Retrograde amalgam filling: a scanning electron microscopic study

Richard M. Moodnik, DDS; Marc H. Levey, DDS; Martin A. Besen, BS; and Bernard G. Borden, DMD, New York

The scanning electron microscope was used to examine four retrograde amalgam fillings in three human teeth and an extracted tooth. Micrographs showed large interfaces or defects between the amalgam and the prepared root; the measurements of the defects ranged between 6μ and 150μ. The significance of the defects is unknown.

In the past two decades, retrograde obturation of the root canal has been an increasingly favored adjunct to apicoectomy. Various materials for retrograde filling have been advocated, but amalgam appears to be the most acceptable material.[1-5] However, Cavit,[6] Biobond,[7] zinc oxide and eugenol,[8] and gold foil[9] also have been recommended.

Orr[5] listed the advantages of amalgam; it is easy to manipulate, available in all dental offices, radiopaque, well tolerated by tissues, slightly bacteriostatic, and seals acceptably. A position has been advocated that only zincfree amalgam be used since Omnell[10] has shown electrolysis with precipitation of zinc carbonate around regular amalgam retrofillings. However, Jorgensen[11] has noted that zincfree amalgam tends to corrode more readily than amalgam containing zinc; therefore, he recommends amalgam containing zinc. Kopp and Kresberg[9] listed the disadvantages of amalgam: introduction of mercury into the periapical tissues; scattering of amalgam particles into adjacent tissues; introduction of a nonsterile material into the body; corrosion; and a slow setting time that allows change in dimensions and contamination of fluid.

Description of specimens

Three of the specimens that were examined were human teeth where apical amalgams had been successful in effecting periapical repair after the failure of conventional endodontic therapy. A fourth specimen was of a retrograde amalgam completed on an extracted tooth; it was used as a control. The first specimen was a maxillary canine (Fig 1). Complete healing had followed the placement of the retrograde amalgam, but three years later, the tooth was extracted for prosthetic reasons. The second specimen was a mandibular second molar (Fig 2). The tooth was extracted as a result of periodontal involvement that occurred two years after the placement of the retrograde amalgam. The third case (Fig 3) was initially treated without periapical surgery, but because of postoperative pain, a retrograde amalgam filling was placed two weeks later. The tooth was finally extracted five months later because of the patient's persistent pain.

Materials and Methods

The three clinical specimens were placed in 10% buffered Formalin fixative. After sectioning the apical third of the root, the apices were postfixed in 2.5% glutaraldehyde for 48 hours. The specimens were dehydrated by passage through a graded ethanol series (ethanol was replaced by amyl acetate). A critical-point drying apparatus was used. The specimens were mounted on aluminum stubs with colloidal silver. They then were placed on a rotating table in a high-vacuum evaporator and were coated with approximately 200 A of carbon and a 200 A layer of gold-

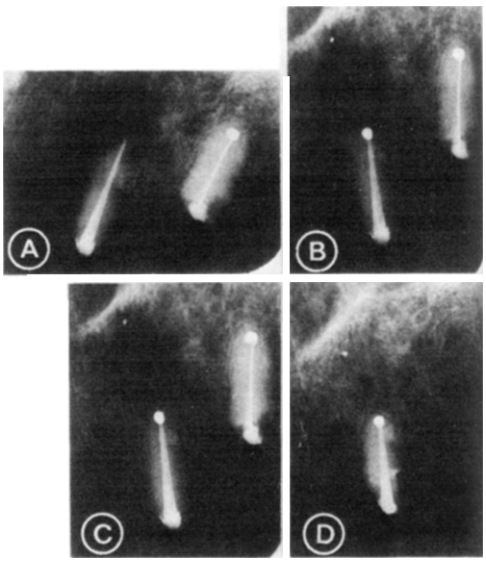

Fig 1—Radiographs of retrograde amalgam in maxillary left canine in case 1; dates are June 16, 1970 (A); June 16, 1970 (B); June 16, 1970 (C); and July 20, 1973 (D).

