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Prevalence and technical quality of root fillings in Dakar, Senegal

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Abstract

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Aim To examine the prevalence and technical quality of root fillings and the periapical status of root-filled teeth in a subpopulation of Dakar, Senegal.

Methodology Full-mouth periapical radiographs were obtained from 208 consecutive adults presenting as new patients to the Dental Service of the University. The occurrence and technical quality of root fillings were assessed for each root according to the apical extent of the root fillings and its density. The periapical status was evaluated using the Periapical Index Scoring System with a PAI > 2 indicating periapical disease. The presence of coronal restorations and posts was also noted. Statistical analysis was performed with the chi-square test with a significance level set at $P < 0.05\%$.

Results Of the 6234 teeth examined, 2.6% were root filled. A PAI > 2 was associated with 56.1% of the filled roots. Only 17.7% of the root fillings were technically acceptable and 26.2% of these were associated with a PAI > 2. In roots with unacceptable root fillings, 62.5% had a PAI > 2. Unacceptable root fillings were associated with a higher prevalence of periapical disease ($P < 0.001$). A post was seen in 18.9% of the filled roots with 66.2% associated with a PAI > 2. A permanent coronal restoration was present in 78.5% of the filled roots, of which 50.7% had a PAI > 2 vs 75.7% for no permanent restoration. At least one periapical lesion was seen in 59.6% of the subjects.

Conclusion The results indicate a low prevalence of teeth with radiographic periapical disease, a low prevalence of root-filled teeth and a high prevalence of unacceptable root fillings.

Keywords: endodontics, epidemiology, periapical disease, radiographic evaluation, root canal treatment.

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Introduction

Numerous epidemiological studies designed to evaluate dental health have reported a high prevalence of apical periodontitis of endodontic origin, which raises an important public health problem in many countries concerning the medical, economic and ethical repercussions (Figdor 2002).

Several reports have confirmed the pioneer studies performed in Sweden and indicate that the prevalence of apical periodontitis (1–15%) increases significantly when considering only root filled, ranging then from 20% to 65% (Table 1).

These studies also noted a discrepancy between the quality of treatments that are recommended by competent scientific committees, experts and professional guidelines (European Society of Endodontology 2006), and those performed by general practitioners. A large percentage of root fillings do not satisfy the professional guidelines. Consequently, the prevalence of apical periodontitis increases with a decrease in the quality of treatment. These epidemiological findings are in agreement with longitudinal clinical outcome data showing that treatments facilitating cleaning and

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Table 1 Estimated prevalence of apical periodontitis (AP) in various countries according to published studies

Country	Reference	Number of teeth	AP (% of teeth)	AP (% of RF teeth)
Sweden	Petersson *et al.* (1986)	4985	7	31
Sweden	Allard & Palmqvist (1986)	2567	10	27
Sweden	Eckerbom *et al.* (1987)	4889	5	26
Norway	Eriksen *et al.* (1988)	3197	1	34
Sweden	Ödesjö *et al.* (1990)	17 430	3	25
Sweden	Eckerbom (1991)	4889	5	26
Switzerland	Imfeld (1991)	2004	8	36
Norway	Eriksen *et al.* (1991)	2940	4	37
Holland	De Cleen *et al.* (1993)	4196	5	39
Norway	Eriksen & Bjertness (1995)	3282	7	38
USA	Buckley & Spångberg (1995)	5272	4	31
Finland	Soikkonen (1995)	2355	4	25
Scotland	Saunders *et al.* (1997)	8420	5	58
Germany	Weiger *et al.* (1997)	7897	3	61
Portugal	Marques *et al.* (1998)	4446	2	22
Germany	Schulte *et al.* (1998)	ns	ns	24–26
Lithuania	Sidaravicius *et al.* (1999)	3892	7	39
Belgium	De Moor *et al.* (2000)	4617	7	40
Denmark	Kirkevang *et al.* (2001)	15 984	3	52
France	Boucher *et al.* (2002)	5373	7	30
France	Lupi-Pegurier *et al.* (2002)	7840	7	31
Canada	Dugas *et al.* (2003)	16 148	3	45
Spain	Jimenez-Pinzon *et al.* (2004)	4453	4	65
Greek	Georgopoulou *et al.* (2005)	7664	13	60
Brazil	Siqueira *et al.* (2005)	2051		50
Poland	Boltacz-Rzepkowska & Laszkiewicz (2005)	10 054	6	36
France	Chazel *et al.* (2005)	5678	5	25
Bielorussia	Kabak & Abbott (2005)	31 212	12	45
Ireland	Loftus *et al.* (2005)	7427	2	25
Japan	Tsuneishi *et al.* (2005)	16 232	9	40

