Electrophoretic differentiation of radicular cysts and granulomas

Donald R. Morse, B.S., D.D.S., M.A., Joseph W. Patnik, B.S., O.D., D.D.S.,** and George R. Schacterle, B.S., P.M.D.,****
Philadelphia, Pa.

TEMPLE UNIVERSITY SCHOOL OF DENTISTRY

Polyacrylamide-gel electrophoresis was used for differential diagnosis of radicular cysts and granulomas. Root canal fluids were aspirated from forty anterior teeth with radiographic evidence of periapical pathosis, and from one pulpless anterior tooth with no radiographic evidence of periapical pathosis. Endodontic therapy was performed on all the teeth, and all the periapical lesions were surgically removed. The lesions were examined histologically, and the histopathologic diagnoses were then compared with the electrophoretic patterns. Analysis of the root canal fluids showed the following: (1) An albumin pattern was found in all thirty-one of the cases diagnosed histologically as being granulomas. The same pattern was also found in the case of the pulpless tooth without an area of rarefaction. (2) In eight of the nine cases diagnosed histologically as cysts, there was a much more intense albumin pattern and other patterns in the globulin regions. In the one case of a cyst that was misdiagnosed, the apical portion of the canal was calcified and the cyst lumen was never penetrated.

The pretreatment differential diagnosis of periapical areas of pathosis has always been a clinical problem. From the treatment aspect, it appears to be important to differentiate a radicular cyst from a periapical granuloma. According to radiographic evidence, granulomas usually heal after a nonsurgical endodontic procedure has been performed.[1] However, if the lesion is a radicular cyst, the belief has been that endodontic obturation has to be followed by surgical removal of the lesion.[2] This concept is currently being challenged. There has been a marked discrepancy in reports of the incidence of radicular cysts, in contrast to reports on granulomas. Most previous studies showed a relatively low incidence of radicular cysts (6 to 26 per cent),[1, 3-7] whereas recent reports on large samples

*Associate Professor, Department of Endodontics.
**Graduate Student, Department of Endodontics.
***Assistant Professor, Department of Biochemistry.

have shown a much higher incidence of radicular cysts (42 to 45 per cent).[8, 9] Clinical success reported by endodontists usually ranges between 80 and 95 per cent.[10-12] The conclusion reached by some people from these combined statistics (incidence of cysts and success rate) is that many cysts are being healed by nonsurgical endodontic therapy. There is no direct proof of this postulate, because, to date, the only proved method of diagnosis of a periapical lesion is removal of it and the examination of sections histologically. This, of course, precludes the following of the case insofar as nonsurgical periapical repair is concerned. If a means were available to differentiate a radicular cyst from a granuloma before treatment, and in such a manner that the lesion were not altered, then the case of predetermined cyst could be treated by nonsurgical endodontic therapy and followed periodically in order to determine whether periapical repair was taking place. Several attempts to devise such a test have been made in the past.

The earliest method used was radiographic. Staunch supporters of this modality were McCall and Wald.[13] They stated that a cyst typically had a circumscribed radiolucent appearance with a diameter greater than 3/8 of an inch, and that it was often bounded by a thin, even white line. Granulomas also had a radiolucent outline, but were generally smaller, not circumscribed, and did not have the white line. Formerly, this view was popular, but now most investigators have shown no positive correlation between the radiographic image and the histologic diagnosis.[1, 4, 5, 8, 14, 15]

Along with radiographs, contrast media have been used. Forsberg and Hägglund[6] applied the contrast medium into the lesion, either through the alveolar mucosa or the root canal. With a sample of thirty-six cases, they reported that they could differentiate a cyst from a granuloma by the radiographic appearance in thirty-three of the cases. This was a preliminary report that was published 12 years ago, and no follow-up studies have been reported. Also, this test would have no value in predicting whether a cyst would heal, because the use of the contrast medium might set up an inflammatory reaction that would alter the lesion and aid in repair. Cunningham and Penick,[7] who used a water-soluble contrast medium for root canal injections in a sample of forty-one cases, did not find a positive correlation between the postinjection radiographic image and the histologic diagnosis.

The third method that has been used was a cytologic evaluation of aspirated fluids. Howell and his co-workers[16] performed the aspiration either through the root canal or the alveolar mucosa. Aspirated fluids were placed on slides, stained by the Papanicolaou method, and examined for the presence of epithelial cells. A positive correlation was found between the presence of epithelial cells and the diagnosis of radicular cysts in eight of the nine cases examined. Possible pitfalls of this study are: (1) Aspiration through the alveolar mucosa could cause contamination of the fluid by mucosal epithelial cells, and this would produce a false positive result. (2) Epithelial cells are often found in granulomas as well as in cysts, and this could cause a misdiagnosis. (3) The sample was very small.

In another study that was not related to cyst-granuloma differentiation,

Fig. 1. Radiograph of Case 18; maxillary left lateral incisor with a periapical granuloma.
Fig. 2. Radiograph of Case 1; maxillary left central incisor with a periapical granuloma.
Fig. 3. Radiograph of Case 34; maxillary right lateral incisor with a radicular cyst.
Fig. 4. Radiograph of Case 4; maxillary left lateral incisor with a radicular cyst.

