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ORIGINAL RESEARCH

Clinical and radiographic outcome of the root canal treatment of infected teeth with associated sinus tract: A retrospective study

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Abstract

This retrospective study evaluated the outcome of the endodontic treatment/retreatment of teeth with intraoral sinus tracts. Seventy-two teeth from 70 individuals were included. One operator treated all teeth over about 20 years. Time for the sinus tract to heal was recorded. Treatment outcome was evaluated after at least 1 year and classified as healed, healing or diseased. The overall healed rate of periradicular lesions was 73.6% (74.1% for treatment and 72.2% for retreatment). In 6 (8.3%) teeth, lesions were healing. Thirteen teeth (18.1%) exhibited persistent disease. In 68/72 (94.4%) cases, the sinus tract healed in less than 1 month. No preoperative/intraoperative variable affected the outcome ($P > 0.05$). Missing restorations had a negative impact ($P < 0.05$). Healing of both the sinus tract quickly after treatment and the periradicular lesion later were usually achieved. Closure of the sinus tract in the first month was a good predictor of lesion healing.

Introduction

Chronic apical abscess is a form of apical periodontitis caused by bacterial infection of the root canal and characterised by a periapical radiolucency associated with an intraoral or extraoral sinus tract (1). Discharge of purulent exudate from the chronic abscess can occur in active sinus tracts, which makes the condition usually asymptomatic. However, the patient may complain of symptoms in the event the sinus tract closes or is blocked.

Histopathologically, lesions associated with sinus tracts can be diagnosed as an abscess or even a granuloma or cyst with focal abscessed areas (2,3). These findings can be possibly explained by the theories about the pathogenesis of the chronic apical abscess, which has been claimed to result from a slight subclinical exacerbation of a chronic lesion (granuloma or cyst) or a chronicisation of an acute abscess (1,3,4).

The prevalence of apical periodontitis lesions associated with sinus tracts has been shown to vary from 8.5% to 18% (5,6). Sinus tracts have been reported to occur more commonly intraorally on the buccal mucosa of teeth with large radiolucencies (2,5). They are usually associated with longstanding root canal infection (7). Teeth with chronic apical abscesses and sinus tracts show a very complex infectious pattern in the apical root canal system, with predominance of biofilms, in many cases extending to the outer root surface to form an extraradicular infection (3).

Many studies have reported that the presence of a sinus tract does not significantly influence the prognosis of the endodontic treatment of teeth with apical periodontitis (6,8–10). However, a large cohort study showed a worse prognosis for teeth with sinus tracts than teeth without a sinus tract (11). In addition to this inconsistency in results, there has been no clear correlation between healing of the sinus tract in a few days or weeks after treatment and the healing of the apical periodontitis lesion one or more years later.

The purpose of this retrospective study was to report on the clinical and radiographic outcome of the root canal treatment or retreatment of teeth with chronic apical abscesses with an intraoral sinus tract performed

consecutively by a single experienced operator. The demographic data of these consecutive cases are reported. Further, the influence of some preoperative, intraoperative and postoperative variables on the treatment/retreatment outcome of teeth with sinus tracts was also evaluated.

Material and methods

Case selection

Cases included in this study were selected from 144 patients (81 women and 63 men; age ranging from 15 to 86 years) who were referred to a specialist in Endodontics (L.A.), in a private practice, for endodontic evaluation because of the presence of an intraoral sinus tract. All these referred patients showed up consecutively over the period from 1999 to 2019. Initially, case selection followed inclusion criteria as follows: tooth with a sinus tract and radiographic evidence of periradicular bone destruction, tooth with a necrotic pulp confirmed by pulp tests or with previous root canal treatment, tooth that was restorable and had an indication for root canal treatment or retreatment, tooth with a mobility score <3 and absence of periodontal pockets >4 mm deep, and patients without significant systemic disease. All patients were informed about the treatment options, as well as the benefits and risks associated with each one, and gave consent for examination and treatment of their teeth. The approval of this retrospective study protocol was obtained from the Institutional Board Review.