RF,root-filled; ns, non-specified.

disinfection of the root canal followed by its complete obturation result in fewer apical periodontitis than those which do not (Strindberg 1956, Kerekes & Tronstad 1979, Byström *et al.* 1987, Sjögren *et al.* 1997), consistent with the microbial aetiology of periapical disease (Nair 2006).

Because of the limited number of subjects compared with the general population and possible biases in the sampling, these epidemiological studies are only indicators of the real state of health. They nevertheless provide key data in order to build health indicators and public health planning. In Africa, these dental epidemiological data are lacking. In view of the potential consequences of apical periodontitis on local and general health (Simon 1998, Márton 2004) it is important to collect these data.

The aim of this study was, therefore, to evaluate the prevalence and technical quality of root fillings and the periapical status of root-filled teeth in a subpopulation of Dakar, Senegal.

Materials and methods

The sample consisted of patients attending the dental service of the Odontology Department of the Faculty of Medicine, Pharmacy and Odontology, University of Dakar, Senegal. The criteria for inclusion were the same as those of Boucher *et al.* (2002), i.e. the patients should be attending for the first time, have not had dental treatment during the previous year, must not have been referred by colleagues, and must not have consulted the dental service for orthodontic reasons or full mouth prosthodontic rehabilitation.

The patients were at least 18 years old, and were accepted in the order of their attendance over a period extending from February 2004 to July 2005. All proposed subjects agreed to participate to the study. The data collection was interrupted for a period of 3 months due to a mechanical problem related to the generator used for the radiographic equipment. The scientific committee of the Medicine, Pharmacy and

Odontology Faculty approved the study, and patient anonymity was respected. Periapical radiographs were taken by two experienced radiographers using the long-cone paralleling technique with Rinn angulators (Denstply Maillefer and Hawe neos Dental, Bioggio, Switzerland) and radiographic films (Agfa Dentus M2 Confort Single Film Size 2, 150 × 1 Heraeus Kulzer GmbH & Co. KG, South Bend,IN,USA), which were manually developed and fixed, and then mounted on black holders. The radiographs were then evaluated by three examiners with negatoscope light using a magnifier (×2) and the Mattson viewer (Mattson 1953) in difficult cases. The three examiners were all members of the Restorative Dentistry and Endodontic Department who participated in the pre-doctoral and post-graduate endodontic teaching programmes of their Dental School. The scoring system proposed by Ørstavik *et al.* (1986) was used for evaluating the periapical condition of each root. Each of the roots was categorized as: (i) normal periapical structure; (ii) small changes in bone structure; (iii) changes in bone structure with some mineral loss; (iv) periodontitis with well-defined radiolucent area; and (v) severe periodontitis with exacerbating features. Each category used in the PAI represents a step on an ordinal scale of registration of periapical infection. Two sessions, within 1 month interval between them were spent in calibrating the examiners before beginning radiographic analysis (Reit & Hollender 1983, Reit 1987). At the first session, 100 radiographs chosen from a previous study (Boucher *et al.* 2002) with different periapical status covering all the PAI scales were examined by all the examiners. Interexaminer agreement, calculated as Cohen's kappa, ranged from 0.80 to 0.95. At the second session, 75 different radiographs taken from the same material were examined. Intraexaminer reproducibility was evaluated with a Cohen's kappa ranging from 0.83 to 0.92. When disagreement in interpretation was noted between observers, radiographs were re-examined until an agreement on PAI score was noted. For each tooth and root the following items were surveyed: the presence of coronal restorations (including crowns); the presence of a root filling defined as radio-opaque material present in the pulp chamber and/or in the root canal(s); the presence of posts and the distance from the end of the post to the apex; and the periapical status (PAI 1–5). PAI > 2 was considered to be a sign of periapical disease (Ørstavik *et al.* 1986). For multirooted teeth, the highest score of PAI was taken. The quality of root fillings was evaluated according to the density of the filling and the distance between the end of the filling and the radiological apex. A filling was considered to be acceptable when no voids or defects along the walls of the canal could be detected and when the filling terminated between 0 and 2 mm from the radiographic apex.

