

# Cost-effectiveness of Endodontic Molar Retreatment Compared with Fixed Partial Dentures and Single-tooth Implant Alternatives

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## Abstract

**Introduction:** One of the most challenging situations in dentistry is a failed root canal treatment case. Should a failed root canal–treated tooth be retreated nonsurgically or surgically, or should the tooth be extracted and replaced with an implant-supported restoration or fixed partial denture? These four treatment alternatives were compared from the perspective of cost-effectiveness on the basis of the current best available evidence.

**Methods:** The costs of the four major treatment modalities were calculated using the national fee averages from the 2009 American Dental Association survey of dental fees. The outcome data of all treatment modalities were retrieved from meta-analyses after electronic and manual searches were undertaken in the database from MEDLINE, Cochrane, ISI Web of Knowledge, and Scopus up to April 2010. The treatment strategy model was built and run with TreeAge decision analysis software (TreeAge Software, Inc, Williamstown, MA).

**Results:** Endodontic microsurgery was the most cost-effective approach followed by nonsurgical retreatment and crown, then extraction and fixed partial denture, and finally extraction and single implant-supported restoration. **Conclusions:** The cost-effectiveness analysis showed that endodontic microsurgery was the most cost-effective among all the treatment modalities for a failed endodontically treated first molar. A single implant-supported restoration, despite its high survival rate, was shown to be the least cost-effective treatment option based on current fees. (*J Endod* 2011;37:321–325)

## Key Words

Cost-effectiveness, dental implant, endodontic surgery, fixed partial denture, nonsurgical retreatment

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Health care providers and patients are challenged in the clinical decision-making process. The lack of information on the total costs and outcomes of available treatment options makes the decision-making process more difficult. One of the most challenging decisions in current endodontics deals with intervention in a failing endodontic situation. Should a failed root canal–treated tooth be retreated nonsurgically or surgically, or should the tooth be extracted and replaced with an implant-supported restoration or fixed partial denture? Many studies have reviewed and compared the treatment alternatives to be considered in an informed decision-making process (1–5); however, studies comparing the cost-effectiveness of these treatment modalities were sparse (3, 6, 7).

Intelligent clinical judgments should be made on the basis of outcomes of alternative treatment modalities, considering the cost to the patient. Recently, many systematic reviews with meta-analysis were published to provide the highest level of current evidence for various dental procedures (3, 8–11). These “best” current evidences can be the basis in the decision-making process.

Various economic models have been used in dentistry (7, 12, 13) and medicine (14, 15) to evaluate the various treatment modalities. Cost-effectiveness analysis is one of the economic models used to assess the monetary value of a treatment. Cost-effectiveness analysis was shown to be a useful tool in previous studies, quantitatively comparing dental implants with fixed bridges (6), experimental caries-control regimens (12), large amalgams versus crowns (16), and various periodontal treatment modalities (17). The previous analysis (7) comparing endodontic treatment with fixed partial denture and implant-supported restoration in a maxillary incisor with a pulp infection indicated that nonsurgical retreatment was a more cost-effective approach than surgical retreatment assuming that the initial root canal treatment failed. In our study, we aimed to evaluate the cost-effectiveness of a hypothetical clinical scenario (ie, a failed endodontically treated first molar). Four different treatment modalities were explored: nonsurgical retreatment with restoration, endodontic microsurgery, extraction with fixed partial denture, and extraction with single implant-supported restoration.

## Materials and Methods

### Treatment Strategy

Four major treatment modalities must be considered in treating a failed endodontic case: extraction with implant-supported restoration, extraction with fixed partial denture, endodontic microsurgery, and nonsurgical retreatment with restoration. Considering that root canal–treated teeth often require crown-lengthening procedures and/or post/core placement before restoration, the list of treatment options can be extended to seven: (1) nonsurgical retreatment with full-coverage restoration, (2) nonsurgical retreatment with crown lengthening and full-coverage restoration, (3) nonsurgical retreatment with post/core and full-coverage restoration, (4) nonsurgical retreatment with crown lengthening and post/core and full-coverage restoration, (5) endodontic microsurgery, (6) extraction with fixed partial denture, and (7) extraction with single implant-supported restoration.

An endodontically treated tooth should ideally be restored with full coverage but often is restored with dentin bonding material or amalgam. The longevity of a posterior

tooth after root canal therapy is significantly increased by the presence of a full-coverage restoration (18, 19). Most endodontic failures were found in teeth without a full-coverage restoration (18). Thus, in our study, all the retreated cases were followed by full-coverage restorations.