Data collection

The following preoperative clinical and radiographic data were recorded: patient's age and sex, sinus tract location (buccal, distal, palatal/lingual), size of the radiolucent lesion, root canal status (necrotic pulp or previous treatment), tooth type and location (maxillary or mandibular), symptoms, periodontal probing and tooth mobility. The size of the apical periodontitis lesion was measured on periapical radiographs as the largest diameter and was classified as small (≤5 mm), large (from >5 to <10 mm) or very large (≥10 mm).

Intraoperative data were also recorded, including the number of treatment sessions, working length, obturation technique, quality of the root canal filling and filling of lateral canals. The root canal filling was regarded as adequate when all canals were obturated, with no voids in the filling mass and the apical terminus of the filling was 0–1 mm short of the radiographic apex.

Endodontic treatment/retreatment procedures

Of the cases with preoperative presence of a sinus tract, 137 teeth from 128 patients met the inclusion criteria and were subjected to root canal treatment or retreatment by a single operator (L.A.). In all cases, thermal pulp tests were used to evaluate the pulp diagnosis and a gutta–percha point was used to follow the pathway of the sinus tract down to the involved tooth and radiographed. Periodontal probing, tooth mobility assessment and evaluation of fissures and fractures were also performed. In the first treatment session, local anaesthesia was administered and the tooth was isolated with a rubber dam. After disinfection of the operative field, chemomechanical preparation was performed using 2.5% sodium hypochlorite as the irrigant and diverse manual or rotary NiTi instruments, which differed over the years. The working length (WL) was established by using an electronic apex locator, and then radiographically confirmed. Most cases were treated in a single visit, provided that a dry canal was achieved after preparation. An additional visit with interappointment calcium hydroxide medication was made necessary in more anatomically complex cases or when a dry root canal could not be achieved before obturation. Calcium hydroxide had to be renewed for one more session in a few cases when the canal was still wet. Root canals were filled by the lateral compaction or the Schilder's vertical compaction technique.

In retreatment cases, the previous filling material was removed by using Gates–Glidden burs and Hedström files. Gutta–percha solvent (xylol, Dickinson, Buenos Aires, Argentina) was used in most cases. Afterwards, the root canal procedures were conducted as described for the initial treatment.

Follow-up

Healing of the sinus tract was recorded during follow-up examinations performed at 7, 14, 21 and 30 days postoperatively. The result was dichotomous, that is healed (closed) or not healed (active sinus tract). Persistent cases were recorded as those that did not heal after 30 days. Recurrent cases were those in that the sinus tract re-emerged any time after having healed.

Regarding periradicular tissue healing, patients were followed up periodically (range, from 1 to 17 years). Appearance or persistence of any clinical signs or symptoms of apical periodontitis were indicative of a failed outcome, even if they occurred in less than one-year follow-up. Patients were contacted by telephone every year after treatment for recall examination. At the follow-up visit, patients were evaluated for the presence

of clinical signs and symptoms, such as sinus tract, spontaneous pain, tenderness to percussion/palpation, root fracture, loss of function, mobility and periodontal probing depths. The presence, type and quality of the coronal restoration at the time of follow-up examination was evaluated by visual inspection and radiographs and included as a postoperative variable. Coronal restoration was regarded as adequate when it appeared intact, showing no detectable defects or recurrent caries.

For radiographic follow-up examination, preoperative, postoperative and follow-up radiographs were compared to evaluate the fate of the apical periodontitis lesion. For evaluation, radiographs were incorporated in Keynote files and examined on the computer screen, in a darkened room, independently by 2 blinded evaluators, who are experienced endodontists. The treatment provider did not participate of the evaluations. The periradicular status was evaluated on the basis of the Periapical Index (PAI) system (12). Joint discussion was used to score the disagreement cases. Observers were calibrated against a set of 100 reference radiographs (kindly supplied by Dag Ørstavik, University of Oslo). The outcome in multirooted teeth was categorised according to the root with the highest PAI score.