Observations of the teeth and the roots were analysed using the Excel® (Microsoft, WA, USA) software. The chi-squared test was used to determine if there was an association between periapical status and technical quality of the root filling, presence of coronal restoration and presence of posts.

Results

A total of 208 subjects were examined with a mean age 31.9 ± 11.2 years. The distribution of the subjects by age is given in Fig. 1; females comprised 45% of the sample.

Teeth

The mean number of teeth per subject was 29.9 which corresponded to a total number of 6234 teeth (Table 2). No subjects had less than 19 teeth. The prevalence of root filled teeth was 2.6%, and 35.5% of the subjects had at least one root filled tooth. The periapical status of all teeth is indicated in Table 2. Altogether, 4.6% of the teeth had a periapical lesion (PAI > 2). The most frequently root-filled teeth were the mandibular first molars (8.9%) and the mandibular second molars (5.4%), followed by the maxillary first molars (5.1%) and the maxillary second premolars (4.2%). There were 27 fractured instruments (5.8% of the roots). No patients had undergone periapical surgery, and 59.6% of the patients presented with at least one periapical lesion. Root filled teeth that were most frequently associated with disease were,

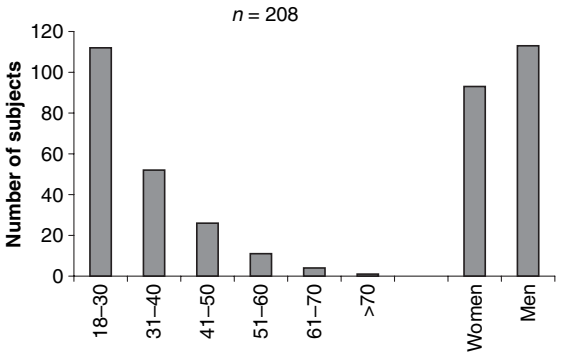

Figure 1 Age and gender distribution of the sample.

Table 2 Presence/absence of teeth and periapical status

Teeth FDI index	Status					PAI score						
	Absent	Present (n)	Present (%)	Root-filled teeth (n)	Root-filled teeth (%)	1	2	3	4	5	PAI>1 (%)	PAI>2 (%)
11–21	11	405	97.4	14	3.4	386	1	2	6	10	4.7	4.4
12–22	5	411	98.8	10	2.4	396	1	2	6	6	3.6	3.4
13–23	0	416	100	8	1.9	405	2	3	2	4	2.6	2.2
14–24	10	406	97.6	11	2.7	391	0	1	4	10	3.7	3.7
15–25	15	401	96.4	17	4.2	369	3	8	5	16	7.9	7.2
16–26	41	375	90.1	19	5.1	333	5	13	14	10	11.2	9.9
17–27	28	388	93.3	8	2.1	364	0	4	11	9	6.2	6.2
18–28	59	357	85.8	0	0	343	0	3	2	9	3.9	3.9
31–41	9	407	97.8	2	0.5	396	0	1	4	6	2.7	2.7
32–32	13	403	96.9	4	0.9	395	1	2	2	3	1.9	1.7
33–43	5	411	98.8	2	0.4	410	1	0	0	0	0.2	0
34–44	4	412	99.0	6	1.4	403	0	1	2	6	2.2	2.2
35–45	8	408	98.1	11	2.7	393	3	5	3	4	3.7	2.9
36–46	90	326	78.4	29	8.9	257	13	14	16	26	21.7	17.2
37–47	46	370	88.9	20	5.4	339	4	6	7	14	8.4	7.3
38–48	78	338	81.2	4	1.2	330	0	0	3	5	2.4	2.4
Anterior	43	2453	98.3	40	1.6	2388	6	10	20	29	2.6	2.4
Premolars	37	1627	97.8	45	2.8	1556	6	15	14	36	4.4	3.9
Molars 1 & 2	205	1459	87.7	76	5.2	1293	22	37	48	59	11.4	9.9
Molar 3	137	695	83.5	4	0.6	673	0	3	5	14	3.2	3.2
Total	422	6234	93.7	165	2.6	5910	34	65	87	138	5.2	4.6