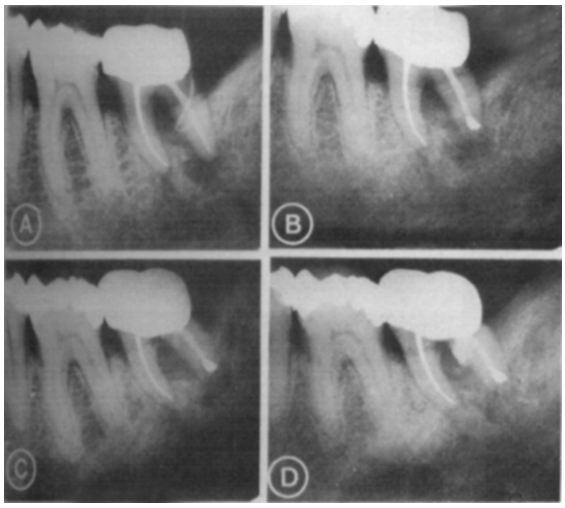

Fig 2—Radiographs of retrograde amalgam in distal root of mandibular right second molar in case 2; dates are July 9, 1971 (A); Oct 10, 1971 (B); Jan 8, 1972 (C); and Oct 24, 1973 (D).

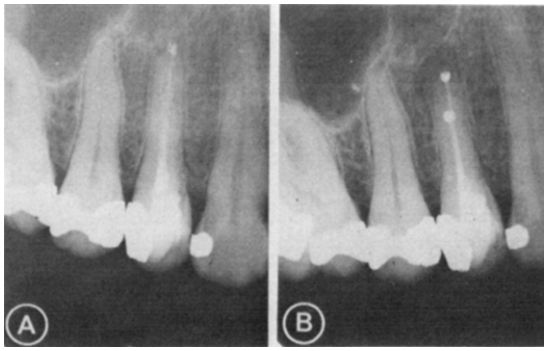

Fig 3—Radiographs of retrograde amalgam in maxillary left first premolar in case 3; dates are Aug 8, 1973 (A) and Aug 20, 1973 (B).

palladium to render the specimens electrically conductive. The specimens were examined with a scanning electron microscope operated at 20 kv. Micrographs were obtained at various magnifications ranging from X20 to X4,000. The micrographs were compared and evaluated.

Findings

Gouges were created by the bur during mechanical preparation of the apex in case 1 (Fig 4A). There was a lack of close adaptation between the amalgam filling and the beveled root; the dentinal tubules were exposed (Fig 4B). The interface between the amalgam seal and the prepared apex measured between 10μ and 40μ; there was an average separation of 24μ (Fig 4C,D). An apparent adaptation of the apical amalgam to the beveled root was shown in case 2 (Fig 5A). In a micrograph with greater magnification, the actual adaptation of the amalgam to the root can be seen; the average defect was 15μ (Fig 5B). Another area along the dentinal-amalgam interface is shown; it depicts an average defect of 13μ between the two surfaces (Fig 5C). In another portion of the interface, there was a large cavernous opening into the depths of the dentinal tubules; the average separation was 140μ (Fig 5D).

