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ORIGINAL ARTICLE

Success rate of orthograde endodontic retreatment after failed apicectomy – A retrospective study

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Abstract

Aim: Orthograde retreatment after failed apicectomy maybe a treatment alternative to endodontic resurgery. The purpose of this study was to examine the clinical outcome of orthograde endodontic retreatment after failed apicectomy.

Methodology: Success was rated radiographically in 191 cases of orthograde retreatment after failed apicectomy that were treated in a private practice with a documented recall of at least 12 months. The radiographs were rated individually by two observers, in cases of disagreement a consensus was reached by joint discussion with a third observer. Success or failure were evaluated according to previously described criteria. The success rate and the median survival were calculated using the Kaplan–Meier survival analysis. The log rank test was used to evaluate the effect of prognostic factors/predictors. Hazard ratios of predictors were analysed using Univariate Cox Proportional Hazard regression analysis.

Results: The mean follow-up of the included 191 patients (124 females, 67 males) was 32.13 (±23.68) months and the median was 25 months. The overall recall rate was 54%. Cohen Kappa analysis revealed nearly perfect agreement between both observers ($k = 0.81$; $p = 1.0$). The overall percentage of success was 84.82% (complete healing 79.06%, incomplete healing 5.76%). The median survival was 86 months (95% CI: 56–86). None of the selected predictors had an influence on the treatment outcome ($p > .05$).

Conclusions: Orthograde retreatment should be considered a valuable treatment option after failed apicectomy. A surgical endodontic retreatment can still be a treatment option after orthograde retreatment to obtain outcome for the patient.

KEYWORDS

endodontic resurgery, failed apicectomy, MTA, orthograde retreatment

INTRODUCTION

Apicectomies are performed on teeth that have been preceded by unsuccessful orthograde root canal treatment, in many cases even without the attempt of orthograde retreatment (Appel, 2011). The aim of an apicectomy is not the elimination of microorganisms in the entire infected root canal system, because only the apical part of the root canal is accessible. For this purpose, approximately 3 mm of the end of the root is resected and, according to current concepts and standards, the remaining apical 3 mm of the root canal are prepared retrogradely, disinfected and sealed with a biocompatible material (Floratos & Kim, 2017).

The available literature shows different success rates for apical surgery, ranging from 37% to 85% (Friedman & Mor, 2004). Success rates are higher in cases that were subjected to orthograde retreatment before performing apicectomy (Taschieri et al., 2010). Cases treated with advanced microsurgical methods (use of a surgical microscope, 0°–10° bevel angle, retrograde preparation with ultrasonic instruments, sealing with bioactive hydraulic cements) are even more successful (Setzer et al., 2010).

For insufficient root canal fillings, with a root canal system harbouring a high remaining bacterial load, even a "state of the art "apical surgery using recent microsurgical methods has lower success rates (Von Arx et al., 2010). Surgical attempts to leave the remaining microorganisms in the root canal system and simply to prevent communication with the periapical tissue may fail because of leaky retrograde fillings, insufficient coronal restorations and incompletely prepared areas of the canal system (isthmuses) (Friedman, 2005). It is to be assumed that remaining microorganisms in the root canal system that can communicate with the periapical tissue cause a persistent apical periodontitis (Appel, 2011).

Due to the high success rates of orthograde retreatment with the aid of an operating microscope, complete preparation of the entire root canal system, use of effective disinfection and irrigation protocols, and sufficient obturation of all canals, correspondingly high success rates can also be expected in orthograde retreatment after failed or unsuccessful apicectomy (de Chevigny et al., 2008; Ng et al., 2008). The currently available literature provides merely three studies with a comparable aim (Çalişkan, 2005; Hülsmann et al., 2018; Mente et al., 2015). However, these studies vary considerably with regard to the number of included cases and treatment concepts. The success rates range from 45.5% to 82.6%.

The primary outcome of this retrospective study was the success rate of orthograde retreatment after failed apicectomy performed in a private practice limited to endodontics.