According to the clinical and radiographic evaluations, the outcome was classified as:

1 Healed: the tooth was asymptomatic and functional, the sinus tract disappeared, and there was no radiographic apical periodontitis lesion (PAI scores 1 or 2)

2 Healing: the tooth was asymptomatic and functional, the sinus tract disappeared, and the apical periodontitis lesion decreased in size (PAI score decreased, but it was still >2), in follow-up evaluations shorter than 4 years

3 Diseased: the tooth was symptomatic and nonfunctional, the sinus tract persisted or recurred, and/or the radiographic apical periodontitis lesion was unchanged or enlarged (PAI scores 3 to 5).

Data analysis

Data were tabulated and described as the percentage of the different outcome categories in relation to the different variables. For statistical analysis, the treatment outcome was dichotomised as success (healed and healing cases) and failure (diseased cases). The Fisher's exact test or the chi-square test was used to assess the influence of the different variables on the treatment outcome. Some variables were also dichotomised for the analyses. Evaluations included short-term (sinus tract healing) and long-term (periradicular tissue healing) outcomes. All tests were 2-sided and the level of significance was established at 5% ($P < 0.05$).

Results

Of the 154 total cases referred for endodontic treatment, 17 were not subjected to root canal treatment because of a diagnosis of fissure, fracture or severe structural destruction that made the tooth unrestorable. Of the 137 teeth that were subjected to root canal treatment or retreatment, 70 were followed up for <1 year. Reasons for no return for longer follow-ups included no answer to the phone calls, and allegations of having no symptoms or no time available. Of the cases followed up for <1 year, 4 presented with persistent sinus tract for more than one month and one retreatment case had a recurrent fistula after 4 months. Even having a <1-year follow-up, these 5 cases were included in the outcome analysis because they represented short-term failures based on clinical signs/symptoms. Because of the persistent disease, these 5 patients were subjected to periradicular surgery or extraction. At the end of the study, 72 teeth were evaluated, 67 of which with >1-year follow-up clinical and radiographic evaluation. Demographic data are listed in Table 1.

The overall healed rate for the 72 cases with preoperative sinus tracts was 73.6%; 74.1% for the initial treatment and 72.2% for retreatment cases (Fig. 1). Six teeth (8.3%) showed lesions that were not completely healed in the follow-up examination, but had their sizes reduced. These cases classified as 'healing' had a follow-up period ranging from 1 to 2.25 years. Thirteen teeth (18.1%) exhibited persistent disease as demonstrated by clinical and/or radiographic findings (Fig. 2). Teeth with a small periradicular lesion (≤5 mm) had a healed rate of 88.2%, while lesions that were large (5–10 mm) or very large (≥10 mm) completely healed in 72.7% and 54.5% of the cases, respectively. The healed rates according to the age were 85.7%, 73.9% and 71.4% for patients ≤25, between 25 and 40, and ≥40 years old, respectively. Most of the sinus tracts occurred on the buccal side and the most frequently affected teeth were the maxillary molars. No statistically significant differences were observed for these and the other demographic and preoperative variables evaluated ($P > 0.05$; Table 1).

Different intraoperative factors and their influence on the periradicular status were analysed and are described in Table 2. The large majority of cases were treated in one visit, with a healed rate of 79.3%. More complicated cases required 2 or 3 visits and received an interappointment medication with calcium hydroxide. In these complicated cases treated in 2 visits, the healed rate was 63.6%. All 3 cases treated in 3 visits showed recurrent sinus tracts and were classified as failures. Because only the most complicated cases were treated in more than

Table 1 Clinical and radiographic outcome of teeth with periradicular lesions and associated sinus tract according to the different demographic and preoperative variables