Toller[17] used paper electrophoresis of mucosal aspirated fluids in order to differentiate keratinizing cysts from nonkeratinizing cysts. Toller found that, in the keratinizing cyst fluids, there was a very low level of all soluble proteins as compared to the level in blood sera. In the nonkeratinizing cysts (radicular and dentigerous), albumin levels were comparable to those in blood sera. Beta-1 globulin was in levels comparable to those in sera; alpha globulins were diminished compared to those in sera; and gamma globulins varied. Sometimes the gamma globulin levels were less than those of sera; at other times, they were greater. Gross[18] began preliminary work on the use of electrophoresis for the differentiation of cysts from granulomas. He used a technique of aspiration through the alveolar mucosa, but very few cases were examined and no definite findings were made. Recently, a study was begun with a technique of root canal aspiration of periapical fluids. Analysis was by polyacrylamide-gel electrophoresis.

MATERIALS AND METHODS

The total sample consisted of forty-six cases. Of these, forty-one were used in the study. Five cases were discarded because the root canal fluids were

contaminated with saliva and/or hemorrhagic exudates. In forty of the forty-one cases, there were endodontically involved anterior teeth with radiographic evidence of periapical pathosis. One patient had a pulpless central incisor with no radiographic indication of a periapical area. No previous endodontic therapy had been performed on any of the involved teeth (Figs. 1, 2, 3, and 4). Each tooth was isolated by means of a rubber dam. Access was gained by a lingual approach. In those cases in which there was adequate drainage from the canals (eighteen cases), aspiration was made directly into a syringe. When there was no apparent fluid, or fluid that was too thick to be aspirated, a root canal file was used to penetrate through the apex. This method often caused fluid to flow into the root canal from the periapical lesion, and the fluid was then withdrawn with the syringe (six cases). If no fluid could be aspirated, either because it was too thick or because not enough was present, then a root canal file was used to withdraw the material from the canal (seventeen cases). The specimen was then mixed in a dappen dish with 5 μL of tris-HCl buffer (containing EDTA and borate at a pH of 7.5). The mixture was then withdrawn into a capillary tube (10 μL). After the samples were removed, endodontic therapy was performed. The canals were filled by lateral condensation with gutta-percha and chlorpercha. Periapical surgery was performed on all the teeth during a single visit, except in the case of the one that had no evidence of periapical pathosis. The specimens were placed in 10 per cent formalin and sent to the school pathology laboratory for diagnosis. The specimens were accompanied by the same forms that are used for all biopsy samples sent routinely to the pathology department. The data furnished on this form include the patient's name, address, age, and sex, and the size of lesion, location of lesion, and clinical diagnosis. The diagnosis of a cyst was made by the pathologists when there was evidence of a lumen lined with epithelium. Doubtful cases were examined by two pathologists, and a consensus was given. The examiners had no knowledge of the results of the biochemical fluid analysis, and they did not know which cases were involved in the study. For the forty surgical cases, blood was withdrawn from both the fingertips and the periapical regions.* Aspiration was made into heparinized capillary tubes (10 μL). The samples of blood were centrifuged at 2,500 r.p.m. for 10 minutes in order to separate the formed elements from the plasma. The formed elements were discarded, and the samples of plasma and the root canal fluids were then quick-frozen. They were kept for 3 days or less, and then several samples were defrosted and their proteins were separated by the use of a modification of the Davis technique of polyacrylamide-gel electrophoresis.[19] The modification consists of changes in the composition of the stacking and running gel buffers. The stacking gel buffer is composed of tris-phosphoric acid at pH 7, and 0.05 ml. of Temed. The running gel buffer is composed of tris-HCl at pH 9, and 0.23 ml. of Temed. Seven per cent gels were prepared for the separation in tubes 5 mm. by 65 mm. Five to 10 microliters per sample was layered on the stacking gel, and electrophoresis was carried out with

*In one patient, periapical blood was withdrawn immediately after the lesion was entered, and then again before suturing. Blood was also withdrawn from the normal contralateral tooth, in the region of the apical periosteum.

Table I

Case	*Histopathologic diagnosis*	*Biochemical diagnosis*	*Size of lesion (mm.)*	*Fluid aspirated*	*File removed material*	*Tooth§*	*Extra band present in periapical serum*	*Distinct zone in gamma globulin region in periapical serum*
1	Granuloma	Granuloma	10	+		ULCI	+	+
2	Granuloma	Granuloma	12	+		URCI		+
3	Granuloma	Granuloma	5	+		ULCI	+	+
4	Cyst	Cyst	19	+		ULLI		+
5	Granuloma	Granuloma	2		+	URCI	+	+
6	Granuloma	Granuloma	4	+		ULCI	+	+
7	Granuloma	Granuloma	4		+	URCI	+	+
8*						LLLI		
9	Granuloma	Granuloma	5		+	URCI	+	
10	Cyst	Cyst	9	+		URCI	+	+
11	Granuloma	Granuloma	4		+	URCI	+	
12	Granuloma	Granuloma	3		+	ULCI	+	
13	Granuloma	Granuloma	8	+		URLI	+	+
14*						LRCI		
15	Granuloma	Granuloma	3		+	LRLI	+	+
16	Granuloma	Granuloma	4	+		URCI	+	+
17	Cyst	Cyst	19	+		ULCI	+	+
18	Granuloma	Granuloma	5		+	ULLI	+	+
19	Granuloma	Granuloma	3		+	LRCI	+	+
20*						ULCI		
21	Granuloma	Granuloma	2		+	LLCI	+	+
22	Granuloma	Granuloma	2		+	ULCI	+	
23	Granuloma	Granuloma	5		+	ULC	+	+
24	Granuloma	Granuloma	7		+	URCI	+	+
25*						URCI		
26	Granuloma	Granuloma	5	+		URCI	+	+
27	Granuloma	Granuloma	5	+		URCI	+	
28	Cyst	Cyst	4	+		LLLI	+	
29†	Cyst	Granuloma	5		+	ULC	+	
30	Granuloma	Granuloma	4		+	ULLI	+	
31	Granuloma	Granuloma	7	+		LLC	+	+
32	Cyst	Cyst	5	+		URCI	+	+
33	Granuloma	Granuloma	3	+		URLI	+	+
34	Cyst	Cyst	19	+		URLI	+	+
35	Granuloma	Granuloma	3	+		LLCI	+	
36	Granuloma	Granuloma	5	+		URCI	+	
37‡		Granuloma			+	ULCI		
38*						ULCI		
39	Granuloma	Granuloma	3		+	ULC	+	+
40	Cyst	Cyst	12	+		ULLI		+
41	Granuloma	Granuloma	5	+		URCI		
42	Granuloma	Granuloma	5	+		URCI		
43	Granuloma	Granuloma	4	+		ULLI	+	+
44	Cyst	Cyst	5	+		LRCI		
45	Granuloma	Granuloma	3	+		URCI		
46	Granuloma	Granuloma	5		+	ULCI		