MATERIALS AND METHODS

This study was approved by the ethics committee of the medical association Westphalia-Lippe and the Westphalian Wilhelms-University Münster, Germany (file reference: 2022-069-f-S).

Case selection

In this study cases were examined and evaluated in which patients have undergone orthograde retreatment because of persisting apical periodontitis after failed surgical endodontic treatment. Determination that the included teeth were apiceted was based both on the diagnostic radiograph and was confirmed clinically (scar at the apical region of the tooth).

The inclusion criteria were as follows:

1. Root canal filled teeth with apicectomy.
2. No reduction or enlargement of an existing periapical lesion at least 2 years after apicectomy or distinct clinical symptoms (spontaneous pain, pain on chewing, palpation or percussion, sinus tract formation). As the radiographs of the previous root canal treatment were not available in every case, the persistence or enlargement of a periapical lesion was diagnosed by the referring dentist.

The secondary inclusion criterion was:

1. Patients attended the follow-up appointment after a minimum of 12 months.

The exclusion criteria were as follows:

1. Teeth with longitudinal root fracture.
2. Teeth that were involved in a dental trauma.
3. Teeth with increased mobility due to advanced marginal periodontitis.
4. Teeth with pre-existing perforation.
5. Cases with inadequate radiographs that could not be precisely diagnosed.
6. Patients with any kind of systemic disorders or under any kind of systemic medication.

Inclusion and exclusion of cases in the present study is described in Figure 1. A total of 369 cases were treated between January 2004 and March 2020, out of which 16 had to be excluded due to fracture ($n=8$), inadequate radiographs ($n=4$), dental trauma ($n=1$) and pre-existing perforation ($n=3$). From the remaining 353 cases, 191 showed a documented recall of at least 12 months. Thus, a total of 191 patients with 191 teeth were eligible for the present study.

Treatment

In all cases, the pre-treatments (root canal treatment and apicectomy) were carried out in other practices (general dental practices, oral surgery practices, practices for oral and maxillofacial surgery). Prior to retreatment, all cases were clinically examined for percussion sensitivity, sinus tracts, bite pain and probing depths to

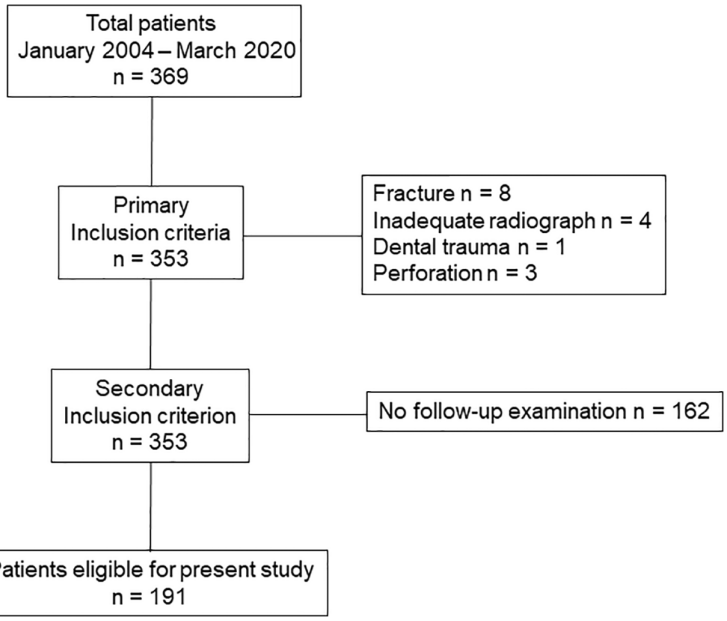

FIGURE 1 Flow chart showing the process of inclusion and exclusion of patients for the present study.

rule out any cases with pre-existing vertical root fractures. Diagnostic intraoral radiographs were taken in all cases.

All retreatments were carried out in a dental practice limited to endodontics in Bonn, Germany, by trained and calibrated specialists in endodontics with at least 3 years of professional experience at the beginning. The most experienced endodontist (CA) with 19 years of experience at the end of the observation time treated 90% of the included cases. All teeth were treated by using rubber dam isolation and an operating microscope (ProErgo).

