



Treatment of calcified root canals in elderly people: a clinical study about the accessibility, the time needed and the outcome with a three-year follow-up

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Treatment of calcified root canals in elderly people: a clinical study about the accessibility, the time needed and the outcome with a three-year follow-up

Objective: Determination of accessibility, time needed and outcome of endodontic treatment of teeth with calcified root canals in a sample of elderly participants in a private practice limited to endodontics.

Background: Due to demographic changes, gerodontology is becoming more and more important, also in the field of endodontology. Elderly patients can show up with severe calcifications of root canals. Root canal treatment, when needed, can be very challenging in these cases. Only few data exist about the treatment of calcified root canals and its outcome, especially in an elderly population.

Materials and methods: Forty-one participants (median age: 72 years) needing a root canal treatment were included. The total number of treated teeth was 41 with 114 negotiated root canals. A specialist limited to endodontics performed the treatment in a private practice. Outcome was assessed by applying the periapical index score on the basis of recall radiographs provided by the referring dentists. Likewise, time required to localise the root canals was measured.

Results: All root canals have been detected using the operating microscope, and full working length could be established in 90% of the cases. Success rate was 80% after an observation time of 3 years. In three of five teeth, root canals could be localised within 15 min.

Conclusion: Calcified root canals of older people treated in this study were all accessible within a maximum of 60 min. The success rate after a follow-up of 3 years was 80%.

Keywords: calcified root canals, root canal treatment, outcome, elderly patients.

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Introduction

The total number and the proportion of elderly people in the population and their need for dental treatment are continuously increasing in many countries^{1–4}.

The longer the functional period of a tooth, the higher the risk that the pulp will be exposed to various noxious influences like cariogenic or periodontal pathogens. This may lead in the end to pulp necrosis, making it questionable whether such compromised teeth can be retained. With the growing number of elderly patients expecting retention of their teeth into old ages, there is also an increased percentage of endodontically treated teeth in this population^{5,6}.

Treatment and prevention of apical periodontitis, still the major goal of endodontology⁷, achieved by thorough cleaning and shaping of the root canal⁸, can be very challenging in older people because of a lifelong apposition of secondary or tertiary dentin, which can end up in a severe pulp canal calcification⁹. This may lead to several clinical changes starting with a visible yellowish discoloration due to a decrease in tissue transparency¹⁰. Also the response to thermal stimuli and electric pulp tests can be diminished or even absent¹¹, which may lead to difficulties to make a diagnosis.

There are not much data about root canal treatment of calcified teeth, even though these changes can also be encountered in young

patients after accidental or iatrogenic dental trauma^{12,13}. Andreasen *et al.*¹⁴ reported that 15% of traumatised permanent incisors showed pulp canal calcification, which is interpreted as a sign of a vital pulp that does not need endodontic intervention. However, there is a risk for these teeth to become necrotic, ranging from 1–27%^{11,14–19}. Preparation of an adequate access cavity and identification of the canal orifices are very challenging in these cases and may lead to a tremendous loss of tooth tissue coming along with a higher risk of fracture²⁰ and as a consequence a high failure rate²¹. Reaching full working length and establishing patency can similarly be tricky and very time-consuming. Only few data exist about the feasibility and the prognosis of root canal treatments performed under such difficult conditions in the elders. In a study of Akerblom and Hasselgren, treatment of calcified root canals resulted in an overall success rate of 89% after 2–12 years, but only 62.5% for teeth with pre-existing periapical disease²². Rutz *et al.*²³ stated in a systematic review that there is no consensus in literature between quality of root canal obturation and periapical status of older people.

Therefore, the aim of this study was to determine the accessibility, the time required and the outcome of endodontic treatment of teeth with calcified root canals in a sample of elderly participants referred to a private practice limited to endodontics.

Materials and methods

This study included 41 participants that have been referred to a private practice limited to endodontics for a root canal treatment. To be included to this study, participants had to be completed at least 60 years and in need of endodontic treatment of one tooth showing severe pulp canal calcification.

A total of 41 teeth from 25 female and 16 male participants (i.e. one tooth per subject) could be included and treated within a period of 6 months. These teeth consisted of two upper incisors, five upper premolars, 15 upper molars and two lower incisors, four lower premolars and 13 lower molars with a total number of 114 treated root canals.