*Saliva or blood contamination.

†Apex was calcified and cyst was not penetrated.

‡No periapical lesion was present and operation was not performed.

the use of a tris-glycine buffer at pH 8.3 and a constant current of 3 Ma. per tube. After 1 hour of separation, the gels were removed from the tubes and stained for 1 hour with Buffalo Black NBR. After destaining, the patterns were visualized and then photographs were taken. The freezing process had no discernible effect on the appearance of the electrophoretic patterns. In four

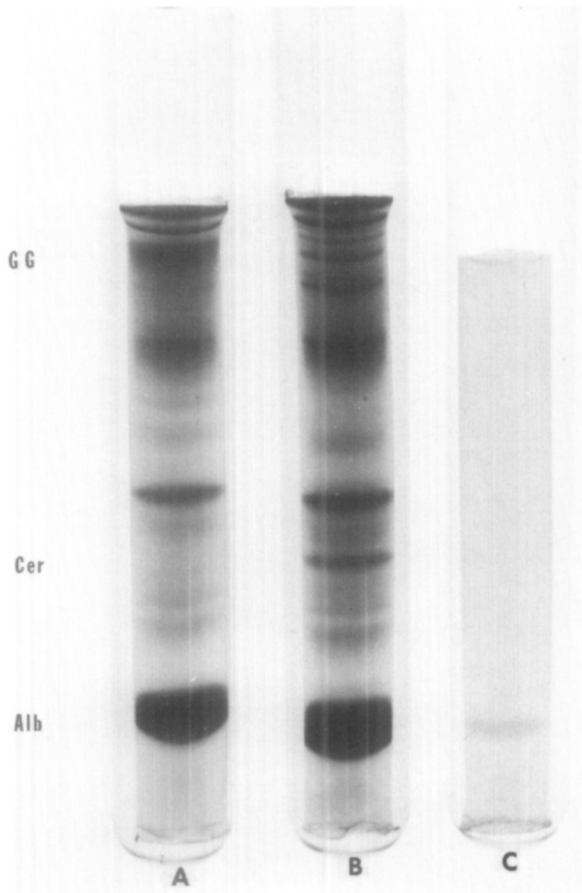

Fig. 5. Polyacrylamide-gel electrophoretic patterns from Case 18; periapical granuloma. *A*, Fingertip plasma. *B*, Periapical plasma. *C*, Root canal fluid. *Alb*, Albumin; *Cer*, ceruloplasmin region; *GG*, gamma globulin region.

cases, sufficient exudate was available to allow for a comparison between immediate sample patterns and fluid sample patterns after defrosting, in the same patient. The pattern for the nonfrozen sample and that for the defrosted sample from the same patient were identical. Therefore, in order to simplify the procedure, only previously frozen samples were used. The members of the biochemistry department staff had no knowledge of the histopathologic results. The data from the biochemical and pathological examinations were collected and analyzed by members of the endodontic staff.

RESULTS

The results are summarized in Table I. Histopathologic examination of the forty cases showed thirty-one to be periapical granulomas and nine to be radicular cysts. In two of the cases of cysts, the diagnosis was arrived at by a consensus of the two pathologists. Analysis of the root canal samples by polyacrylamide-gel electrophoresis showed the following: All thirty-one