Variables	$N = 72$[‡]	Periradicular status[†]			P value[§]
		Healed	Healing	Diseased	
Gender					
Male	32 (44.4%)	23 (71.9%)	3 (9.4%)	6 (18.8%)	0.86
Female	40 (55.6%)	30 (75.0%)	3 (7.5%)	7 (17.5%)	
Age (years)[¶]					
≤25	7 (9.7%)	6 (85.7%)	1 (14.3%)	0 (0.0%)	1
26–40	23 (31.9%)	17 (73.9%)	1 (4.3%)	5 (21.7%)	
≥40	42 (58.3%)	30 (71.4%)	4 (9.5%)	8 (19.0%)	
Sinus tract location[††]					
Buccal	67 (93.1%)	50 (74.6%)	4 (6.0%)	13 (19.4%)	0.58
Distal	4 (5.5%)	2 (50.0%)	2 (50.0%)	0 (0.0%)	
Palatal/lingual	1 (1.4%)	1 (100%)	0 (0.0%)	0 (0.0%)	
Lesion size[‡‡]					
≤5 mm (small)	17 (23.6%)	15 (88.2%)	1 (5.9%)	1 (5.9%)	0.17
5–10 mm (large)	44 (61.1%)	32 (72.7%)	4 (9.1%)	8 (18.2%)	
≥10 mm (very large)	11 (15.3%)	6 (54.5%)	1 (9.1%)	4 (36.4%)	
Intervention					
Treatment	54 (75%)	40 (74.1%)	5 (9.3%)	9 (16.7%)	1
Retreatment	18 (25%)	13 (72.2%)	1 (5.6%)	4 (22.2%)	
Tooth type					
Incisive	21 (29.2%)	16 (76.2%)	1 (4.8%)	4 (19.0%)	0.66
Canine	4 (5.5%)	3 (75.0%)	1 (25.0%)	0 (0.0%)	
Premolar	11 (15.3%)	6 (54.5%)	2 (18.2%)	3 (27.3%)	
Molar	36 (50%)	28 (77.8%)	2 (5.6%)	6 (16.7%)	
Tooth location					
Maxillary	39 (54.2%)	28 (71.8%)	5 (12.8%)	6 (15.4%)	0.74
Mandibular	33 (45.8%)	25 (75.8%)	1 (3.0%)	7 (21.2%)	
Total	72	53 (73.6%)	6 (8.3%)	13 (18.1%)	

[†]For dichotomisation, healed and healing cases were grouped together.
[‡]72 teeth from 70 patients (1 male and 1 female patients contributed 2 teeth each).
[§]Fisher's exact test or chi-square test.
[¶]For dichotomisation, patients were grouped as < and ≥ 40 years old.
[††]For dichotomisation, location of sinus tract was categorised as buccal and others.
[‡‡]For dichotomisation, large and very large lesions were grouped together.

one visit, statistical analyses were not performed for these data. The WL established at 0 or 1 mm short of the radiographic apex resulted in no differences in outcome ($P > 0.05$). The quality of obturation was rated as adequate for all cases and as such it was not subjected to statistical evaluation. Teeth with radiographic evidence of filled lateral canals exhibited a 75% success rate as opposed to 73.3% success of cases with no evidence of lateral canal filling ($P > 0.05$). No difference in outcome was observed for teeth with different root canal obturation techniques. The type and quality of the coronal restoration did not influence the outcome, but its absence had a significantly negative impact ($P < 0.05$).

Table 3 shows data on the closure of the sinus tract following treatment. In 68/72 (94.4%) of the cases, the sinus tract opening healed between 1 week and 1 month after the obturation visit. Most sinus tract closing occurred within 14 days (42/72; 58.3%). Four cases (5.6%) showed sinus tracts that persisted for more than 1 month following treatment and were regarded as diseased. Five cases that had the sinus tract healed before 1 month exhibited recurrent sinus tracts after 4 to 29 months and were also regarded as diseased. These 5 teeth were associated with persistent radiolucencies. Therefore, 4 teeth with persistent sinus tracts and 5 with recurrent sinus tracts were categorised as diseased and were retreated, subjected to periradicular surgery or extracted. The other 4 cases that showed a diseased outcome, that is persistent periradicular radiolucency, had sinus tracts that disappeared in the 1-month interval. The variables examined were not found to influence sinus tract closing ($P > 0.05$; Table 3).