Following access cavity preparation, the existing root canal fillings were removed with engine-driven nickel-titanium ProTaper Universal retreatment instruments and Hedstroem files (both Dentsply Sirona). In cases with a formerly untreated root canal, patency was determined with an electronic apex locator and then confirmed by a radiograph. Working length was set 0.5 mm short of patency. A glide path was created using manual stainless-steel files and prepared up to ISO-size 20. Further preparation of the root canals was done with engine-driven nickel-titanium instruments. Depending on the requirements, either ProTaper Universal, ProTaper Gold (Dentsply Sirona), Twisted file (Kerr), Reciproc (VDW) or Lightspeed files (Kerr) were used. In the case of pre-existing retrograde fillings, an attempt was made to remove them from orthograde. For the removal ultrasonic tips and Micro-Openers of different sizes (Dentsply Sirona) were used. In the case of unsuccessful orthograde removal, the retrograde fillings were left in place.

All canals were copiously irrigated with 5% sodium hypochlorite after each instrument used, with the irrigation needle placed up to 1 mm short of working length. Once canal preparation was completed, all canals were irrigated with 10% citric acid to remove the smear layer, followed by 5% NaOCl for 30 seconds each and the irrigant was activated for another 30 seconds with [passive ultrasonic irrigation (PUI)] using the Satelec ultrasonic (Acteon) device and the IRRI tips (VDW). Thereafter, an intracanal calcium hydroxide dressing was placed and the access cavity was sealed with a light curing composite, not matching the tooth colour for an easy removal later on. In the following session, the dressing was removed by PUI irrigation with 10% citric acid. After drying the canals with paper points and, if present, controlling the bleeding inside the canals, an apical plug with ProRoot MTA (Dentsply Sirona) of 4 mm length was placed apically and the apical seal was then confirmed radiographically.

In all cases AH Plus (Dentsply Sirona) was used as a sealer, inserted with a gutta-percha point that was smaller than the last preparation size. All root canals were obturated to the level of the MTA plug with warm gutta-percha using the injection technique (Obtura III, Obtura Spartan) or (B&L Beta). Finally, the access cavities were sealed using CorePaste (DentMat) or Clearfil DC Core plus (Kuraray Nuritake). The radiographic control of the root canal filling was carried out immediately after obturation and at regular recall intervals in parallel technique with a right-angle holder. All radiographs included in this study were taken under identical conditions (Model CS 2200; Carestream Dental) and viewed and analysed using the same monitor (RadiForce MS230W; EIZO) with the following parameters: dot pitch 0.27 mm; resolution 1920 × 1080; 60 Hz; brightness 300 cd/m^2 and contrast 3.000:1.

Clinical and radiographic follow-up

The recall intervals were standardized at a minimum of 12 and at 24 months. The recall appointments included radiographic and clinical examination of the tooth and was performed by the same dentist who carried out the retreatment.

Complaints occurring after orthograde retreatment that persisted for longer than 1 week were considered as failure. Additionally, success or failure were evaluated radiographically according to the criteria described by Molven et al. (1987) and Rud et al. (1972), who categorized the treatment results into four groups:

1. Complete healing.
2. Incomplete healing (scar tissue).
3. Uncertain healing.
4. Unsatisfactory healing.

Groups 1 and 2 were considered as success and groups 3 and 4 as failure. Incomplete healing (group 2) was classified as success, because based on the current literature, it can be assumed that apical lesions often need up to 24 months or longer to heal completely and lesions that show a reduction in size after 24 months will most likely heal after further observation without the need for further therapy (Byström et al., 1987).

All cases that met the inclusion criteria were radiographically evaluated by two independent raters (DA and CA); in the case of disagreement, a consensus decision was made after joint discussion with the third rater (ES). This joint discussion was required in 13 cases. The observer's agreement was evaluated using the Cohen–Kappa analysis.

