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Clinically and radiographically determined success rate 1 year after apicoectomy: a retrospective analysis

Eveline Sutter[a], Silvio Valdec[a], Dominique Bichsel[a], Daniel Wiedemeier[b], Martin Rücker[a], Bernd Stadlinger[a]

[a]Clinic of Cranio-Maxillofacial and Oral Surgery, Centre of Dental Medicine, University of Zurich, Plattenstrasse 11; 8032 Zurich, Switzerland

[b]Statistical Services, Centre of Dental Medicine, University of Zurich, Plattenstrasse 11, 8032 Zurich, Switzerland

Corresponding author: Dr Eveline Sutter

Postal address as above.

Email: eveline.sutter@zzm.uzh.ch

Email addresses of co-authors

Silvio Valdec: silvio.valdec@zzm.uzh.ch

Dominique Bichsel: dominique.bichsel@zzm.uzh.ch

Daniel Wiedemeier: daniel.wiedemeier@zzm.uzh.ch

Martin Rücker: martin.ruecker@usz.ch

Bernd Stadlinger: bernd.stadlinger@zzm.uzh.ch

Abbreviations

PAI: periapical index

MTA: mineral trioxide aggregate

Abstract

The aim of the current study was the retrospective analysis of clinically and radiographically determined outcomes of apicoectomies after a 1-year follow-up period. Further, potentially associated factors on the success rate were investigated. All patients were treated at the Clinic of Cranio-Maxillofacial and Oral Surgery at the University of Zurich between 2010 and 2017. To be eligible for inclusion all patients were required to have undergone apicoectomy in local anaesthesia with a retrograde root-end filling, and a 1-year follow-up examination at the University of Zurich. Treatment success at the 1-year follow-up time-point was defined as an absence of clinical complaints and radiographically determined healing categorised by Rud class I or II. Parameters analysed included tooth localisation, periapical index (PAI) of the preoperative lesion, perioperative administration of antibiotics, status of smoking, histopathology of the resected apical lesion, and radiographically determined sufficiency of root canal treatment. A total of 81 teeth fulfilled all inclusion criteria. At the 1-year follow-up time-point 91.4% of the teeth exhibited successful clinical and radiographic healing. The success rate was higher for teeth in the anterior region. Radiological severity of the periapical inflammation, histopathology of the lesion, administration of antibiotics, status of smoking, and the radiographically determined quality of the root canal treatment were not significantly associated with success rate. The results of the present study suggest that apicoectomy with retrograde root-end filling is a reliable therapy for the preservation of teeth.

Keywords: apical surgery, apicoectomy, prognostic factor, success rate

Introduction

Clinical indication of an apicoectomy is persistent periapical inflammation after the failure of an orthograde root canal treatment (JOHNSON & WITHERSPOON 2006). The aim of apicoectomy is the removal of the infected apical delta and the surrounding pathological tissue in order to ensure a hermetic seal between the periodontium and the root canal (VON ARX 2001). Apicoectomy is an established surgical method of tooth preservation, and in appropriate cases it is a valid alternative to tooth extraction (VON ARX ET AL. 2012).

The traditional apicoectomy technique was performed with surgical burs and utilised amalgam as the root-end filling (VON ARX ET AL. 2007). After the introduction of microsurgical instruments in the early 1990s, the treatment outcomes of apicoectomies improved significantly (SETZER ET AL. 2010). Modern microsurgical techniques such as the use of endosonic microsurgical instruments and magnification aids, and the use of more biocompatible root-end filling materials such as modified zinc-oxide cement (Super-EBA, intermediate restorative material) and hydraulic silicate cements such as mineral trioxide aggregate (MTA) have increased the success rate of apicoectomy from an average of 60% to approximately 90% (TSESIS ET AL. 2009, SETZER ET AL. 2010, VON ARX ET AL. 2010, SETZER ET AL. 2012). The biggest advantage of microsurgical techniques is the simplified preparation of a more centred and sufficiently deep root-end cavity (VON ARX ET AL. 2007). Furthermore, smaller osteotomies, and shallower resection angles are sufficient for root-end cavity preparation and detection of the exact anatomical details of the tooth (KIM & KRATCHMAN 2006). Aim of the present study is the retrospective analysis of the success rate of apicoectomies after a 1-year follow-up period. Further, potentially associated factors on the success rate were investigated.

Materials and methods

All patients who underwent an apicoectomy with a retrograde root-end filling at the Clinic of Cranio-Maxillofacial and Oral Surgery at the University of Zurich between 2010 and 2017 were evaluated for inclusion in the study. To be eligible for inclusion, patients were required to have completed a follow-up examination 1 year at the University of Zurich after undergoing an apicoectomy using endosonic microsurgical instruments, magnification aids and either MTA (Dentsply Maillefer, Ballaigues, Switzerland) or Super-EBA cement (Harry J. Bosworth Co., Skokie, IL, USA) as the retrograde root-end filling material. Furthermore, only patients who were treated under local anaesthesia and first time surgery cases were included. In cases where a patient underwent apicoectomies in more than one tooth, one tooth was randomly selected. Exclusion criteria were periodontal disease of the tooth, and vertical tooth fracture. The distribution of the included teeth is shown in Table 1.

