Cost-effectiveness of Single- Versus Multistep Root Canal Treatment

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Abstract

Introduction: Single-visit root canal treatment requires fewer visits and reduces treatment time and material use compared with multiple-visit treatment. However, it might result in a higher risk of complications. We aimed to assess the long-term cost-effectiveness of single- versus multivisit root canal treatment using a model-based approach. **Methods:** A mixed public-private-payer perspective in German health care was adopted. Permanent teeth were simulated over the lifetime of 40-year-old patients. Different tooth types and preoperative conditions were modeled. Teeth could experience endodontic and nonendodontic complications. The risk of endodontic complications after single- versus multiple-visit treatment was estimated based on systematically collected data and adjusted depending on the preoperative conditions. The health outcome was tooth retention time. Costs were calculated based on the German dental fee catalogs and the Monte Carlo microsimulations were performed for analysis. **Results:** For nonvital molars without periapical lesions, single-visit treatment was minimally less costly (1703 Euro vs 1729 Euro) and more effective (19.9 vs 19.8 years) than multiple-visit treatment. This cost-effectiveness ranking also applied to vital molars or those with periapical lesions. In single-rooted teeth, multiple-visit treatment was less costly (1667 vs 1770 Euro) and more effective (18.9 vs 15.1 years). **Conclusions:** The overall cost-effectiveness difference between treatments seems limited. The resulting cost-effectiveness differs in subgroups of teeth, whereas data supporting such subgroup analyses are scarce. Practical aspects in scheduling treatments as well as patients' and dentists' preferences should be considered for decision making. *(J Endod 2016;■:1–7)*

Key Words

Decision making, endodontic, health economics, Markov model, pain, tooth loss

Significance

When deciding for or against single- or multiple-visit treatment, dentists should weigh initial treatment costs versus the need for follow-up interventions. Because the cost-effectiveness of both treatments differs only limitedly, decision making should consider practical aspects and the specific endodontic conditions.

An increasing number of studies have found single-visit root canal treatment (ie, combined instrumentation and canal obturation in 1 visit) to be a possible alternative to conventional multiple-visit endodontics, which uses 2 or more visits and usually places a medication into the root canal to allow canal disinfection between visits (1). Given the reduced number of visits and the associated treatment efforts (eg, no repeated application of anesthetics, no intermediary restorations, and no canal medication) as well as material costs, single-visit treatment might be attractive from a patient's, dentist's, and payer's perspective. However, it might also result in higher risks of complications like swelling, sinus tract formation, or periapical bone resorption because single-visit treatment might not be as effective as multiple-visit treatment for disinfecting the root canal system (1–4). The comparative effectiveness of both treatments might be further modified by the preoperative conditions of the pulp (vitality and symptomatology) as well as periapical health (4). There are currently no American (American Association of Endodontists) or European (European Society of Endodontology) guidelines available recommending one or the other procedure; however, the European Society of Endodontology quality guidelines state that multiple-visit treatment is rarely needed for vital teeth (5).

In summary, the initial treatment costs might be lower in single- compared with multiple-visit treatment. However, single-visit treatment could also be less effective long-term, with complications generating costs for retreatments. The resulting long-term cost-effectiveness of single- versus multivisit root canal treatment is currently unknown. The present study aimed to assess this cost-effectiveness using a model-based approach.

Methods

Setting, Perspective, Population, and Horizon

This study adopted a mixed public-private-payer perspective in the context of German health care. We modeled a population of 40-year-old male individuals with 1 permanent molar with a nonvital asymptomatic pulp and without a radiographically detectable periapical lesion. Age and sex determined the remaining lifetime and, thus, the period of modeling. Modeling younger/older or female individuals would have changed the period of modeling and thus increased or decreased absolute differences between groups without having a significant impact on strategy rankings. We assumed retention of the tooth via root canal treatment to be justified (eg, to avoid tooth-bound

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gaps or shortened dental arches). The tooth was assumed to be root canal treated and followed over the patient's lifetime (TreeAge Pro 2013; TreeAge Software, Williamstown, MA). To avoid clustering effects, only 1 tooth per mouth was simulated. Tooth type, vitality, symptomatology, and periapical conditions were varied in sensitivity analyses to account for clinical heterogeneity.

Comparators

We compared single-visit versus multiple-visit root canal treatment. Single-visit treatment comprised access cavity preparation, instrumentation (using hand and/or rotary instruments), and obturation (root canal filling using lateral condensation) in 1 visit. Multiple-visit treatment was assumed to perform access cavity preparation and large parts of the instrumentation in the first visit and finalization of preparation as well as root canal filling in the second visit. We assumed calcium hydroxide to be placed within the canals between visits as medication. No third visit was performed. Regardless of the treatment group, we assumed teeth to be treated under rubber dam isolation. Before treatment, a clinical and radiographic assessment including sensitivity (vitality) testing was assumed. For vital teeth, local anesthetics were assumed to be applied. After treatment, molars were provided with a coronal cast restoration. (In the sensitivity analysis on single-rooted teeth, a porcelain-bonded crown was placed.)