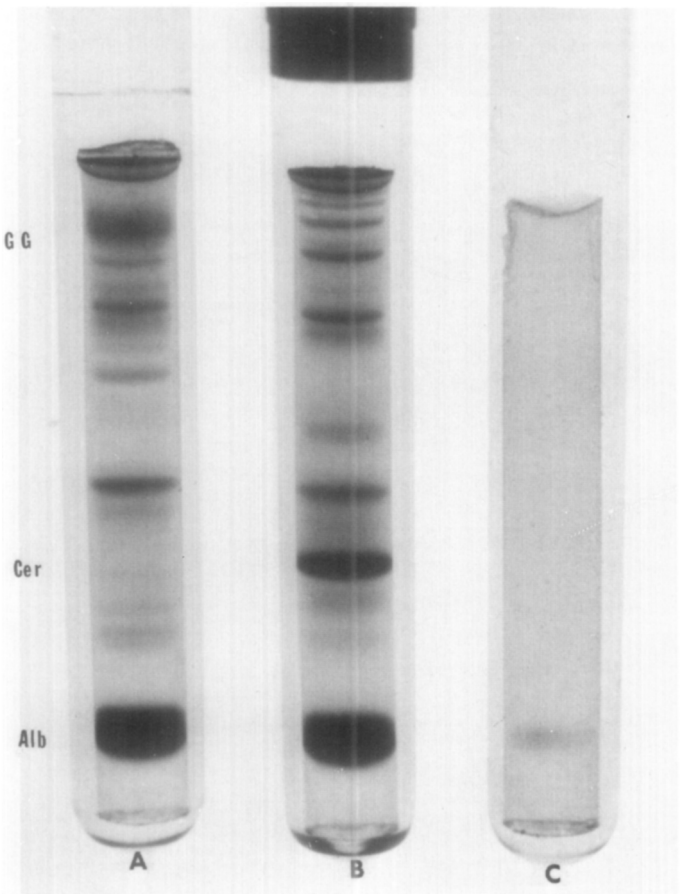

Fig. 6. Polyacrylamide-gel electrophoretic patterns from Case 1; periapical granuloma. *A*, Fingertip plasma. *B*, Periapical plasma. *C*, Root canal fluid. *Alb*, Albumin; *Cer*, ceruloplasmin region; *GG*, gamma globulin region.

cases diagnosed histologically as granulomas had a faint to moderate pattern in the albumin zone, and either no pattern or only a vague pattern in other areas of the gel (Figs. 5, *C*, 6, *C*, and 9, *C*). A similar pattern was seen in the case in which no periapical area was evident (Fig. 11). In eight of the nine cases of cysts, different patterns were observed. The albumin zone was larger and denser than that found in the granulomas, and definite bands were found in the globulin regions (Figs. 7, *C*, 8, *C*, and 10, *C*). In the other case of a cyst, the apical portion of the canal was calcified, and, consequently, there was no penetration of the cyst by the root canal contents. Therefore, the resulting pattern was the same type as that observed in granulomas and the one pulpless tooth (Fig. 12, *C*).

Analysis of the plasma samples showed that in thirty-two of the forty cases, the periapical plasma pattern had an extra band in the postalbumin region (Figs. 5, *B*, 6, *B*, 7, *B*, 9, *B*, 10, *B*, and 12, *B*). This band was not discernible in the plasma samples from the fingertips (Figs. 5, A, 6, A, 7, A, 9, A, 10, A, and

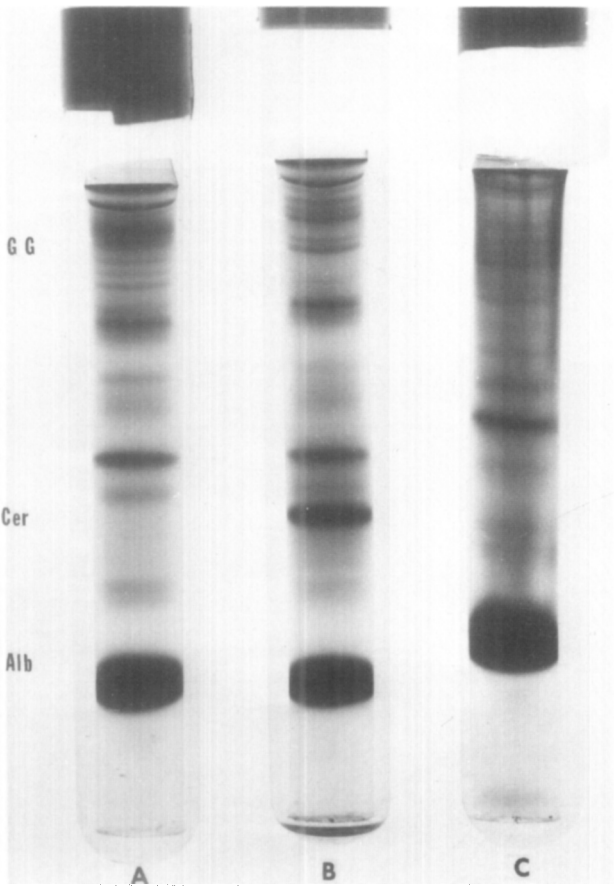

Fig. 7. Polyacrylamide-gel electrophoretic patterns from Case 34; radicular cyst. *A*, Fingertip plasma. *B*, Periapical plasma. *C*, Root canal fluid. *Alb*, Albumin; *Cer*, ceruloplasmin region; *GG*, gamma globulin region.

12, *A*). The extra band was found in the region of the gel in which ceruloplasmin (C-reactive protein) occurs, and it may be indicative of the presence of that protein. In twenty-five of the forty cases, there were more intensive bands in the gamma globulin region of the periapical plasma samples (Figs. 5, *B*, 6, *B*, 7, *B*, 8, *B*, 9, *B*, and 10, *B*) than the fingertip samples (Figs. 5, *A*, 6, *A*, 7, *A*, 8, *A*, and 10, *A*). For the single case in which two samples of periapical blood were taken, the patterns were the same both before and after operation. The periosteal blood taken from the region of the apex of the normal contralateral tooth showed a pattern similar to that of blood plasma from the fingertip (Fig. 13).