Table 3 Periapical status of root-filled roots and non filled roots

Teeth FDI index	All roots								Root-filled roots							
	PAI score								PAI score							
	1	2	3	4	5	Total	PAI>1	PAI>2	1	2	3	4	5	Total	PAI>1	PAI>2
11–21	386	1	2	6	10	405	4.7	4.4	5	1	1	4	3	14	64.3	57.1
12–22	396	1	2	6	6	411	3.6	3.4	1	1	2	5	1	10	90	80
13–23	405	2	3	2	4	416	2.6	2.2	3	2	1	2	0	8	62.5	37.5
14–24	770	0	1	8	20	799	3.6	3.6	8	0	1	8	5	22	63.6	63.6
15–25	738	6	15	9	28	796	7.3	6.5	4	6	5	7	8	30	86.7	66.7
16–26	1007	20	42	33	25	1127	10.6	8.9	11	10	13	14	9	57	80.7	63.2
17–27	1092	0	14	34	24	1164	6.2	6.2	6	0	3	12	3	24	75.0	75.0
18–28	1002	0	12	6	27	1047	4.3	4.3	0	0	0	0	0	0	0	0
31–41	396	0	1	4	6	407	2.7	2.7	0	0	1	1	0	2	100	100
32–32	396	1	1	2	3	403	1.7	1.5	2	0	1	1	0	4	50	50
33–43	410	1	0	0	0	411	0.2	0	2	0	0	0	0	2	0	0
34–44	479	0	1	2	6	488	1.8	1.8	2	0	0	1	3	6	66.7	66.7
35–45	445	3	5	3	6	462	3.7	3	5	1	2	3	0	11	54.5	45.4
36–46	786	42	33	42	75	978	19.6	15.3	30	10	15	21	8	84	64.3	52.4
37–47	998	11	19	20	40	1088	8.3	7.3	25	9	12	0	12	58	56.9	41.4
38–48	992	0	0	8	15	1015	2.3	2.3	7	0	0	2	3	12	41.7	41.7
Anteriors	2389	6	9	20	29	2453	2.6	2.4	13	4	6	13	4	40	67.5	57.5
Premolars	2432	9	22	22	60	2545	4.4	4.1	19	7	8	19	16	69	72.5	62.3
Molars 1 & 2	3883	73	108	129	164	4357	10.9	9.2	72	29	43	47	32	223	67.7	54.7
Molar 3	1994	0	12	14	42	2062	3.3	3.3	7	0	0	2	3	12	41.7	41.7
Total	10 698	88	151	185	295	11 417	6.3	5.5	111	40	57	81	55	344	67.7	56.1

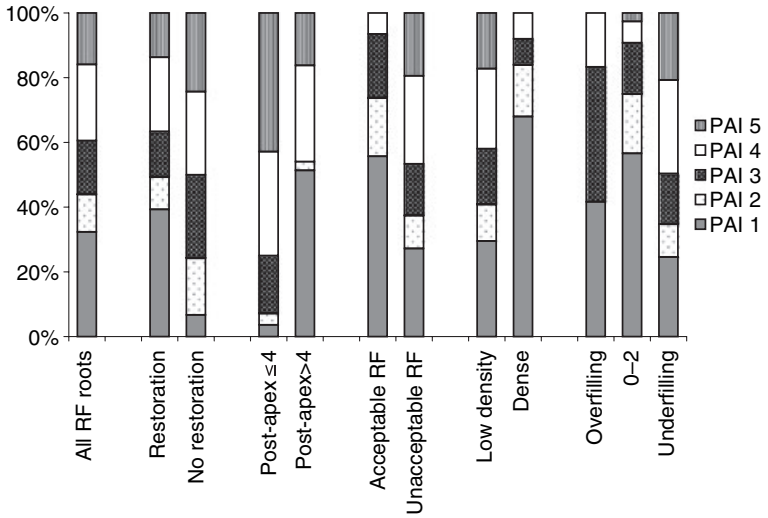

Figure 2 PAI distribution according to the various categories of roots. RF, root filling.