Statistical analysis

The success rate and, using the Kaplan–Meier survival analysis, the median survival [with 95% confidence interval (CI)] were calculated. The log rank test was used to evaluate the effect of prognostic factors/predictors [gender, age, location of tooth (maxillary versus mandibular, pre-existing retrograde filling)] on the treatment outcome. Hazard ratios of predictors were analysed using Univariate Cox Proportional Hazard regression analysis. The level of significance was set at $p < .05$.

RESULTS

The overall recall rate was 54%. Of the included 191 cases (124 females, 67 males) the age of the patients ranged between 22 and 85 years, with a mean age of 46.40 (±11.16) years. The mean of the follow-up was 32.13 (±23.68) months, the median was 25 months. Out of the 191 included teeth, 33 showed a pre-existing retrograde filling, which was completely removed from orthograde in 17 cases and was left in place in 15 cases. In one case the pre-existing retrograde filling was dislodged into the apical tissue, however, the periapical lesion showed radiographic healing. The mean success rate for cases with pre-existing retrograde filling was 81.12% (Table 1).

Cohen–Kappa analysis revealed nearly perfect agreement between both observers ($k = 0.81$; $p = 1.0$). The overall percentage of success rate (Rud et al. (1972) scores 1 and 2) was 84.82% (Figures 2–4). The median survival was 86 months (95% CI: 56–86) and the mean survival was 97.08 ± 9.59 months (95% CI: 78.28–115.87) according to the Kaplan–Meier survival analysis (Figure 5). The cumulative survival after 155 months was 43.78% (Figure 5). The influence of prognostic predictors is summarized in Tables 1 and 2 and none of the predictors had an influence on the treatment outcome ($p > .05$).

None of the failed cases were rated as failure due to immediate post-treatment pain but primarily because of persisting clinical symptoms at the recall appointment or because no radiographic reduction of the periapical lesion was evident during the follow-up period.

DISCUSSION

A recent CBCT study revealed a prevalence of apical radiolucency of 42.5% for root canal-filled teeth in a German population (Bürklein et al., 2020). Based on CBCT examinations, prevalence values of up to 78% have been reported for root canal-filled teeth associated with apical radiolucency (Lemagner et al., 2015). Technical treatment errors such as missed root canals, inhomogeneous obturation, overextension, or underfilling of root canals have been identified as possible reasons for treatment failure, with underfilling (obturation >2 mm short of the apex) as the most frequent type of technical error associated with apical radiolucency (Bürklein et al., 2020). The cases included in the present study corroborate these findings as nearly all of the initial root canal treatments of these cases were radiographically of poor quality (e.g., inhomogeneous and/or short fillings, insufficient preparation of the root canals regarding diameter and taper). Moreover, only 33 out of the 191 included teeth showed a retrograde filling, which in all cases were not performed according to the actual state-of-the-art of apicectomy procedures (Floratos & Kim, 2017).

TABLE 1 Effect of different prognostic factors on the outcome according to Cox regression analysis [healed and failure percentages, Hazard ratios with 95% confidence interval (CI) and *p* values].

Prognostic factor	Case (*n*, %)	Healed (*n*, %)	Failure (*n*, %)	Hazard ratio (95% CI)	*p* Value
Gender					
Male	67; 35.08%	57; 85.07%	10; 14.93%	1	.749
Female	124; 64.92%	105; 84.68%	19; 15.32%	1.14 (0.52–2.52)	
Age (years)					
18–35	25; 13.09%	22; 88.0%	3; 12%	1	.956
36–85	166; 86.91%	140; 84.34%	26; 15.66%	1.03 (0.31–3.43)	
Tooth location					
Maxillary	140; 73.30%	119; 85.0%	21; 15.0%	1	.962
Mandibular	51; 26.70%	43; 84.31%	8; 15.69%	1.06 (0.47–2.38)	
Retrograde filling					
No	158; 82.72%	135; 85.44%	23; 14.56%	1	.242
Yes	33; 17.28%	27; 81.12%	6; 18.18%	1.65 (0.71–3.82)	
Tooth type					
Incisor	78; 40.84%	69; 88.46%	9; 11.54%		
Premolar	37; 19.38%	32; 86.49%	5; 13.51%	See Table 2	.451
Molar	76; 39.78%	61; 80.26%	15; 19.74%		

FIGURE 2 Representative example of score 1. Left: diagnostic radiograph of tooth 36; right: recall after 13 months.