Model and Assumptions

Simulations were performed in discrete 6-month cycles. Construction of the model (Fig. 1) was performed according to the clinical routine, current evidence (see later), and a previous study using a similar methodology (6). Model validation was performed by varying distributions and key parameters to check their impact on the results.

In the base case, treatments were performed in a nonvital upper or lower, possibly painful molar with 3 root canals without radiographic signs of periapical bone resorption. These assumptions were submitted to various sensitivity analyses, exploring cost-effectiveness in single-rooted teeth, those with vital pulps, teeth with periapical lesions, and teeth without any preoperative pain. Note that we could not assess the impact of specific single-rooted tooth types or treatments in a different dental arch given that insufficient data were available.

For treated teeth, we separately modeled endodontic and nonendodontic (restorative, periodontal, and surgical) complications (Fig. 1). The risk of endodontic complications differed between treatment groups and further depended on the preoperative conditions (tooth type, vitality, symptomatology, and presence of radiographically detectable periapical lesions). All complications were assumed to lead to retreatments including nonsurgical (orthograde) or surgical retreatment (apical surgery) as well as extraction as a last resort. Nonpulpal complications included decementations of crowns or secondary caries or fracture, leading to crown recementation, renewal, or extraction accordingly. A proportion of extracted teeth were replaced using an implant-supported single crown. In the base case scenario, this proportion was 50% but varied in sensitivity analyses.

Health Outcomes

The health outcome was tooth retention years (ie, the mean time a tooth was retained in a patient's mouth), reflecting long-term complications and assumed need for retreatment. Tooth retention years were determined based on the applied model, with teeth translating between health stages depending on transition probabilities until some teeth eventually required removal.

Transition and Allocation Probabilities

Transition probabilities were estimated as follows. Risks of endodontic complications after single- versus multiple-visit root canal treatment were estimated based on systematically collected data. Two authors (F.S. and G.G.) independently screened 1 database (PubMed via Medline) for clinical controlled studies comparing both treatments. Studies needed to have randomly allocated patients to treatments or needed to have indicated that although no randomization was used, allocation was not biased by indication and so on. Studies needed to report on complications in both groups, allowing the estimation of relative risks. The search was performed by combining the following search term blocks using Boolean operators: patients AND (first or second or third or 1st or 2nd or 3rd or one or two or three or single or multi or multiple) AND (visit or appointment or session) AND (endodontic or root canal), yielding 338 entries. These were complemented with cross-referencing from bibliographies. From the identified articles, 59 were retrieved as full texts, and 9 studies (10 articles) were included (Supplemental Table S1 and Supplemental Figure S1 are available online at www.jendodon.com). Based on these studies, we extracted the risk of complications in single- versus multiple-visit treated teeth. Moderator variables were extracted as well. All studies had used calcium hydroxide as medication during multiple-visit treatment. Random effects meta-analysis was performed to estimate risk ratios and 95% confidence intervals for the risk of complications after single- versus multiple-visit treatment (Supplemental Table S2 is available online at www.jendodon.com).

To allow risk of complications to vary time dependently (accounting for higher risks shortly after treatment compared with long-term), data from a large German study that had mined an insurance database were used (7). Overall, 555,067 root canal–treated teeth had been followed, allowing the estimation of 3-year survival of teeth. Survival estimates had been reported separately for single- versus multirooted teeth and vital versus nonvital teeth. Three events (nonsurgical, surgical retreatment, and extraction) had been reported on, allowing the estimation of allocation probabilities (the proportion of teeth receiving 1 of these retreatments). Reported survival at years 1, 2, and 3 were transformed into hazards and distributed along the reporting period (in 6-month cycles) to estimate a hazard function. Because this hazard function applied to all assessed teeth, we adjusted it accordingly (Supplemental Table S3 is available online at www.jendodon.com) for nonvital molars (base case), nonvital single-rooted teeth, vital molars (7), and nonvital molars with periapical lesions (4).

The resulting hazard functions were conservatively assumed to apply to teeth that had received multiple-visit treatment. Note that this assumption could distort our estimates. The per-cycle hazards for single-visit treatment were adjusted according to the described risk ratios.

Hazards of further endodontic complications (ie, after nonsurgical or surgical retreatment) as well as nonendodontic hazards (ie, complications of crowns and technical and biological complications of placed implants and implant-supported crowns) were derived from systematically compiled data (Table 1). Allocation probabilities were built on the described studies as well as previous cost-effectiveness analyses (6, 12).

Resources and Costs

Cost calculations were based on the German public and private dental fee catalogs Bewertungsmaßstab and Gebührenordnung für Zahnärzte (GOZ) (13). Fee items allow the estimation of costs occurring to payers (12). The majority of patients in Germany (87%) are enrollees of the statutory insurance (14). For these, most fee items can be drawn from Bewertungsmaßstab, and only fee items not covered by the