Indication for endodontic treatment has been acute pain caused by irreversible pulpitis in 9 cases and apical periodontitis in 32 cases (16 symptomatic).

In cases of pulpitis, participants complained about prolonged throbbing pain on cold or warm stimuli or even at night without stimuli. The 16 symptomatic teeth with apical periodontitis were tender to percussion, and the 16 teeth without symptoms did not respond to sensitivity tests, but showed a periapical lesion on the radiograph.

All 41 teeth showed a calcified root canal system on the pre-operative periapical radiograph. Root canals were rated as ‘calcified’ when the outline of the root canal was partially or completely not discernible on the radiograph. All cases, including the ones with partial obliterations, were assigned to a high difficulty level according to the AAE Endodontic Case Difficulty Assessment Form. Figure 1 shows an example of a completely and a partially calcified root canal system.

All periapical radiographs taken during the course of the root canal treatment were made by the use of a dental radiographic unit (in eXam, KaVo, Biberach, Germany) and dental films (insight, Kodak, Rochester, NY, USA) mounted in a Rinn’s film holder (Dentsply, Konstanz, Germany). Radiographs were digitalised using a Sony DCR-PC110E PAL digital camera (Sony Corporation, Tokyo, Japan) and an appropriate software tool (Adobe Photoshop, Adobe Systems, San Jose, CA, USA) to enhance contrast. The digitalised radiographs were evaluated at a 4× magnification

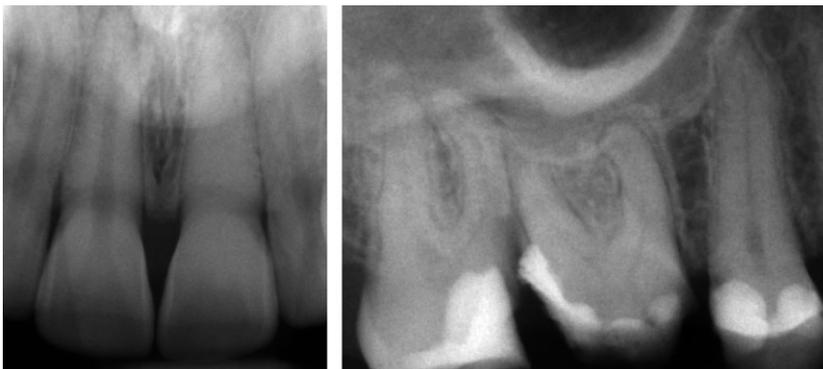


Figure 1 Left: Central incisor with a completely calcified root canal. Right: Upper molar with partially calcified root canals.

on a 21" computer monitor (Iiyama, Nagano, Japan).

After initial clinical and radiographic examination, informed consent was obtained from the participants. Root canal treatment was performed by a single specialist in a private practice limited to endodontics.

The quality of the coronal restoration was checked, insufficient restorations were removed, and after excavation of decayed hard tissue, composite resin (Spectrum TPH, Dentsply) as temporary filling was placed using a total-etch bonding technique (Optibond FL, Kerr, Rastatt, Germany). Access cavity preparation was performed using diamond burs in a high-speed contra angle hand-piece with water cooling under rubber dam isolation (Ivory, Heraeus, Hanau, Germany). After gaining access to the pulp chamber, its roof was completely removed and the orifices were localised by means of a dental operating microscope (ProErgo[®], Zeiss, Oberkochen, Germany). Calcifications in the pulp chamber were gently removed with a round diamond-coated high-speed bur or diamond-coated ultrasound tips (Acteon, Mettmann, Germany). The pulp chamber floor was dried by air stream and carefully inspected in order to localise colour changes that may indicate the way to the orifice of the root canal. By scouting the pulp floor gently with stainless steel hand instruments (MC-File sizes 08 and 010; VDW, Munich, Germany), access to all root canals, of which the presence has been expected due to the given tooth anatomy, could be established (Fig. 2).