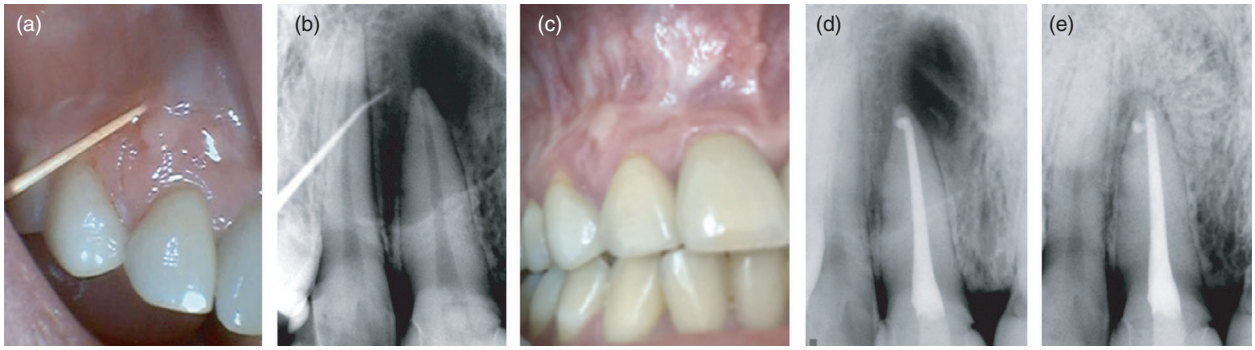

Figure 1 Representative case of a tooth with associated sinus tract categorised as healed. (a and b) Tracing the sinus tract with a gutta–percha point. (c) Postobturation radiograph. (d) Follow-up radiograph showing periradicular bone healing after 2 years.

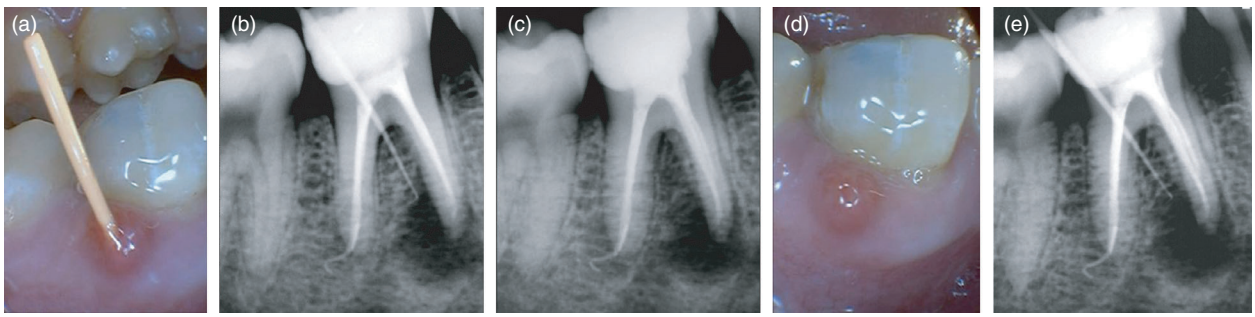

Figure 2 Representative case of a tooth with associated sinus tract categorised as diseased. Retreatment case. (a and b) Tracing the sinus tract with a gutta–percha point showed that it was associated with the periapical lesion in the mesial root. The radiograph shows canals previously treated and an instrument fragment in the apical portion of the distal canal. The tooth was subjected to retreatment, but attempts to remove the fractured instrument did not succeed. (c) Postobturation radiograph after retreatment. (d) After 5 months, the sinus tract recurred. (e) Sinus tract traced back to the persistent lesion in the mesial root.

Discussion

This retrospective study evaluated the outcome of the endodontic treatment/retreatment of teeth presenting with chronic apical abscess associated with a sinus tract. The overall healed and healing rates were 73.6% and 8.3%, respectively. Cases subjected to initial treatment resulted in 74.1% healed and 9.3% healing rates. Corresponding figures for retreatment were 72.2% and 5.6%, respectively.