Generally, lesions diagnosed as cysts were larger in size than lesions diagnosed as granulomas (two were 9 to 12 mm. in diameter; three were 19 mm. in diameter). However, four cysts had diameters of 5 mm. or less. Most granulomas (twenty-seven) were 5 mm. or less in diameter. However, in three cases the diameters were from 8 to 12 mm.

In twenty-four of the forty-one cases, fluid was aspirated directly into the

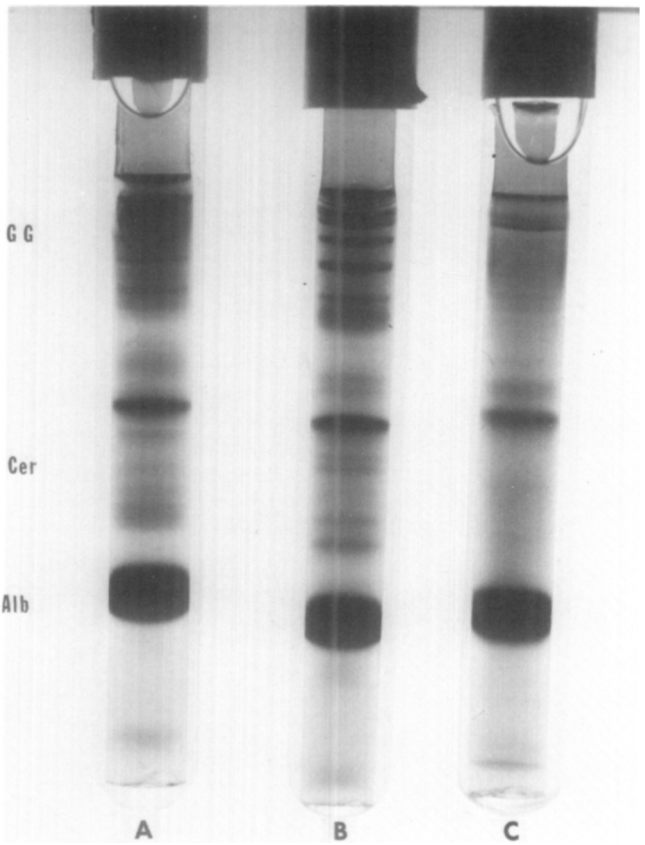

Fig. 8. Polyacrylamide-gel electrophoretic patterns from Case 4; radicular cyst. *A*, Fingertip plasma. *B*, Periapical plasma. *C*, Root canal fluid. *Alb*, Albumin; *Cer*, ceruloplasmin region; *GG*, gamma globulin region.

syringe. In seventeen of the cases, a file had to be used to remove the inspissated material.

DISCUSSION

In obtaining fluids for analysis, we used root canal aspiration instead of aspiration through the alveolar mucosa. This was done to avoid the contamination with blood that might occur when gaining access to the lesion via the alveolar mucosa. Any blood in the sample would cause the plasma pattern to be superimposed on the fluid pattern, and would thus invalidate the results. This is also why hemorrhagic exudates cannot be used.

Polyacrylamide-gel electrophoresis was used rather than paper electrophoresis (method employed by Toller) because it allows for better separation of the constituent proteins. Electrophoresis is a process that causes proteins that are dissolved in a suitable buffered solution to migrate in an electrical field. The rate of migration from one pole (cathode) to the other (anode) is de-

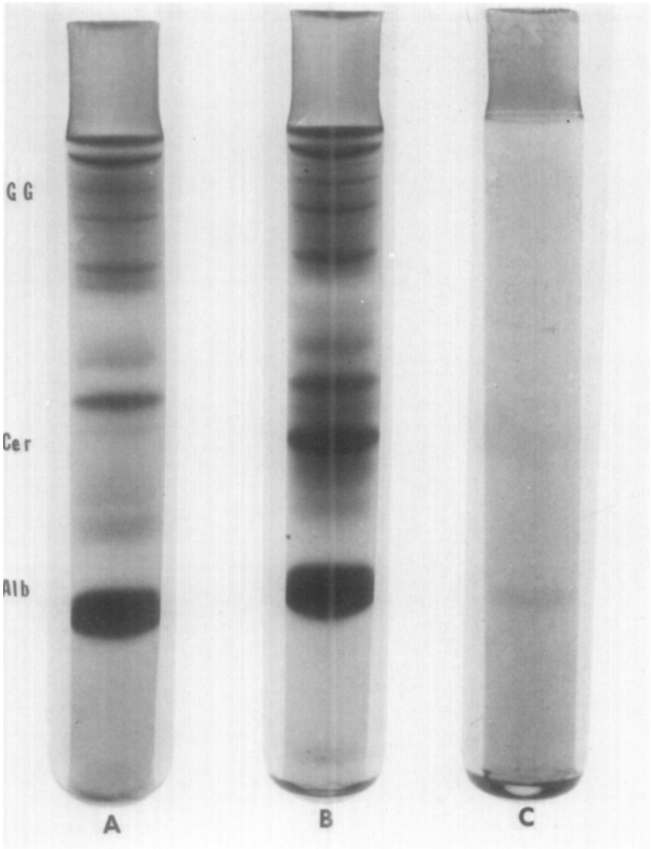

Fig. 9. Polyacrylamide-gel electrophoretic patterns from Case 24; periapical granuloma. *A,* Fingertip plasma. *B,* Periapical plasma. *C,* Root canal fluid. *Alb,* Albumin; *Cer,* ceruloplasmin region; *GG,* gamma globulin region.

termined by the electrical charge of the individual molecules, and the molecular weight of the proteins. With the use of the polyacrylamide gel, the individual proteins move at different rates through the pores of various size in the gel. Albumin, which is of a lighter molecular weight (69,000) migrates fastest and is found in the area near the anode. Heavier gamma globulin (molecular weight of 156,000) moves more slowly and is found in the cathode region.