Radiological assessment

Preoperative and postoperative radiographs were evaluated. Preoperative X-rays were used to register, if an apical lesion was present using the periapical index (PAI) (BRYNOLF 1967, ORSTAVIK ET AL. 1986). The PAI is based on scores from 1 (healthy periapex) to 5 (severe apical periodontitis with exacerbating attributes). In the current study, all included patients had a periapical radiolucency (Table 2). It was discerned between PAI grades 4 and 5, with 5 representing a histologically more severe lesion (BRYNOLF 1967). Orthograde root canal treatment of the corresponding teeth was classified as radiographically sufficient (dense filling with adequate length) or insufficient. Postoperative X-rays at the 1-year follow-up examination were used to radiographically determined periapical bone healing according to Rud classes I–IV (RUD ET AL. 1972). Successful healing was defined as Rud classes I or II (complete

healing with or without scar tissue). Unsuccessful healing was defined as Rud class III (uncertain healing) or IV (unsatisfactory healing). If one tooth had multiple roots and unsuccessful healing of a single root was diagnosed, the tooth was classified as unsuccessfully healed.

Assessment of medical records

The patient-specific information recorded included age, status of smoking, the perioperative use of antibiotics, and the histopathological diagnosis of the periapical lesion. Clinical assessment parameters were recorded at the 1-year postoperative examination. Clinical success criteria were an absence of local signs of inflammation, no percussion sensation, no increased tooth mobility at the time of examination.

Statistical analysis

Fisher's exact test was used to investigate potential associations between variables. Associations between 1-year success and localisation, PAI, administration of antibiotics, smoking, histopathology of the lesion, and quality of the root canal treatment were assessed. The significance level α was set at 0.05 for all tests. The entire data analysis was conducted using R (R CORE TEAM 2018).

Results

A total of 235 apicoectomies were performed in local anaesthesia at the Clinic of Cranio-Maxillofacial and Oral Surgery at the University of Zurich between 2010 and 2017. Of these, 95 teeth fulfilled the inclusion criteria (140 teeth were followed-up externally). In cases where a patient underwent apicoectomies in more than one tooth, one tooth was randomly selected using R (R CORE TEAM 2018). After this randomized selection process, a total of 81 teeth were ultimately included in the

study. The mean age of the patients included was 46.9 years (range 18–84 years), maxillary anterior and premolar teeth were the most prevalent tooth types in the study.

A total of 74 teeth (91.4%) exhibited clinical and radiographic healing after 1 year. One tooth was clinically symptom-free, but was radiographically categorised as Rud class III after 1 year and thus counted as a failure. Healing was deemed to have failed in six teeth, which were subsequently extracted. The type of tooth (anterior, premolar, or molar) had a significant effect on the success rate (p = 0.006). The healing success rate of teeth in the anterior region was higher compared to teeth in the premolar or molar regions. Successful healing was not significantly associated with preoperative PAI score, histopathological diagnosis, perioperative administration of antibiotics, smoking, or the quality of the root canal treatment. The success rates of maxillary and mandibular teeth did not differ significantly. Due to the unequal distribution of the two retrograde root-filling materials (MTA 9 versus Super-EBA 72), no statistically reasonable assessment of the influence of the filling material was possible (Table 2).

Discussion

The current study suggested that success rate of apicoectomy may be related to tooth location rather than other clinical factors such as the histological or radiological severity of the periapical inflammation, the administration of antibiotics, the smoking status and the apparent quality of the pre-existing root canal treatment.

The present investigation is limited by the fact that it was retrospective. To maintain a quality standard in the clinical and radiological assessment, we focussed on the patients that appeared for recall at our clinic, which equalled 37.5% of the 235 performed apicoectomies. Being a referral centre, patients that are sent by private

practitioners are recalled in private practice and were thus lost to our follow-up without any apparent induction of bias by that fact.