Table 4 Periapical status of root-filled (RF) teeth according to different parameters of the treatment

	Number						%						
PAI	1	2	3	4	5	total	1	2	3	4	*5*	PAI>1	PAI>2
All RF roots	111	40	57	81	55	344	32.3	11.6	16.6	23.5	15.9	67.7	56.1
Restoration	106	27	38	62	37	270	39.3	10.0	14.1	22.9	13.7	60.7	50.7
No restoration	5	13	19	19	18	74	6.7	17.6	25.7	25.7	24.3	93.2	75.7
Post	20	2	5	20	18	65	30.7	3.1	7.7	30.8	27.7	69.2	66.2
Post-apex ≤4	1	1	5	9	12	28	3.6	3.6	17.8	32.1	42.8	96.4	92.8
Post-apex>4	19	1	0	11	6	37	51.3	2.7	0.0	29.7	16.2	48.6	45.9
Acceptable RF	34	11	12	4	0	61	55.7	18.1	19.7	6.5	0.0	44.3	26.2
Unacceptable RF	77	29	45	77	55	283	27.2	10.2	15.9	27.2	19.4	72.8	62.5
Low density	94	36	55	79	55	319	29.5	11.3	17.2	24.7	17.2	70.5	59.2
Dense	17	4	2	2	0	25	68.0	16.0	8.0	8.0	0.0	32.0	16.0
Overfilling	5	0	5	2	0	12	41.7	0.0	41.7	16.7	0.0	58.3	58.3
0–2	43	14	12	5	2	76	56.6	18.4	15.8	6.6	2.6	43.4	25.0
Underfilling	63	26	40	74	53	256	24.6	10.2	15.6	28.9	20.7	75.4	65.2

respectively, the single-rooted teeth>premolars>molars. In this study, if the mandibular incisors are excluded because of low numbers, the teeth that were most often associated with periapical disease were the maxillary lateral incisors.

Roots

The teeth included in the survey had a total number of 11 417 roots and 344 had root fillings (3.01%). Among these 56.1% had radiological signs of a periapical pathosis (PAI > 2) compared with 5.5% for the entire sample of roots. The PAI value attributed to each root by tooth type is outlined in Table 3. Overall, 17.7% of the roots had acceptable root fillings and 26.2% of these were associated with a PAI > 2 compared with 62.5% for roots with unacceptable fillings (Fig. 2). the difference was statistically significant ($P < 0.001$, OR = 36.31, $\chi^2 = 26.86$). Overall 18.9% of the filled roots had posts, and these were associated with a PAI > 2 in 66.2% of the cases. There was no statistically significant difference in the prevalence of periapical radiolucency between the filled roots with and without a post ($P = 0.7$, $\chi^2 = 3.28$). However, root fillings with a post extending more than 4 mm from the apex were associated with more

periapical lesions than root filled with a post extending less than 4 mm ($P < 0.001$, OR = 15.29, $\chi^2 = 15.67$). Among the teeth with root fillings, 78.5% had a permanent coronal restoration at the moment of the examination. For these roots, the PAI was >2 in 50.7% of the cases (Fig. 2); 21.5% exhibited no coronal restoration and were associated with a periapical lesion in 75.7% of the cases.

Teeth root filled without coronal restorations showed significantly more periapical disease compared to those with restorations ($P < 0.001$, OR = 3.02, $\chi^2 = 14.66$) (Table 4). Roots with a low density fillings were associated with periapical periodontitis significantly more than those exhibiting a dense filling ($P < 0.001$, OR = 7.63, $\chi^2 = 17.6$). Both overfilled and under filled roots exhibited a higher prevalence of periapical periodontitis ($P < 0.02$, OR = 4.2, $\chi^2 = 5.51$ and $P < 0.001$, OR = 5.63, $\chi^2 = 38.51$ respectively). Figure 2 illustrates the distribution of the different scores of PAI expressed as percentages for the different categories cited.

Discussion

The sample included in this study consisted of adult patients attending the Dental School of Dakar, Senegal for the first time. The dental service of the Odontology department attracts a patient population from numerous parts of the city and its surroundings, which eliminates the risk of only including patients previously treated by a limited number of practitioners. However, the sample did not represent a random sample of the Senegalese population, and extrapolation of the results to the general population must be carried out with caution. Although a socio-economic analysis of the patient's hasn't been performed it was known that some patients sought care because of the cost of treatment, which is less at the dental service than in the private sector, and that others were patients who sought care because of the reputation of the University dental service.