The reason for the difference in patterns found between a cyst and a granuloma may be related to the semipermeable nature of the cyst lining.[17] Cyst fluids contain variable amounts of proteins that probably originate in the subepithelial blood vessels. Toller[20] has shown that plasma cells in the cyst wall could excrete gamma globulins into the cyst fluid. In the present study, plasma cells were found in cyst fluids. In granulomas with liquefaction necrosis, no plasma proteins, or very few, are present (unless hemorrhage has occurred). The albumin pattern found in granulomas, and in the one pulpless tooth without an area of rarefaction, may be derived from the breakdown of either microbes or tissue cells. Degenerating pulpal tissues apparently produce protein

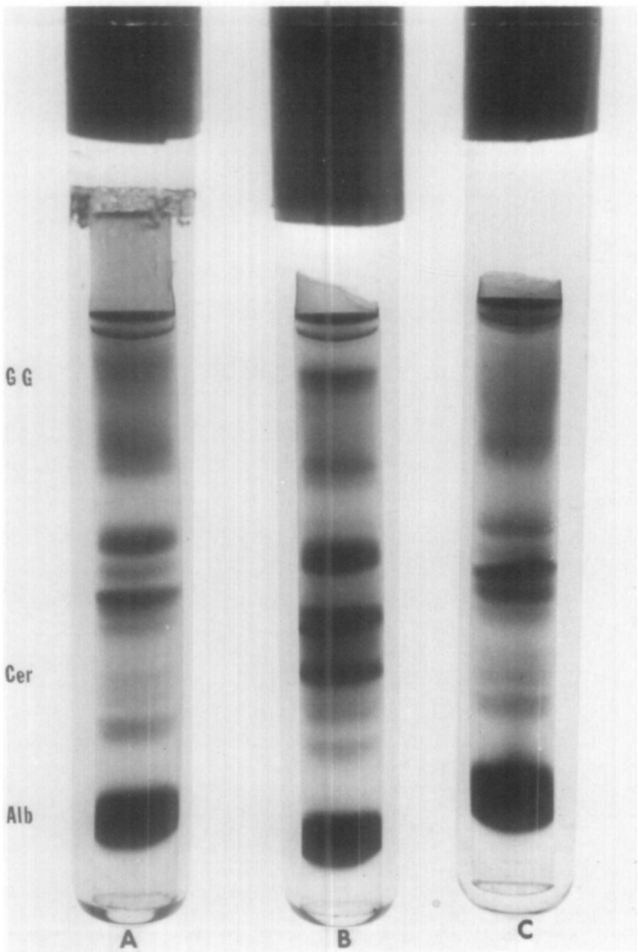

Fig. 10. Polyacrylamide-gel electrophoretic patterns from Case 10; radicular cyst. *A,* Fingertip plasma. *B,* Periapical plasma. *C,* Root canal fluid. *Alb,* Albumin; *Cer,* ceruloplasmin region; *GG,* gamma globulin region.

breakdown products that migrate in the albumin region in the electrophoretic gel.

In addition to hemorrhagic exudates, saliva that gains access to the root canal will contaminate samples of fluid so that these cannot be used, because salivary proteins have a distinctive electrophoretic pattern that would be superimposed on the fluid pattern and would thus invalidate the results.

Ceruloplasmin in serum indicates that an inflammatory reaction is taking place somewhere in the body.[21] The possible appearance of it in periapical blood can be related to the local inflammatory response. The decreased ceruloplasmin in the samples of fingertip plasma indicates that there is little systemic reaction from periapical cysts and granulomas. In the special case (Fig. 13), the preoperative and postoperative periapical plasma patterns were similar. This shows that the surgical procedure was not responsible for the inflammatory re-

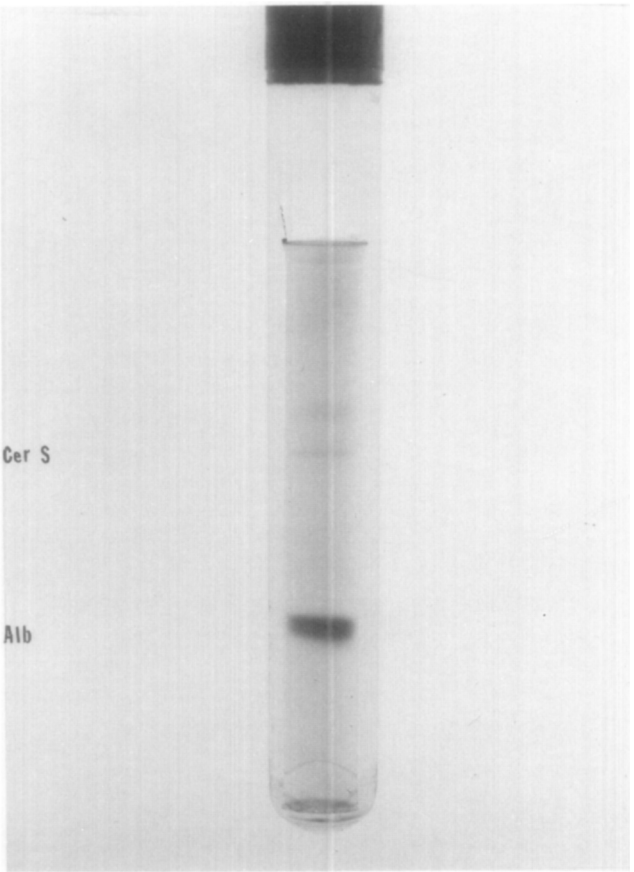

Fig. 11. Polyacrylamide-gel electrophoretic patterns from Case 37; pulpless upper left central incisor with no periapical pathosis and necrotic contents in canal. *Alb*, Albumin; *Cer S*, slight pattern in ceruloplasmin region.