Successful radiographic and clinical healing after 1 year was observed in 91.4% of the teeth in the present study. This is comparable to previously reported success rates of apicoectomies (ZUOLO ET AL. 2000, TSESIS ET AL. 2009, SETZER ET AL. 2010, SETZER ET AL. 2012). In this study, the type of tooth (anterior, premolar, or molar) had a significant effect on the success rate. Anterior teeth exhibited the highest success rate, followed by premolars and maxillary molars. Mandibular molars exhibited the lowest success rate (71.4%). These results are concordant with a meta-analysis reported by von Arx et al. (VON ARX ET AL. 2010). Reason may be to the comparably difficult surgical access for apicoectomy in premolars and molars together with reduced visibility, compared to anterior teeth. The more complex root canal anatomy of mandibular molars may also contribute to the different success rate (VON ARX ET AL. 2010). Notably however, different results were reported with regard to the effect of tooth type on treatment outcome. In a meta-analysis by Tsesis et al. (TSESIS ET AL. 2009) tooth type only had a significant effect on the success rate in cases where the traditional preparation technique was used. In cases where the modern techniques of apicoectomy including the use of endosonic microsurgical instruments, magnification aids, and root-end filling materials such as modified zinc-oxide cement and MTA were used there was no significant association between tooth type and success rate. Tsesis et al. (TSESIS ET AL. 2009) included 11 studies in their meta-analysis, 6 of which distinguished between anterior and posterior teeth. Some studies were based on a small number of treated teeth, which may explain why no significant differences were reported.

In the current study the influence of the biopsy result of the lesion - granuloma or cyst- and the radiological severity of the periapical inflammation on the success rate

were equivocal. Nair et al. (Nair ET AL. 1996) reported an incidence of cyst among periapical lesion of 15%. 61% of these cystic lesions were classified as true cysts, and 39% as periapical pocket cysts. Cystic condition of the periapical lesion seems to be an etiological factor in the failure of root canal treatment (Nair ET AL. 1993, Nair ET AL. 1996). Some pocket cysts might heal after orthograde treatment, but the tissue dynamic of a true cyst is self-sustaining (Nair ET AL. 1993, Nair ET AL. 1996). Whilst there is possible bias in both, the histological assessment of periapical lesions as performed by standard hospital procedures as well as in the radiological screening using the PAI score system, the currents study nevertheless suggests that the inflammatory status and histological findings of the periapical tissues has little influence on treatment outcome. This may be different in non-surgical endodontic treatments (Nair ET AL. 1999).

In this study the success rate was not significantly associated with perioperative administration of antibiotics, smoking, or the quality of the root canal treatment. This is in accordance with various previous studies, in which the success rate was not significantly associated with the administration of antibiotics, status of smoking or the length of the root canal filling (VON ARX ET AL. 2007, VON ARX ET AL. 2010).

The results of the present study suggest that factors influencing the outcome of apicoectomies with retrograde filling are limited. A significant factor however was the type of tooth, with anterior teeth exhibiting the highest success rate. The surgical accessibility for apical surgery seems to have impact on the success rate. In the future, clinically emerging techniques may influence success rates. Guided techniques for apicoectomy may be a promising approach, as the use of prefabricated 3D printed splints facilitates a predefined osteotomy and root resection (STRBAC ET AL. 2017). This should be investigated in the future.

Conclusion

The present study shows a high success rate after 1 year for apicoectomies, when using endosonic microsurgical instruments, magnification aids and MTA or Super-EBA cement.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

Ethics and consent statement

The study protocol was approved by the Cantonal Ethics Committee of Zurich (ID 2018-01085), who waived the usual requirement for informed consent.

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Tables

Table 1. Distribution of treated teeth (*n* = 81).

	Anteriors	Premolars	Molars
Maxilla	29	16	5
Mandible	7	10	14
Total	36	26	19

Table 2. Tooth distributions (*n* = 81) and patient parameters.

	Investigation cohort	1-year follow-up
Variable	***n* (%)**	**healed (%)**
Total	81 (100%)	74 (91.4%)
Teeth *		
Maxillary anteriors	29 (35.8%)	29 (100%)
Maxillary premolars	16 (19.8%)	15 (80.0%)
Maxillary molars	5 (6.2%)	4 (80.0%)
Mandibular anteriors	7 (8.6%)	7 (100%)
Mandibular premolars	10 (12.3%)	8 (80.0%)
Mandiblular molars	14 (17.3%)	11 (71.4%)
Dental Arch		
Maxilla	50 (61.7%)	48 (96.0%)
Mandible	31 (35.3%)	26 (83.9%)
Smoker		
Yes	26 (32.1%)	22 (84.6%)
No	55 (67.9%)	52 (94.5%)
Antibiotics		
Yes	36 (44.4%)	33 (91.7%)
No	45 (55.6%)	41 (91.1%)
Root-end Filling		
Super-EBA	72 (88.9%)	65 (90.3%)
MTA	9 (11.1%)	9 (100%)
PAI		
4	46 (56.8%)	42 (91.3%)
5	35 (43.2%)	32 (91.4%)
Periapical Lesion		
Cyst	15 (18.9%)	13 (86.7%)
Granuloma	63 (77.8%)	58 (92.1%)
Not recorded	3 (3.7%)	3 (100%)
Root Canal Treatment		
Sufficient	51 (63.0%)	47 (92.2%)
Insufficient	30 (37.0%)	27 (90.0%)

* Fisher's exact test: p = 0.006