In 39 root canals, it was not initially possible to establish full working length with an instrument size 10. In these cases, only with very small pre-

bended hand files (C-Pilot Files size 06 and 08; VDW) it succeeded to negotiate the entire root canal with the balanced force technique²⁴. Electronic working length measurement was taken using the Raypex 5 device (VDW). After having reached working length with a file size 10, root canal preparation was finally completed using MTwo rotary NiTi instruments (VDW). The root canals were apically enlarged to size 30.05 (10 canals), 35.04 (30 canals), 40.04 (39 canals), 50.02 (20 canals) and 60.02 (15 canals), respectively. Distribution of preparation size by type of root canal is shown in Table 1. Irrigation was performed using 5.25% sodium hypochlorite and 17% EDTA solution. After cleaning and shaping of the root canal, an additional passive ultrasonic irrigation was performed three times for 20 s. In cases of pulpitis, treatment was performed in one visit and in cases of apical periodontitis a Ca(OH)₂ dressing was placed between two appointments. All root canals were filled with thermoplasticised gutta-percha in a vertical compaction technique using the dental microscope for every procedural step.

Time needed to localise and access the root canals was recorded.

The referring dentist was asked to recall the participant every year for a period time of at least 3 years. The radiographs and any information related to the clinical status of the specific tooth were sent or electronically transmitted to the treating specialist.

All pre-operative and follow-up radiographs were analysed by three independent experienced observers, which have been calibrated before by evaluating a standard set of radiographs under 4× magnification. The absence or presence of an

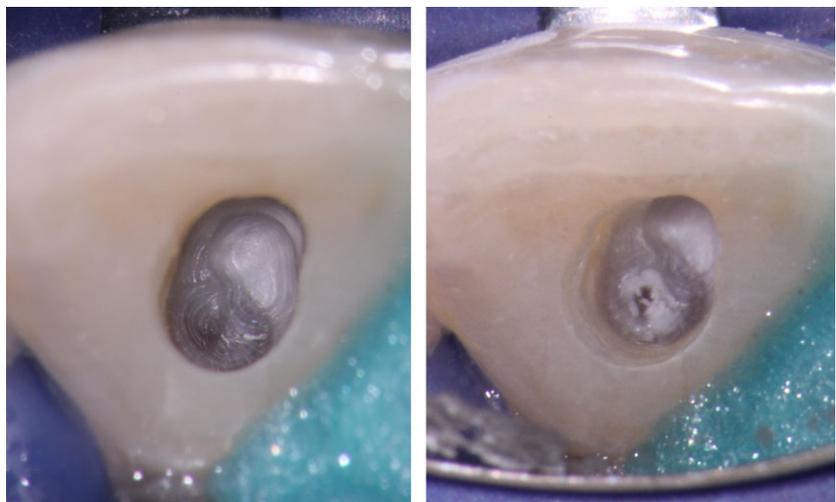


Figure 2 Accessing an obliterated root canal (same incisor as in Figure 1). Left: Dried access cavity with varying coloured dentin, indicating the way to the root canal. Right: Accessed root canal.

Table 1 Distribution of preparation size by type of tooth/root canal.

| Type of tooth / root canal | Preparation size of root canal | | | | |
|----------------------------|--------------------------------|-------|-------|-------|-------|
| | 30.05 | 35.04 | 40.04 | 50.02 | 60.02 |
| Upper incisor | 1 | – | – | 1 | – |
| Upper premolar | – | 4 | 2 | 2 | – |
| Upper molar | | | | | |
| Mesiobuccal 1&2 | 5 | 10 | 10 | – | – |
| Distobuccal | – | 8 | 6 | 1 | – |
| Palatal | – | – | – | 5 | 10 |
| Lower incisor | 2 | 1 | 1 | – | – |
| Lower premolar | – | – | 1 | 3 | – |
| Lower molar | | | | | |
| Mesiobuccal | 1 | 4 | 8 | – | – |
| Mesiolingual | 1 | 3 | 9 | – | – |
| Distal | – | – | 2 | 8 | 5 |
| Total | 10 | 30 | 39 | 20 | 15 |

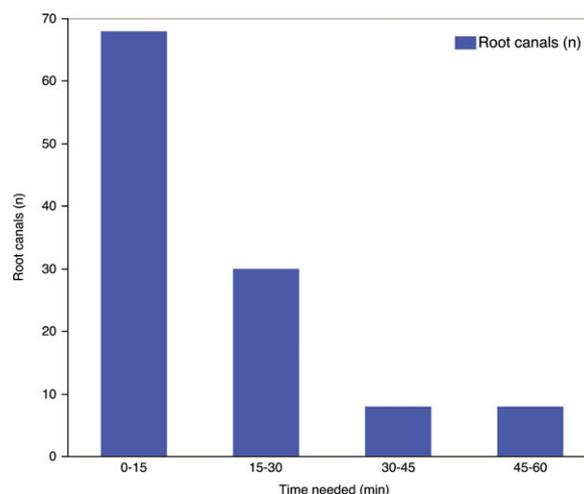
apical translucency was noted and the radiographs were assigned to one of the five groups according to the periapical index score (PAI) ²⁵. Radiographs assigned to PAI scores 1 and 2 were classified as healed cases, and those cases assigned to PAI 3, 4 and 5 were classified as failures. In case of disagreement, a joint decision was made. In teeth with two and more root canals, the worst score was included in the analysis.