action which resulted in the appearance of the ceruloplasmin band. Since the sample from the normal contralateral tooth showed the same pattern as the blood plasma from the fingertip, it is likely that the periapical inflammatory response (resulting from microbial action or tissue breakdown products) is the determinant of the ceruloplasmin band.

The increased intensities in the gamma globulin regions of many of the periapical plasma samples indicate that antigen-antibody reactions have taken place. Verification of this awaits further tests, such as immunoelectrophoresis.

The low incidence of cysts found in the present study (22.5 per cent), as compared to recent studies by Bhaskar[8] and Lalonde and Luebke,[9] may be related to: (1) the smaller size of this sample; (2) the selection of cases—large lesions (probably with a larger incidence of cysts) in caries-active mouths were often sent directly to the surgery clinic without prior endodontic evaluation; and (3) no inclusion of retreatment cases (which usually contain more cysts). Other possibilities pertain to the diagnosis of cysts, and may include the following factors: (1) Some pathologists call a lesion a cyst only if a complete

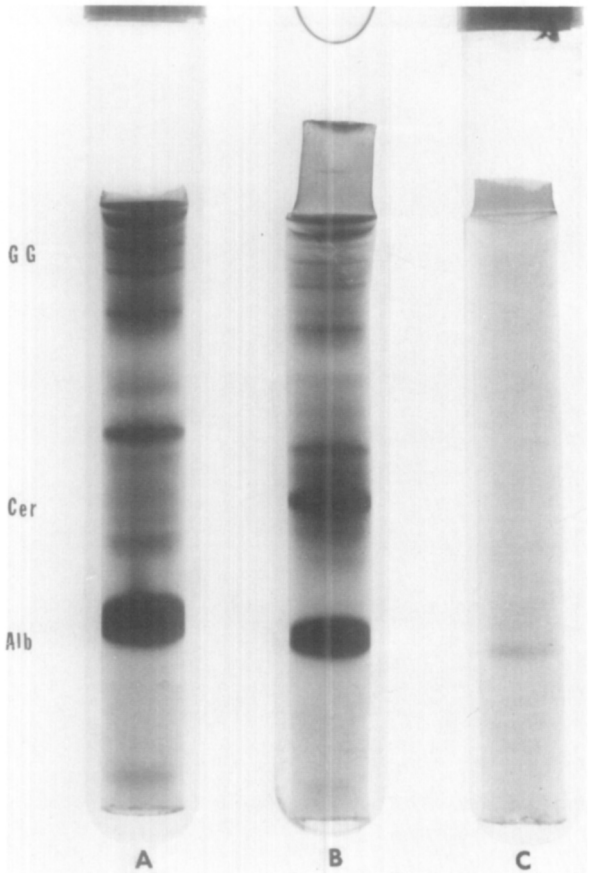

Fig. 12. Polyacrylamide-gel electrophoretic patterns from Case 29; radicular cyst with apical region of canal calcified and consequent failure of penetration of cyst lumen from the root canal. *A*, Fingertip plasma. *B*, Periapical plasma. *C*, Root canal fluid. *Alb*, Albumin; *Cer*, ceruloplasmin region; *GG*, gamma globulin region.

epithelially lined sac can be seen; others are satisfied with a partial lining; and still others settle for actively proliferating epithelium, even with the absence of a definite lumen. (2) A lesion may be a cyst, but, if only part of it is removed, a histopathologic diagnosis of a cyst may not be possible. (3) If serial sectioning is not performed, small cysts can be missed. (4) Oehlers[22] has reported a familial incidence of radicular cysts; hence it is possible that there are more cysts in certain groups of people. (5) In retreatment cases, there is a higher incidence of cysts,[23] and in some of the reported samples, there may have been a high incidence of retreatment cases.

It is interesting that in the two cases that required a consensus by the pathologists for verification as radicular cysts, the biochemical data showed the patterns of a radicular cyst. Neither of the lesions could be removed in toto. It is possible that, as fluid is removed when a lesion is intact, the biochemical diagnosis of a radicular cyst may prove to be more reliable than