The rate of complete periradicular tissue healing after treatment/retreatment of infected teeth with apical periodontitis in this retrospective study is close to the 75%–86% range reported by several previous prospective cohort studies (11,13–16). Specifically for teeth associated with sinus tracts, our overall success rate is within the range observed by previous cohort studies. Chugal et al. (17) reported that the success rate for teeth with a preoperative sinus tract was very low (37.5%), while teeth with no preoperative sinus tract had a 62.7% success rate. Ng et al. (11) showed that the success rates for the treatment of teeth with or without a sinus tract were 66.7% and 85%, respectively. For retreatments, the success rates were 60.3% for teeth with a sinus tract and 82.4% for teeth with no sinus tracts (11). Ricucci et al. (14) reported a success rate of 80.4% for teeth with sinus tracts as compared to 89.6% for teeth without sinus tracts. Differences in success rates between studies may be related to several factors, including the expertise and number of operators involved (a single specialist in this study), number of treatment sessions (most in a single visit in this study), nature of the study, tooth types, treatment protocols and evaluation criteria.

This study has not compared the treatment/retreatment outcome of teeth with a sinus tract to teeth without a sinus tract. Although most data from the literature show a reduced success rate for teeth with a sinus tract, differences rarely reached statistical significance (11). Because a previous histobacteriological study demonstrated that 83% of the teeth with chronic apical

Table 2 Clinical and radiographic outcome of teeth with periradicular lesions and associated sinus tract according to intraoperative/postoperative variables

Variables	$N = 72$[‡]	Periradicular status[†]			P value[§]
		Healed	Healing	Diseased	
Number of sessions[¶]					
1	58 (80.5%)	46 (79.3%)	4 (6.9%)	8 (13.8%)	NE
2	11 (15.3%)	7 (63.6%)	2 (18.2%)	2 (18.2%)	
3	3 (4.2%)	0 (0.0%)	0 (0.0%)	3 (100%)	
Filling of lateral canals					
Yes	12 (16.7%)	9 (75.0%)	1 (8.3%)	2 (16.7%)	1
No	60 (83.3%)	44 (73.3%)	5 (8.3%)	11 (18.4%)	
Working length					
0 mm	8 (11.1%)	7 (87.5%)	0 (0.0%)	1 (12.5%)	1
1 mm short	63 (87.5%)	46 (73.0%)	6 (9.5%)	11 (17.5%)	
2 mm short	1 (1.4%)	0 (0.0%)	0 (0.0%)	1 (100%)	
Obturation technique					
Lateral compaction	38 (52.8%)	28 (73.7%)	3 (7.9%)	7 (18.4%)	0.82
Vertical compaction	34 (47.2%)	25 (73.5%)	3 (8.8%)	6 (17.6%)	
Type of coronal restoration					
Temporary	7 (9.7%)	4 (57.1%)	0 (0.0%)	3 (42.9%)	1
Permanent	65 (90.3%)	49 (75.4%)	6 (9.2%)	10 (15.4%)	
Quality of coronal restoration					
Adequate	51 (70.8%)	39 (76.5%)	5 (9.8%)	7 (13.7%)	<0.05[††]
Inadequate	17 (23.6%)	13 (76.5%)	1 (5.9%)	3 (17.6%)	
Absent	4 (5.6%)	1 (25.0%)	0 (0.0%)	3 (75.0%)	
Total	72	53 (73.6%)	6 (8.3%)	13 (18.1%)	

NE, not evaluated

[†]For dichotomisation, healed and healing cases were grouped together.

[‡]72 teeth from 70 patients (1 male and 1 female patients contributed 2 teeth each).

[§]Fisher's exact test or chi-square test.

[¶]Treatments in more than 1 session were performed in more complicated cases. For dichotomisation, treatments in 2 and 3 sessions were grouped together.