The collected data were subjected to a descriptive and inferential statistical analysis. For the latter, the outcome variable was the time to failure related to the unit 'tooth'. The data from subjects where the event (failure) did not occur within the observation period of 3 years were censored. The 95% confidence intervals were given as measure for uncertainty. Teeth obviously extracted for reasons other than endodontic problems were excluded.

Results

Age at baseline was ranging from 63 to 87 years, with a median of 72 years (female: mean age = 71.9 years; male: mean age = 72.2 years).

All root canals of the treated teeth could be localised with the aid of the dental operating microscope. However, the time needed to localise the root canals varied considerably (Fig. 3). Sixty-eight root canals were accessed within 15 min (60%), 30 root canals within 15–30 min (26%), 8 within 30–45 and 45–60 min (both 7%). Full working length was reached in 103 of the 114 root canals (90.4%).

**Figure 3** Time needed to localise and access the root canals (*n* = number of root canals).

A total of five teeth had to be extracted due to periodontal reasons (4×) or unrestorable fracture (1×) after 25–36 months according to the referring dentist's information. No follow-up radiographs were available in four other cases. The PAI score at baseline for the remaining 32 teeth was '1' (8 teeth), '2' (5 teeth), '3' (11 teeth), '4' (6× teeth) and '5' (2× teeth), respectively.

In 16 cases, the last follow-up radiographs have been taken after 12 months and in ten cases after 24 months. The teeth did not show any clinical signs or symptoms at the time of the last clinical inspection. Radiographically, however, the periapical conditions worsened in five cases, which were classified as failures in the final analysis. One upper and one lower molar failed, as well as one upper premolar and one upper and one lower incisor. Table 2 provides information about the number of teeth being at risk and the 95% confidence intervals (CI). The success rate after 3 years was 80% (95% CI: 0.64–0.96).

Discussion

This study included 41 elderly participants (mean age = 72 years) with a need for a root canal treatment. All teeth showed clear signs of calcification of the root canal system. A total of 114 root canals were treated under largely standardised clinical conditions by one dentist specialised in endodontics.

A main finding of this study is that calcified root canals can be accessed. Full working length, indicated by an electronic apex locator and a radiograph, was achieved in 90% of these root canals with the help of an operating microscope.

Table 2 Success and failure rates determined by periapical index score (PAI) during 36 months including standard deviation (SD), number of failed & censored teeth, teeth being at risk and the 95% confidence interval.

| Interval (months) | Success | Failure | SD | N failed | N censored | At risk | 95% confidence interval |
|-------------------|---------|---------|------|----------|------------|---------|-------------------------|
| 0 | 1.00 | 0.00 | 0.00 | 0 | 0 | 32 | |
| 9 | 0.97 | 0.03 | 0.03 | 1 | 0 | 32 | 0.91–1.00 |
| 10 | 0.94 | 0.062 | 0.04 | 1 | 0 | 31 | 0.86–1.00 |
| 14 | 0.91 | 0.094 | 0.05 | 1 | 12 | 30 | 0.81–1.00 |
| 23 | 0.85 | 0.15 | 0.07 | 1 | 0 | 17 | 0.71–0.98 |
| 24 | 0.80 | 0.20 | 0.08 | 1 | 8 | 16 | 0.64–0.96 |
| 36 | 0.80 | 0.20 | 0.08 | 0 | 4 | 7 | 0.64–0.96 |

SD = standard deviation; N = number of teeth.

Success: PAI score 1 or 2; failure: PAI score 3–5; censored: data from subjects where failure did not occur within the observation period of 3 years.