The apical preparation of case 3

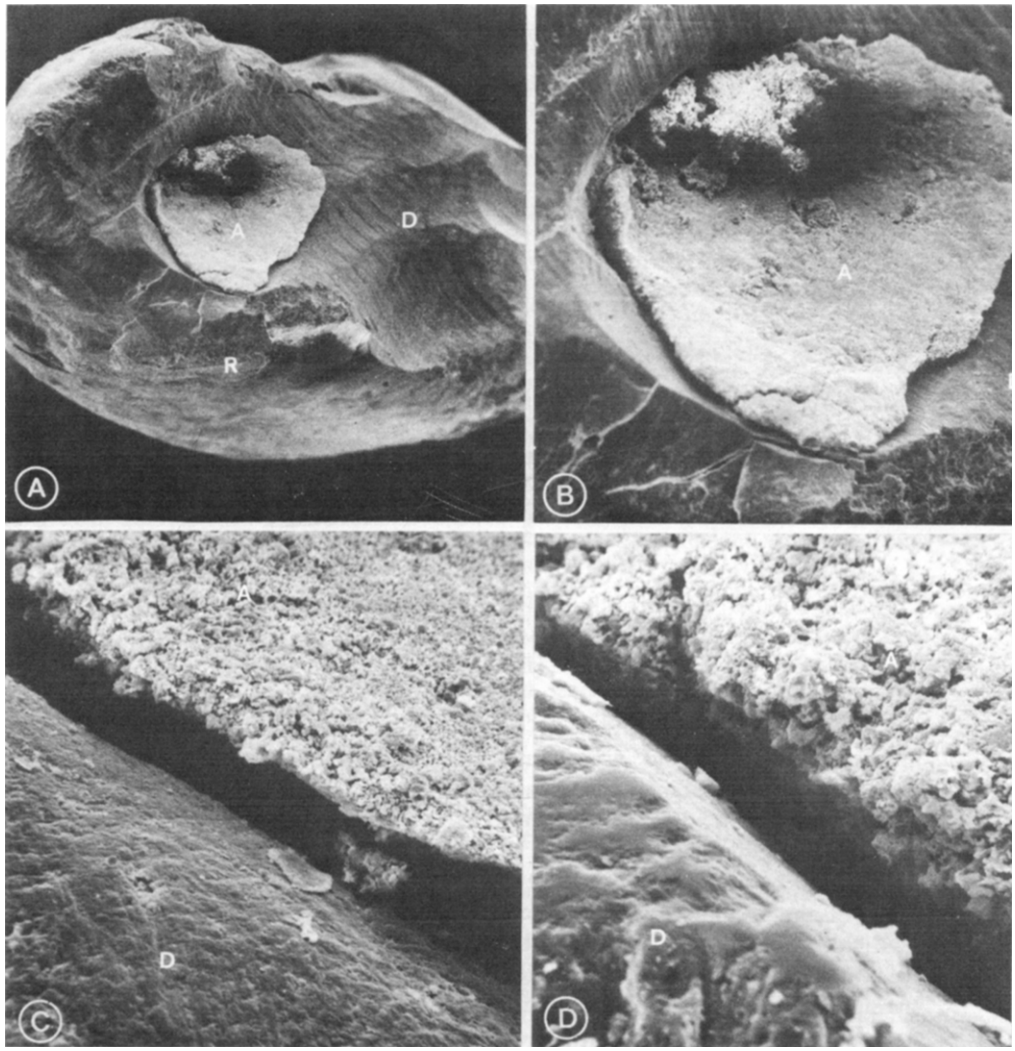

Fig 4—Scanning micrographs of retrograde amalgam in maxillary left canine in case 1. Symbols are amalgam, A; dentin, D; and root, R (orig mag X40 {A}; X90 {B}; X700 {C}; and X1350 {D}).