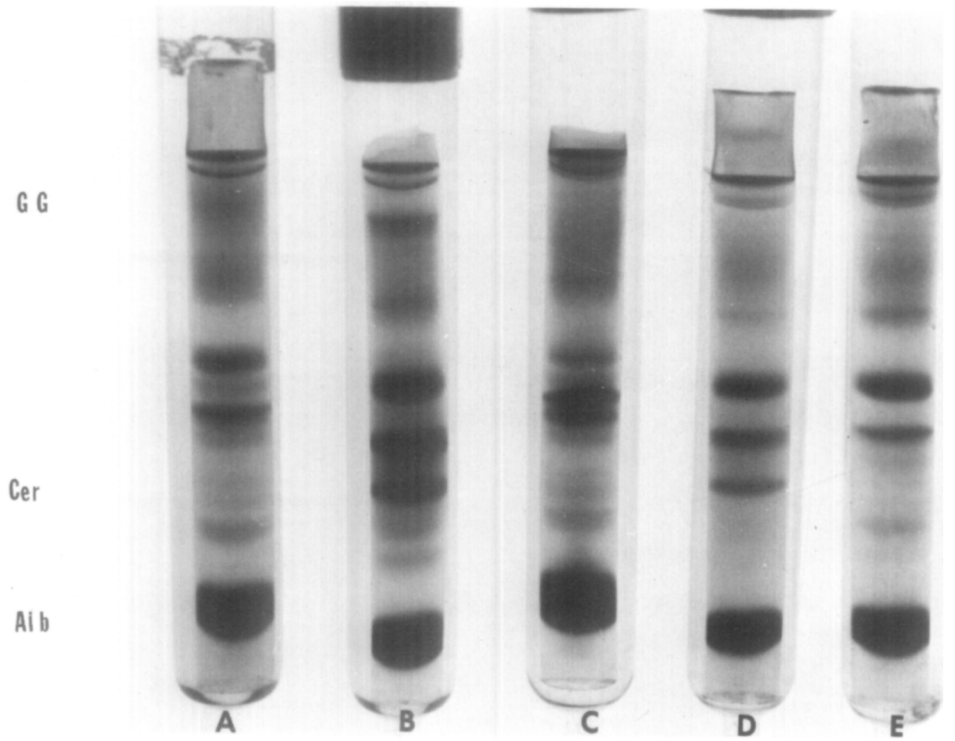

Fig. 13. Polyacrylamide-gel electrophoretic patterns from Case 10; radicular cyst. *A*, Fingertip plasma. *B*, Periapical plasma before operation. *C*, Root canal fluid. *D*, Periapical plasma after operation. *E*, Plasma from periosteum near the apical region of normal, contralateral tooth.

the histopathologic diagnosis. This is only because of the difficulty inherent in histopathologic diagnosis of partial lesions.

There are some possible pitfalls with the use of fluid analysis. One is the fact that there is no definite way to quantitate the relative concentration of solids and liquids in aspirated fluids. This could affect the intensity of the bands, but should not affect the relative types of bands found. Another possible problem would occur in those cases in which there is no connection between the canal and the cyst fluid. This could occur if: (1) the apex of the canal is calcified (as in one of the cyst cases), (2) granulation tissue blocks the cyst lumen from the root canal, and (3) a microcyst is present (not enough fluid will be available). A final pitfall is that there might be some in-between pattern in lesions transitional between granulomas and cysts. However, this has not yet been observed. A possible explanation is that a lesion is not considered to be a radicular cyst until an epithelial-lined sac is formed. It is through this semipermeable lining that plasma proteins are apparently selectively filtered into the cyst fluid. When this occurs, it is possible to obtain the electrophoretic pattern of a cyst. However, even in a granuloma with proliferating epithelium, until a lumen is formed, no semipermeable membrane is present for plasma proteins to filter through. Hence, an electrophoretic pattern typical of a cyst may not

be seen. The albumin pattern that is seen is probably derived from tissue proteins.

Although relatively few cysts were seen because of the case selection procedure, Toller's results[17] with approximately twenty cases of radicular cyst showed electrophoretic cyst patterns similar to those of the present study. This, coupled with the many granulomas that were observed with a markedly different electrophoretic pattern, reinforces the contrasting patterns seen with the two lesions.

Another interesting finding in the study was that granulomas often have little or no fluid, whereas radicular cysts apparently always have fluid. The original study is now being expanded in two ways. Analysis of fluids in anterior teeth with periapical areas is continuing. However, instead of the patients undergoing periapical surgery, they are being treated by nonsurgical endodontic therapy. These cases will then be followed periodically to see whether periapical repair takes place. This will allow observation of electrophoretically determined cases of cysts, in order to ascertain whether periapical healing takes place. The second procedure now being employed is a comparison of cyst fluids and granuloma exudates by a determination of the various enzymes present in each. These results will be reported in the future.

SUMMARY

Root canal fluids were aspirated from forty anterior teeth with radiographic evidence of periapical pathosis, and from one pulpless anterior tooth with no radiographic evidence of periapical pathosis. Samples of periapical and fingertip blood were removed from the surgical cases. All samples were examined by the use of polyacrylamide-gel electrophoresis. The canals were obturated by the use of gutta-percha and chlorpercha. The periapical lesions were removed, sectioned, stained, and examined histologically. The histopathologic diagnoses were then compared with the electrophoretic patterns. Analysis of the root canal fluids showed the following: (1) An albumin pattern was found in all thirty-one of the cases that were histologically diagnosed as being granulomas, and in the one pulpless anterior tooth. (2) In eight of the nine histologically diagnosed cases of cysts there was a larger and more intense albumin pattern, and patterns were found in the globulin regions. Comparison of the samples of fingertip and periapical blood showed that, in general, the periapical samples had more distinct bands in the gamma globulin region and an extra band in the ceruloplasmin region of the gel. This study is being continued, with certain additional procedures being employed.

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Reprint requests to:
Dr. Donald R. Morse
Department of Graduate Endodontics
Temple University School of Dentistry
3223 North Broad St.
Philadelphia, Pa. 19140