Therefore, it seems reasonable to assume that even in the case of failed apicectomy the main treatment approach should aim at improving the quality of the root canal treatment instead of merely performing resurgery. Periradicular resurgery will be of very limited benefit in the case of inadequate preparation, disinfection and obturation of the root canal system as the remaining bacterial load inside the root canal causing the persisting apical periodontitis cannot be adequately addressed. Nevertheless, modern endodontic micro-resurgery achieves high success rates (Kim et al., 2018), but the less invasive treatment is the orthograde retreatment and should therefore be considered first.

FIGURE 3 Representative example of score 2. Left: diagnostic radiograph of tooth 12; right: recall after 40 months.

FIGURE 4 Representative example of score 3. Left: diagnostic radiograph of tooth 12; right: recall after 12 months.

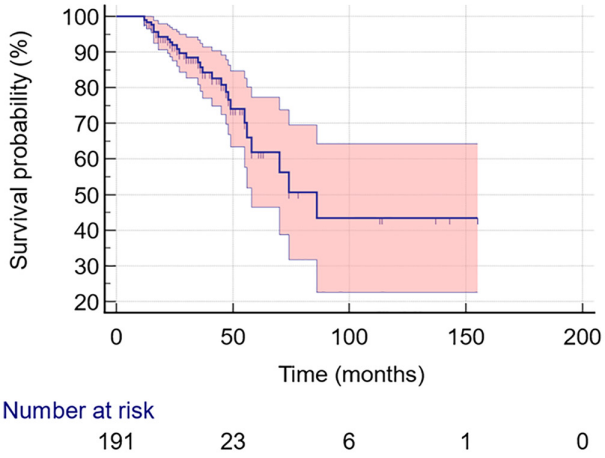

FIGURE 5 Kaplan–Meier survival analysis with 95% confidence interval and number at risk table below.

In the present study the overall success rate was 84.82% and the median survival was 86 months. Previous studies reported success rates ranging between 45.5% and 82.6% (Çalişkan, 2005; Mente et al., 2015; Hülsmann et al., 2018; Table 3). It is notable that predictors (gender, age, tooth location, tooth type) had no significant impact on the treatment outcome (Table 2). Qualifying, it should be taken into consideration that in advance of this study no sample size calculation was performed. Thus, insufficient statistical power could be one reason why no potential predictors for treatment outcome were identified. This aspect warrants further prospective clinical studies. Anyhow, the results of the present study suggest that even in teeth with complex root canal anatomy orthograde retreatment after failed apicectomy can be recommended. This observation is of clinical importance as root canal-filled teeth most often associated with apical radiolucency were maxillary molars (prevalence 56.7%; Bürklein et al., 2020).

TABLE 2 Detailed Cox regression analysis of the prognostic factor "tooth type".

Factor	Incisor	Premolar	Molar
Incisor	–	1.26 0.45–3.52	1.68 0.75–3.75
Premolar	0.79 0.28–2.21	–	1.33 0.48–3.72
Molar	0.60 0.27–1.33	0.75 0.27–2.10	–

Note: Given are the Hazard ratios with 95% confidence interval (CI).

Furthermore, even teeth with pre-existing retrograde fillings can be treated successfully by an orthograde retreatment as the mean success rate for these cases did not differ significantly from the mean success rate obtained for cases without any preexisting retrograde filling (Table 1). Admittedly, as the radiographs of the previous root canal treatment were not available in every case and the fact that the persistence or enlargement of a periapical

TABLE 3 Characteristics of previous studies on orthograde retreatment after failed apicectomy.