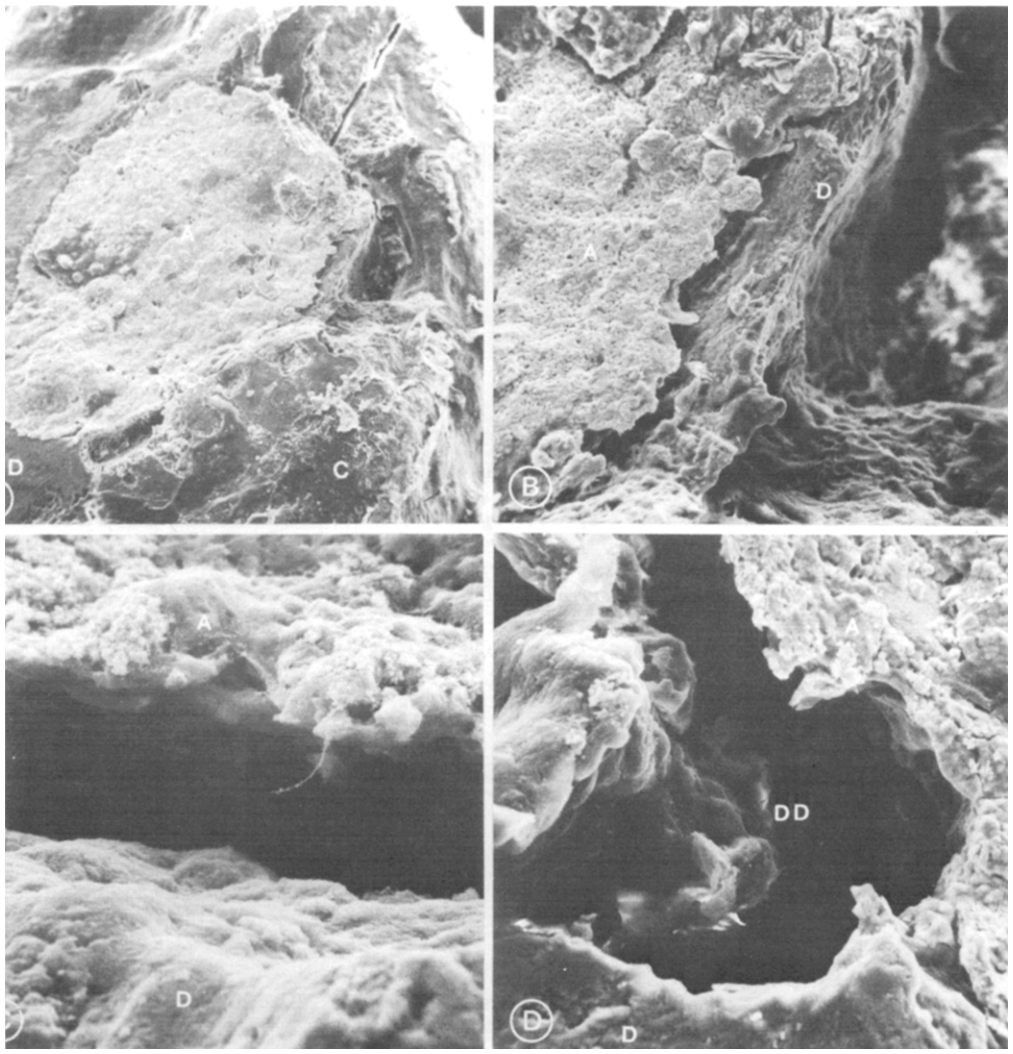

Fig 5—Scanning micrographs of retrograde amalgam in distal root of mandibular right second molar in case 2. Symbols are amalgam, A; dentin, D; and root, R (orig mag X80 {A}; X320 {B}; X3200 {C}; and X800 {D}.)

showed a submerged retrofilling (Fig 6A,B). The measurements of interfacial defects averaged 100μ (Fig 6C).

The control case was prepared on an extracted tooth and was immediately processed (Fig 7A,B). Again, there was a 10μ deficit along the dentinal-amalgam interface.

It should be noticed that on several areas of the specimens, a few minor dentinal cracks were observed that were probably caused by mechanical manipulation as a result of extraction or apical beveling with a bur. These cracks were not seen in other teeth that were examined and prepared in a similar manner to the teeth in this study.

Discussion

The purpose of the retrograde seal is to obturate the main apical foramen by using a surgical approach. This is not done as a substitute for conventional endodontic therapy, but rather in cases that are not amenable to conservative treatment.

Three cases of human teeth deemed successful by radiographic evaluation, and a case that was com-