[††]Significant for pairwise comparisons between absent restoration and the other conditions. For adequate x inadequate, $p > 0.05$.

abscesses and sinus tracts had an extraradicular component of infection (3), which is beyond the reach of instruments, irrigants and medications used in nonsurgical treatment, one might assume that the treatment of most teeth with sinus tracts would fail. However, the fact that more than 82% of the teeth with a preoperative sinus tract had a favourable outcome (healed + healing) in this study may point otherwise. The same study that showed a high prevalence of extraradicular infection in teeth with sinus tracts also reported that a concomitant intraradicular infection was evident in all cases (3), suggesting that the extraradicular component of infection may be maintained by the intraradicular infection in most cases. Therefore, once the intraradicular infection is effectively controlled, the remaining extraradicular component may be insufficient to cause persistent disease in many cases, and could be dealt with by the host immune defences (18). This helps explain the success rates observed for teeth with chronic apical abscesses and sinus tracts.

The closure of the sinus tract after treatment usually occurred before one month, with most cases showing complete soft tissue healing in less than two weeks. Cases in which the sinus tract persisted active for more than one month or that recurred some months after having closed were regarded as failures. All cases with recurrent sinus tracts showed radiographic lesions that remained the same size or increased in >1-year follow-up. Only 4 cases that had the sinus tract closed in <1 month, which had not recurred later, exhibited persistent radiolucencies in >1-year follow-up. However, these cases were clearly exceptions. The large majority of teeth that showed sinus tract closure in <1 month resulted in complete healing of the associated periradicular tissues later (53/68, 77.9%). Other 6 teeth (8.8%) were categorised as healing. This indicates that the closure of the sinus tract quickly following treatment may be a good prognosis predictor of later bone healing.

This study used several parameters to establish the treatment/retreatment success. A very short-term

Table 3 Frequency of sinus tract healing according to different variables

		Sinus tract healing[†]						
Variables	$N = 72$[‡]	7 days	14 days	21 days	1 month	Persistent $N = 4$	Recurrent $N = 5$[§]	*P* value[¶]
Number of sessions [††]								
1	58 (80.5%)	10 (17.2%)	27 (46.6%)	6 (10.3%)	11 (19.0%)	4 (6.9%)	1 (20.0%)	NE
2	11 (15.3%)	3 (27.3%)	2 (18.2%)	5 (45.5%)	1 (9.1%)	0 (0.0%)	1 (20.0%)	
3	3 (4.2%)	0 (0.0%)	0 (0.0%)	3 (100%)	0 (0.0%)	0 (0.0%)	3 (60.0%)	
Filling of lateral canals								
Yes	12 (16.7%)	1 (8.3%)	9 (75.0%)	2 (16.7%)	0 (0.0%)	0 (0.0)	2 (40.0%)	1
No	60 (83.3%)	12 (20.0%)	20 (33.3%)	12 (20.0%)	12 (20.0%)	4 (6.7)	3 (60.0%)	
Working length								
0 mm	8 (11.1%)	1 (12.5%)	3 (37.5%)	3 (37.5%)	1 (12.5%)	0 (0.0%)	1 (20.0%)	1
1 mm short	63 (87.5%)	12 (19.0%)	26 (41.3%)	11 (17.5%)	11 (17.5%)	3 (4.8%)	4 (80.0%)	
2 mm short	1 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100%)	0 (0.0%)	
Obturation technique								
Lateral compaction	38 (52.8%)	8 (21.1%)	18 (47.4%)	3 (7.9%)	7 (18.4%)	2 (5.3%)	2 (40.0%)	1
Vertical compaction	34 (47.2%)	5 (14.7%)	11 (32.4%)	11 (32.4%)	5 (14.7%)	2 (5.9%)	3 (60.0%)	
Long-term outcome [‡‡]								
Diseased	13 (18.1%)	0 (0.0%)	4 (30.8%)	4 (30.8%)	1 (7.7%)	4 (30.8%)	5 (100%)	<0.001
Healed	53 (73.6%)	12 (22.6%)	23 (43.4%)	9 (17.0%)	9 (17.0%)	0 (0.0%)	0 (0.0%)	
Healing	6 (8.3%)	1 (16.7%)	2 (33.3%)	1 (16.7%)	2 (33.3%)	0 (0.0%)	0 (0.0%)	
Total	72	13 (18.1%)	29 (40.3%)	14 (19.4%)	12 (16.7%)	4 (5.6%)	5 (100%)	

NE, Not evaluated.