Study	Number of cases	Follow-up period	Recall rate	Treatment procedures	Success rate
Çalişkan (2005)	11	2–8 years	95.6%	No use of a microscope, electronic working length determination or use of an apical plug mentioned Evaluation: intraoral radiographs	45.5%
Mente et al. (2015)	23	12–102 months Median 35 months	92%	Use of a microscope and apical MTA plug Evaluation: intraoral radiographs	82.6%
Hülsmann et al. (2018)	59	After 1 year	68.6%	Use of a microscope and apical MTA plug Evaluation: intraoral radiographs	69.5% success 10.2% healing
Present study	191	12–155 months Mean 32.13 months, median 25 months	54%	Use of a microscope and apical MTA plug Evaluation: intraoral radiographs	84.82%

lesion was diagnosed by the referring dentist it cannot be completely ruled out that some asymptomatic cases were in the process of delayed healing and hence contributed to a slightly better outcome.

The cases rated as incomplete healing [Rud et al. (1972) score 2] were finally classified as success because as long as a continuous decrease in the size of the lesion following treatment is obvious, there is no reason to judge a case as failure (Byström et al., 1987). The 11 cases rated as incomplete healing had an average follow-up period of 17.42 months, and it can be assumed that when increasing the follow-up period of these cases to up to 4 years, several cases would most likely have shown complete healing. It has been reported that for complete healing of larger lesions a follow-up period of 4–5 years may be necessary (Sjögren et al., 1990).

Regarding the strengths of the present study, it can be stated that a much higher number of cases was included than in comparable previous studies that included merely 11–59 cases (Table 3). Moreover, only two previous studies used similar modern treatment techniques (microscope, MTA-plug) as in the present study (Hülsmann et al., 2018; Mente et al., 2015). Besides, well established evaluation criteria (Molven et al., 1987; Rud et al., 1972) scores were used and two independent observers evaluated the follow-up radiographs. The agreement between both observers was nearly perfect ($k = 0.81$).

On the other hand, limitations of this study are fourfold. First, retrospective studies as the present one have inherent limitations as they may suffer from some missing information, might be prone to selection or recall bias and, as already mentioned above, lack of upfront sample size calculation. The latter aspect may result in insufficient statistical power allowing proper analysis of different parameters. Secondly, radiographical follow-up evaluation was based on intraoral radiographs, which is in accordance with comparable previous studies (Table 3). CBCT evaluation is more sensitive in the detection of apical pathosis compared with conventional radiography (De Paula-Silva et al., 2009; Kanagasingam et al., 2017). However, according to the recommendation of the European Society of Endodontology (ESE) CBCT imaging should be used cautiously and should only be performed if the additional information would aid diagnosis and/or treatment management (Patel et al., 2019). Thirdly, the recall examination was performed by the same endodontist who performed the retreatment. This may be regarded as a certain bias regarding the interpretation of the clinical evaluation of the patients. However, the following radiographic evaluation was conducted based on strict and defined criteria by two and in few cases even by three examiners with nearly perfect agreement between the observers. Finally, the most relevant limitation represents the recall rate of 54%, which is lower than in previous studies (Table 3). While the other studies on this topic were performed at a university clinic, the present investigation was performed in a private practice limited to endodontics. Most of the included patients were referrals from general dentists from far distances, which resulted in missing out on their recall appointments. Moreover, a great portion of intended follow-up examinations fell in the period of the COVID-19 pandemic. At the beginning of this pandemic endodontic treatment was nearly limited to emergency treatment in Germany and many patients, who were called by phone reported that they were free of any pain, that the treated tooth was functional and in situ and that they therefore refrained from attending a follow-up examination. Thus, although the recall rate was lower than preferable it is, based on the telephone inquiry, reasonable to assume that the reported success rate represents the lower limit of the actual treatment outcome.

In conclusion, as the overall percentage of success was 84.82% (complete healing 79.06%, incomplete healing 5.76%), an orthograde retreatment after failed apicectomy represents a reasonable treatment option and should be considered before resurgery of even extraction of the tooth.

AUTHOR CONTRIBUTIONS

David Appel and Carsten Appel designed the study. Carsten Appel acquired the patients and performed the treatments. David Appel and Edgar Schäfer contributed to the writing of the manuscript. Edgar Schäfer performed the statistical analysis and the final editing. All authors approved the final manuscript.

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None.

CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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