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Three-year outcomes of root canal treatment: Mining an insurance database



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ABSTRACT

Objectives: There is doubt whether success rates of root canal treatments reported from clinical trials are achievable outside of standardized study populations. The aim of this study was to analyse the outcome of a large number of root canal treatments conducted in general practice.

Methods: The data was collected from the digital database of a major German national health insurance company. All teeth with complete treatment data were included. Only patients who had been insurance members for the whole 3-year period from 2010 to 2012 were eligible. Kaplan–Meier survival analyses were conducted based on completed root canal treatments. Target events were re-interventions as (1) retreatment of the root canal treatment, (2) apical root resection (apicoectomy) and (3) extraction. The influences of vitality status and root numbers on survival were tested with the log-rank test.

Results: A total of 556,067 root canal treatments were included. The cumulative overall survival rate for all target events combined was 84.3% for 3 years. The survival rate for nonvital teeth (82.6%) was significantly lower than for vital teeth (85.6%; $p < 0.001$). The survival rate for single rooted teeth (83.4%) was significantly lower than for multi-rooted teeth (85.5%; $p < 0.001$). The most frequent target event was extraction followed by apical root resection and retreatment.

Conclusions: Based on these 3-year outcomes, root canal treatment is considered a reliable treatment in practice routine under the conditions of the German national health insurance system.

Clinical significance: Root canal treatment can be considered as a reliable treatment option suitable to salvage most of the affected teeth. This statement applies to treatments that in the vast majority of cases were delivered by general practitioners under the terms and conditions of a nationwide health insurance system.

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1. Introduction

Randomized controlled trials are considered the gold standard in clinical research. However, these studies are carried out in selected study populations and based on strict study protocols.¹ Therefore, they do not necessarily reflect clinical reality. To overcome this limitation, concepts of practice-based research are increasingly demanded.² Studies based on those concepts deliver valuable information on treatments and outcomes at a population level.² One approach to access dental practice data is to establish practice-based research networks.³ Another approximation to reality can be achieved by data mining in big digital resources.^{4–6} The analysis of digital treatment documentation of some countries' health service systems⁷ as well as the use of health insurance data represents these approaches inside and outside of dentistry.^{8–10}

Root canal treatment is among the most important treatments in conservative dentistry. In critically appraising the literature, a differentiation between the numerous applied outcome criteria is essential. Throughout this paper, the term survival refers to the outcome criterion extraction or a defined re-intervention. The term success may encompass certain conditions relative to clinical and radiographic findings. Systematic reviews by Kojima, Torabinejad and Ng reported high success rates for endodontically treated teeth.^{11–13} The metaanalysis by Kojima comprised 26 clinical studies evaluating the outcome of root canal treatments carried out between 1956 and 1995. Vital teeth showed a success rate of 82.8%. The success rate in nonvital teeth was 78.9%. The metaanalysis by Torabinejad differentiated between success and survival (*in situ*) of the respective teeth. Focusing on hard criteria, survival rates were 94% after 2–6 years and 92% after more than 6 years. The metaanalysis by Ng only focused on survival rates. These were 86% after 2–3 years, 93% after 4–5 years and 87% after 8–10 years. Both prospective and retrospective studies were included in these analyses. In a sample of panoramic radiographs evaluated at a German dental school in 1992, the percentage of root filled teeth without periapical abnormalities was 74.1%.¹⁴

Big data analyses and studies in practice settings are rare with heterogeneous results. The most favourable survival rate of 97% (*in situ*) after 8 years was found in a study by Salehrabi in 2004. This US-American study was based on insurance data from 1,462,936 teeth.⁵ A similar number of teeth were observed over 5 years in Taiwan resulting in survival (*in situ*) rates of 93%.⁶ A study evaluating data from the UK National Health Service (NHS) reported a survival (re-intervention) rate of 74% after 10 years based on 30,843 cases.¹⁵ A British study of the military dental service evaluated the course after root canal treatment in 406 teeth. At fifteen years, the success rate was 85%.¹⁶ In summary, different outcome criteria and treatment under different health system conditions lead to success and survival rates between 74 and 97%.

Therefore, the aim of this study was to extend the knowledge about the outcome of root canal treatment under practice conditions on the basis of a large data set.

2. Materials and Methods

The study was based on digital routine data of a major German national health insurance company (BARMER GEK, Berlin, Germany). This insurance company publishes annual health care reports.¹⁰ In this context, the study group has access to the company's data warehouse. The study design was approved by the responsible local ethics board (EK 113032014). Dental treatment fee codes and treatment dates for every single step were available and allowed for tracing clinical courses. All relevant treatments in the years 2010–2012 were included in a first step of the data analysis. Only data sets of patients that had been a member of the insurance company for the whole 3-year observation period entered the analysis. Because of systematically missing data, some specific German regions had to be excluded. For evaluation, we defined an endodontic standard treatment as study intervention. This study intervention was the sequence of the treatment fee codes for (1) extirpation, (2) root canal preparation and (3) root canal filling carried out within a 3-month period. All teeth that underwent a study intervention within the 3-year period 2010–2012 were analysed. The vitality status could be read from the treatment fee codes that either indicated an extirpation of the vital pulp or the opening of the pulp chamber of a nonvital tooth (so called "trepanation"). With the exception of the maxillary first premolar, all other premolars, canines and incisors were counted as single rooted teeth. Survival analyses were conducted according to the Kaplan–Meier method. Differences between survival functions were tested with the log-rank test. The level of significance was set to $p = 0.05$.

Three different re-interventions were defined as target events:

- (1) retreatment of the root canal treatment
- (2) apical root resection
- (3) extraction

Survival analyses were conducted separately for each target event and as an overall survival analysis for all target events combined on a day count basis (Fig. 1).

The software SAS, Version 9.2 (Statistical Analysis System, SAS Institute, Cary, NC, USA) was used for statistical analyses. The software R, Version 3.0.2 (available from <http://www.r-project.org>) combined with the add-on ggplot 2.1.0.0 was used for producing the survival curves.

3. Results

The study sample comprised of 556,067 teeth with study interventions of which 298,085 had been vital and 257,982 nonvital before root canal treatment. The number of single rooted teeth was 314,827 while 241,240 teeth were multi-rooted.

At 3 years, the cumulative overall survival rate was 0.843 or 84.3%. The respective survival rates at 2 years and at 1 year were 88.2 and 93.0%, respectively. The number of teeth under risk was 2411 at 3 years (time of the last event at 1079 days), 169,351 at 2 years and 366,902 at 1 year. For the specific target

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