The success rate after a follow-up period of 3 years was 80% (Table 2). In three of five teeth, root canals could be localised within 15 min, but in some cases it lasted up to 60 min. In this study, five cases failed according to the PAI score, one upper and one lower molar, one upper premolar, as well as one lower and one upper incisor. The most likely reasons are a missed second mesiobuccal root canal in case of the upper molar, not reaching full working length (lower molar, upper incisor and premolar) and a missed second root canal in case of the lower incisor.

Another five teeth had to be extracted, four of them due to periodontal reasons and one because of an unrestorable fracture. The attachment loss was evident on pre-operative radiographs, but at the time of endodontic treatment the pocket depths were less than 4 mm. Also, it has to be considered that periodontitis therapy was performed by the referring dentist and not by the operator of this study.

A limitation of this study is that the evaluation of the long-term success depends on the cooperation of the referring dentist. Although the dentists were kindly asked to recall the participants of this study every year and send a follow-up radiograph to the operator, this was not done in every case.

The observation period in this study is limited, but the gain of 3 years for an elderly patient appears to be of greater significance than for a younger individual.

The treatment procedure of this study might not be representative for general practice. Although it is known that more canal orifices can be detected by a dental operating microscope²⁶, it is only available to a small percentage of general practitioners²⁷. Another essential aspect is the operator's experience in doing root canal treatment. It is obvious that experienced operators

detect significantly more root canals²⁸ and perform a quicker and safer treatment²⁹. Another useful tool in assessing tooth morphology is cone-beam computed tomography^{30,31}, which is becoming more and more popular in endodontics but at the expense of a higher radiation exposure. Another innovative approach to treat teeth with pulp canal calcifications and periapical pathosis is the fusion of an intra-oral scan with CBCT data to produce a template for a guided access cavity preparation and root canal localisation. Although this technique seems to be promising, it was not tested in molars up to now, but there is already a proof-of-principle *ex vivo* study and a single case report^{32,33}.

Unfortunately, there are not much data about root canal treatment of calcified teeth and its outcome, especially in a group of elderly participants.

In 1988, Akerblom and Hasselgren²² reported about 51 adult participants with root canal calcification. The conventional root canal treatment using hand files, 0.5% sodium hypochlorite and an interappointment calcium hydroxide dressing as disinfectants resulted in an overall success rate of 89% after a follow-up of 2–12 years. In teeth with pre-existing apical periodontitis, the success rate reduced to 62.5%. Another study demonstrated that the treatment of teeth with reduced pulpal lumen is associated with a high failure rate²¹. The overall failure rate for all types of teeth was 20%. Of these teeth, the lower incisors had the highest failure rate with 71%. The overall success rate after 4 years reached 80% and is in agreement with the results of the present study, but teeth with a technical failure were associated with a low success rate of 50%.

In 1991, Imfeld³⁴ assessed endodontic status and the quality of the root canal treated teeth, if present, in an Swiss urban population of 66-year-

old participants. He found that merely 8.5% of all teeth revealed radiographic signs of apical pathosis and that most of these teeth are associated with an insufficient root canal filling.

Six cases failed in the present study, which makes an overall success rate of 80% after 3 years. As mentioned before, this is consistent with other studies dealing with calcified root canals²¹. Although Akerblom and Hasselgren²² reported an higher overall success rate of 89%, success in teeth with pre-existing periapical pathosis was only 62.5%. The percentage of teeth with pre-existing periapical pathosis (PAI score 3,4 & 5) was much higher in this study; therefore, the outcome is comparable. Ng *et al.*³⁵ calculated in a prospective study a quite similar success rate of 83% for initial root canal treatment. This is in the range of a previously published review of the same group of clinical investigations with a weighted pooled success rate from 68 to 85%³⁶.

Treating older people can be challenging for different reasons. These patients often have different comorbidities like Parkinson's disease, chronic

back pain or a high risk of endocarditis¹, making a dental treatment difficult. But there are also tooth-related difficulties due to the long period of time of dentine apposition starting with an impeded diagnosis because of missing sensitivity to the cold test¹¹. A root canal treatment may be also more stressful for older people. In our experience, these patients often complain about discomfort on the dentist's chair due to chronic back pain. It is also seems difficult and painful to keep the mouth wide open for a long period of time for older people.

Considering the increasing number of older people, their need for root canal treatment and the very sparse data dealing with this topic, further research in this field is highly desirable.

Conclusions

All calcified root canals treated in this study were accessible within a maximum of 60 min. The success rate after a follow-up of 3 years was 80%.

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