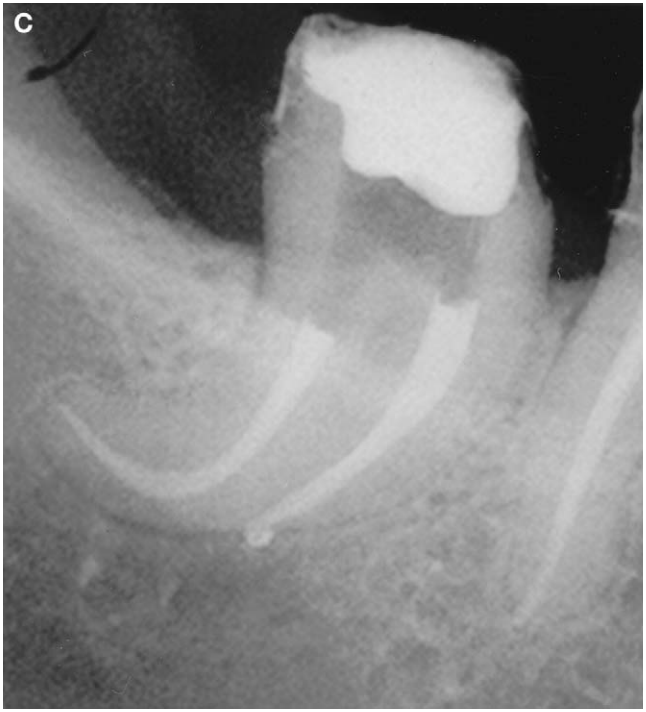

Fig. 32 (*continued*)

anterior teeth with narrow canals did not seem to benefit from the use of accessory cones. Narrow canals were adequately obturated by the use of one master cone without accessory cones. Alternately, upper or lower canines or bicuspid with large canals showed a better obturation when accessory cones were used compared with canals in which only one master cone was used. These teeth also showed a dense obturation in the apical third and in the rest of the canal, especially where isthmuses or irregularities were present.

Using a plugger after the condenser seemed to be associated with a more homogeneous obturation and better adaptation to the canal walls. Also, the use of the plugger seemed to reduce the formation of voids within the gutta percha filling.

The technique, using MicroSeal or Caulk-Densply ISO noncolor gutta percha cones, seemed to be associated with the filling of lateral canals, irregularities, isthmuses, and anastomoses in a high number of cases. In fact, cross-sections from 12 of 16 specimens showed obturation material flowing into the intricacies of the root canal system.

According to the preclinical test and the author's clinical experience, it is important to point out that the inappropriate use of the condenser may

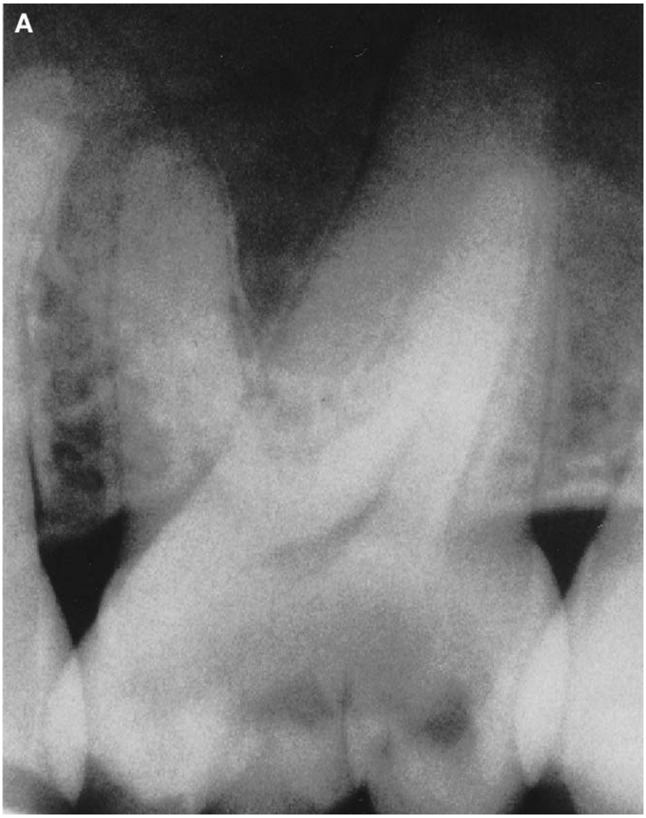

Fig. 33. Tooth No. 14 exhibiting apical bifurcation. (*A*) Preoperative radiograph. (*B*) Radiograph after the first obturation showing five canals and filling material between the two palatal canals. (*C*) Working length determination of the sixth canal. (*D*) Postoperative radiograph showing six separate canals and six separate foramina.

result in instrument separation. This separation may occur at greater speeds than the one suggested by the manufacturer. Also, situations whereby the condenser is roughly forced behind a canal curvature or the condenser is pushed against a ledge on the canal wall may lead to failure. Even if these situations predispose the MicroSeal condenser to fracturing, the author emphasizes that because the instrument is made of superelastic NiTi alloy, it requires significant stress to reach the breaking point (Fig. 27). When the fracture occurs, it appears that the instrument separates at the last 2 mm and the fragment is incorporated into the gutta percha (Fig. 28).