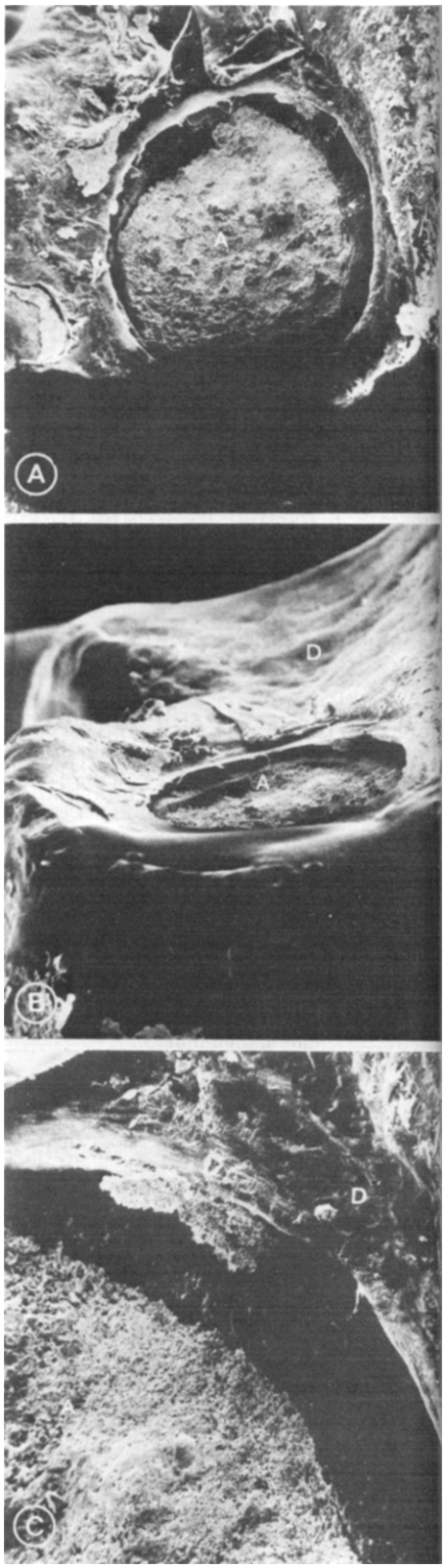

Fig 6—Scanning micrographs of retrograde amalgam in maxillary left first premolar. Symbols are amalgam, A, and dentin, D (orig mag X80 {A}; X320 {B}; and X320 {C}).

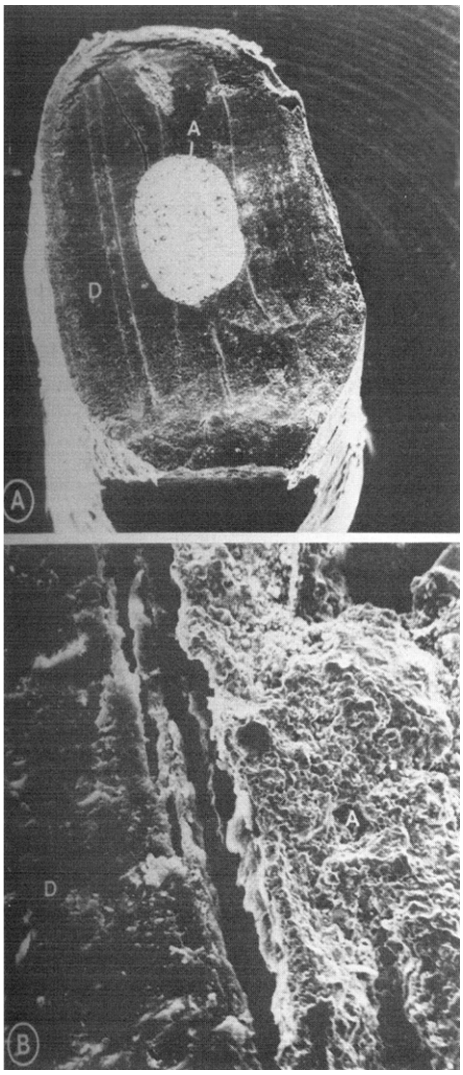

Fig 7—Scanning micrographs of retrograde amalgam in control tooth. Symbols are amalgam, A, and dentin, D (orig mag X30 (A) and X770 (B)).

pleted on an extracted tooth were examined under the scanning electron microscope. Micrographs showed large interfaces or defects between the amalgam and the prepared root; the measurements of the defects ranged between 6μ and 150μ. The magnitude of the interfacial discrepancy varied from case to case. Even when an apical amalgam was placed under controlled conditions in an extracted tooth, a substantial defect could be clearly demonstrated.

It is not possible to relate any clinical significance to the discrepancies. Speculatively, these defects could harbor bacteria and other toxic products. The exposed dentinal tubules as well as the corrosive properties of the materials could be a source of inflammation.

Summary

A scanning electron microscopic study of four teeth showed that defects between the amalgam-dentinal interface varied between 6μ and 150μ after the insertion of the retrograde amalgam filling.

The radiographic depiction of the apical seal did not correlate with the completeness of the seal when it was analyzed micrographically.

Smooth preparation or beveling of the apex of the root is difficult to achieve clinically. Often, the prepared surface is left gouged; the dentinal tubules are grossly exposed. The significance of the defects is unknown.

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Dr. Moodnik is the director of the division of endodontics; Dr. Levey has completed his residency in endodontics; Mr. Besen is the director of electron microscopy; and Dr. Borden is the chairman of the department of dentistry, Nassau County Medical Center, East Meadow, NY. Requests for reprints should be directed to Dr. Richard M. Moodnik, Department of Dentistry, Nassau County Medical Center, 2201 Hempstead Turnpike, East Meadow, NY 11554.

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