The sample consisted of 45% females and 55% males. Similar epidemiological studies reported that gender had no effect on the number of roots filled or the presence of apical periodontitis (Kirkevang *et al.* 2001, Boucher *et al.* 2002, Jimenez-Pinzon *et al.* 2004). In this study, periapical radiography was preferred to panoramic examination because not only the presence, but also the degree of apical periodontitis and endodontic quality were assessed. It has been shown that an underestimation of lesions occurred when only panoramic radiography was used, although the difference was not statistically significant (Muhammed & Manson-Ring 1982). Panoramic radiographs are also more subject to inter-observer variations (Rohlin *et al.* 1991).

The present study shows that 2.6% of teeth had undergone root canal treatment and that a periapical lesion was associated with 56.1% of the root-filled teeth. This figure is in the range of those found in previous studies, which vary from 18% to 61% (Table 1).

This high prevalence of apical periodontitis associated with root filled teeth is of concern, as the prognosis for teeth presenting with periapical disease is poor. In follow-up studies, it has been demonstrated that up to 50% of teeth exhibiting apical periodontitis will be extracted (Petersson *et al.* 1991, Frisk & Hakeberg 2005, Kirkevang *et al.* 2006). However, because of the cross-sectional design of this survey, some of the observed periapical radiolucencies may represent persistent apical periodontitis or incompletely healed lesions after root canal treatment.

Most of the root filled teeth were mandibular molars, which were also the most frequently missing, other than third molars. It is reasonable to hypothesize that some of these teeth were extracted because of periapical disease, with or without endodontic treatment.

As was noted in a previous paper (Boucher *et al.* 2002), the PAI is mainly used with a cut-off at 2, according to the work of Brynolf (1979), Ørstavik *et al.* (1986) and Ørstavik (1988). Choice of the cut-off at 2 for the PAI is debatable and a cut-off at 1 for evaluating periapical health might be more appropriate. With such a cut-off, the prevalence of the PA in the root-filled teeth of the present sample would be 67.7%.

Another interesting finding of the present study concerns the quality of root fillings. Only 17.7% of the roots fulfilled the criteria for an acceptable root canal filling, i.e. a radiographically dense filling with its end located between 0 and 2 mm from the apex (European Society of Endodontology 2006). These results are worse than those of most of the other published studies, which show an acceptable root filling in 25–40% of roots (Table 1). They, therefore, indicate that the majority of root fillings were performed poorly, despite the fact that the technical quality of care is a key factor in the healing or prevention of periapical diseases (Strindberg 1956, Kerekes & Tronstad 1979, Sjögren *et al.* 1990, ANDEM 1996). In addition, these observations only take into account the radiographic image of the treatment. They do not take into account the working conditions and, especially the disinfection of

the root canal prior to filling, which is a major factor in terms of prognosis (Sjögren *et al.* 1997). The present results confirm those of previous studies indicating a strong correlation between technical quality and periapical health. Poor quality of treatment allows the persistence of bacteria in the root canal that can eventually induce periapical lesions (Bergenholtz *et al.* 1982, Ray & Trope 1995, Katebzadeh *et al.* 1999, Trope *et al.* 1999).

Other factors can influence the presence of periapical lesions. The decrease in quality of the coronal seal is associated with a higher number of periapical radiolucencies (Ray & Trope 1995, Hommez *et al.* 2002, Ricucci & Bergenholtz 2003). In the present study, root filled without coronal restorations had significantly more periapical pathology compared to those with restorations ($P < 0.001$, χ^2). The presence of a post was not associated with a PAI > 2 but when the distance between the end of the post and the apex was less than 4 mm, the risk of periapical pathology was significantly increased ($P < 0.001$, χ^2).

Conclusion

This study provides epidemiological data about apical periodontitis in Senegal, Africa. The results indicate a low prevalence of teeth with periapical disease, a low prevalence of root fillings, a high prevalence of unacceptable root fillings among root filled teeth and high prevalence of periapical disease associated with root-filled teeth.

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