Despite the high variety of clinical situations in which the MicroSeal technique is recommended, the clinical scenario at which the technique seems to reach its limit is represented by those cases in which it is not possible to create an apical stop. For example, immature teeth with open

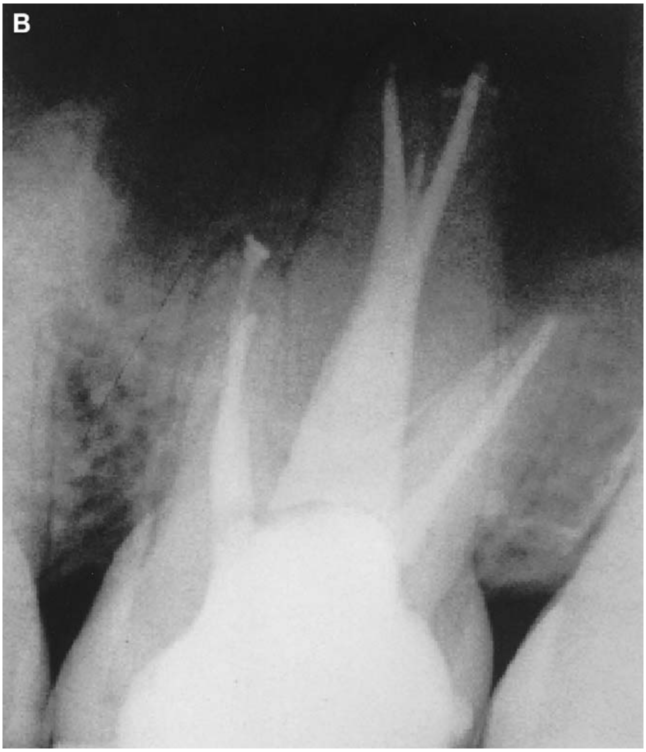

Fig. 33 (*continued*)

apices or retreated teeth with seriously damaged apical foramina may represent a risk too high because of the lack of apical control and the possibility of gutta percha extrusion.

In conclusion, the MicroSeal technique together with the modifications discussed in this article may be a very important tool in the hands of the endodontist. Knowledge of the technique's indications and limitations represent an important step in the learning curve for those practitioners who are willing to incorporate a new obturation method into their clinical techniques.

Clinical cases

The clinical cases presented in Figs. 29 through 33 were performed using Caulk-Densply ISO noncolor gutta percha master and accessory cones.

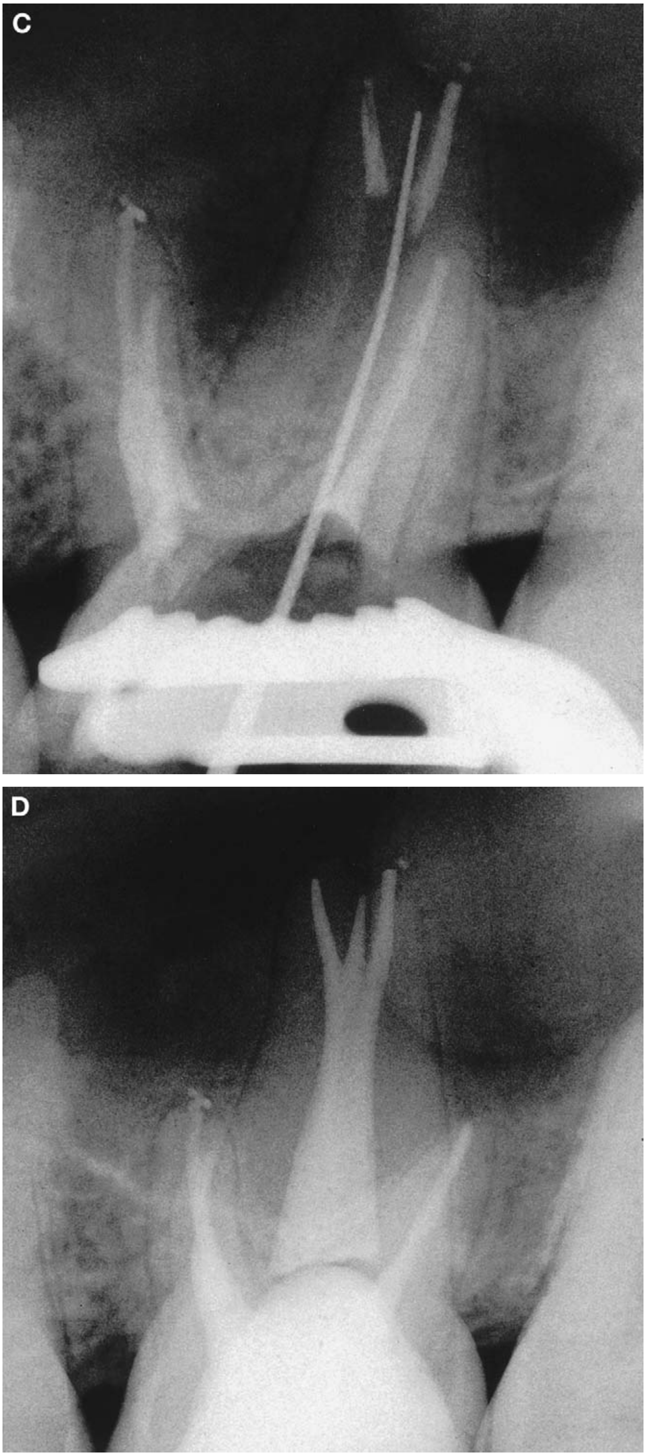

Fig. 33 (*continued*)

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