[†]For dichotomisation, healing of sinus tract was categorised as < and > 1 month.

[‡]72 teeth from 70 patients (1 male and 1 female patients contributed 2 teeth each).

[§]Recurrent sinus tracts were those that reopened after having healed in <1 month. Thus, in this table these cases are counted twice.

[¶]Fisher's exact test or chi-square test.

[††]For dichotomisation, treatments in 2 and 3 sessions were grouped together.

[‡‡]For dichotomisation, healed and healing were grouped together.

evaluation was based on the presence/absence of clinical signs and symptoms, including closure of the sinus tract. Therefore, appearance or persistence of symptoms was regarded as failure, even in evaluations before 1-year follow-up. The periradicular healing rate (>1-year follow-up) was evaluated on the basis of both clinical and radiographic criteria. This is because 1-year evaluation has been regarded as the minimum time period for a reliable radiographic determination of healing of the apical periodontitis lesion (19). The outcome was assessed on rigid criteria that consider as success teeth with no signs and symptoms of disease. In many previous studies, the outcome was based only on radiographic or clinical (survivability) evaluations [for review see (19)]. In both conditions, in which only the clinical or the radiographic aspect is used to assess the outcome, the success rate can be overestimated by the inclusion of teeth with no symptoms (but with radiographically detected disease) or teeth with no radiolucency (but with clinical symptoms).

Demographic data showed that sinus tracts were in higher frequencies on the buccal side (93%) and in females (55.6%), individuals ≥ 40 years old (58.3%), maxillary teeth (especially molars) (54.2%) and teeth associated with large lesions (61.1%). Evaluation of the influence of several variables in the treatment outcomes of teeth with sinus tracts showed no significant results for most comparisons. The only exception was that teeth that showed up for follow-up examination without a coronal restoration had a significantly higher failure rate (diseased). The issue about the influence of the quality of the coronal restoration on treatment outcome has been controversial in the literature (11,14,20). However, lack of a coronal restoration poses a serious risk to the treatment outcome, as the root canal filling becomes frankly exposed to saliva and bacterial challenge. Several ex vivo studies showed that most filling materials fail to promote fluid- and bacteria-tight seal even after short direct exposure to saliva or bacterial cultures (21–24).

The primary purpose of this study was to report on the outcomes of the treatment/retreatment of teeth with a preoperative sinus tract and to describe the demographic data of consecutive cases treated by a single operator. One of the limitations of the present study is its retrospective nature. Another limitation was that the analysis of different factors influencing the treatment/retreatment outcomes of these teeth was not highly powered. Thus,

data from the influence of different variables on the outcomes should be analysed with caution.

Conclusion

Findings from the present study indicate that the quick closure of the sinus tract and the later healing of the associated periradicular lesion are both reliable upon effective control of the intraradicular infection by treatment or retreatment. Persistence of a draining sinus tract for more than a month or its recurrence after treatment indicates the presence of a persistent intraradicular/extraradicular infection that needs to be managed by retreatment, surgery or extraction. Closure of the sinus tract in the first month following treatment may be a good predictor of favourable long-term outcome.

Conflict of interest

The authors declare that they have no conflict of interest.

Authorship declaration

All authors have contributed significantly and are in agreement with the manuscript. L.A., designed the research study, and performed the selection and treatment of all cases. A.F.C., and G.S., involved in data tabulation, analysis and revision. F.R.F.A., involved in data and text revision. I.N.R., involved in data revision and wrote the paper. J. F. S. designed the research study, analysed the data and wrote the paper.

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