Also in this study, we included only the surgeries that used the modern endodontic surgical armamentarium, namely the surgical operating microscope with at least 4 to 8× magnification, fiberoptic lighting, microsurgical instruments, and an ultrasonic apparatus for apical preparation. Finally, for this study, we assumed a three-unit bridge replaced a single nonrestorable tooth. With regard to implants, we only considered a single implant-supported restoration including the abutment and crown.

### Cost

The costs of the seven different treatment modalities were calculated using the national fee averages from the 2009 survey of dental fees conducted by the American Dental Association. Data in this survey have been considered to be the best available evidence to reflect national dental service fees in the United States. The survey segregated the fees of all the treatment modalities into specialist and generalist rates. In our study, therefore, we too analyzed the fees separately (specialist vs generalist).

### Outcome

Systematic reviews with a meta-analysis were used in order to obtain the highest level of evidence in respect to the outcome of individual treatments. All outcome data were based on the most recent meta-analysis studies. The survival probability of each treatment modality was used as our primary outcome data, whereas the success rate was only used as an alternative when survival rate was unavailable. The term “survival” used in nonsurgical retreatment, endodontic microsurgery, fixed partial dentures, and dental implants was generally defined as functional retention without adverse clinical signs or symptoms. The term “success” was defined differently based on the criteria of different treatment modalities. For example, the success for nonsurgical retreatment and endodontic microsurgery meant endodontic healing including the complete resolution of periapical radiolucency and the disappearance of clinical signs and symptoms. The success for fixed partial dentures was designated as the presence of prostheses without complications such as caries and/or periodontal diseases, which might require further clinical intervention. The success criteria for dental implants varied among studies, but the most frequently used was Albrektsson’s, which includes the absence of both mobility and peri-implantitis and only limited vertical bone loss. Because of the lack of unanimity for the definition of success in the various treatment modalities, survival was used as the outcome measurement in this cost-effectiveness analysis.

Electronic searches were undertaken in the database from MEDLINE, Cochrane, ISI Web of Knowledge, and Scopus up to April 2010. The articles reviewed in this search were from peer-reviewed journals published in English. The following key terms were used for the search for nonsurgical retreatment: meta-analysis, systematic review, root canal treatment, root canal retreatment, endodontic treatment, endodontic retreatment, nonsurgical root canal treatment, root canal therapy, secondary root canal treatment, outcome, success, and survival. For endodontic microsurgery, the following key terms were used: meta-analysis, systematic review, apicoectomy, endodontic surgery, endodontic microsurgery, surgical root canal treatment, (peri) apical surgery, root-end surgery, outcome, survival, and success. For fixed partial denture, the following key terms were used: meta-

analysis, systematic review, fixed partial denture, bridge, outcome, survival, and success. For dental implants, the following key terms were used: meta-analysis, systematic review, dental implant, oral implant, osseointegration, edentulous, outcome, survival, and success. A manual search was also performed to enrich the results from the electronic search. It involved the review of the bibliographies of all full-text articles and related citations.

### Cost-effectiveness Analysis

The primary measure of effectiveness was the outcome of individual treatments in the treatment strategy. The lack of consistency of outcome criteria in the different treatment modalities precluded the possibility of making objective comparisons between them. The survival probability for each treatment modality was used for the analysis because this was the best available outcome measure to compare the root canal-treated teeth and single-tooth implants (5).

For the cost-effectiveness analysis, TreeAge decision analysis software (TreeAge Pro Healthcare; TreeAge Software, Inc, Williamstown, MA) was used. The starting point of our strategy model was a failed endodontically treated molar after initial root canal therapy. The cost-effectiveness of the seven treatment modalities was calculated with the software. The cost-effectiveness was determined as the ratio of the survival probability of each individual treatment modality divided by the fee for that individual treatment. Cost-effectiveness ratios were calculated to determine how the seven treatment modalities rank.

### Sensitivity Analysis

The cost-effectiveness analysis in this study is dependent on the estimates of survival probabilities and costs. The robustness of the analysis also depends on these estimated values. Because cost may vary with different practitioners in different locales and because the survival probability was found to be heterogeneous in various studies, this sensitivity test was performed to allow for the possible variation in the order of cost-effective treatment modalities, taking into consideration the variety of cost and effectiveness estimates. In our study, one-way sensitivity analysis was performed with one of the estimates changed. The range of success rates obtained from the meta-analyses of individual treatment modalities was used for this purpose.

## Results

### Cost

We examined costs for generalists and specialists separately for each of the seven treatment modalities. Data were retrieved from the national fee averages from the 2009 survey of dental fees conducted by the American Dental Association. In order to calculate the cost of individual treatments, the following assumptions were made: (1) the full-coverage restoration was a porcelain-fused to metal crown (high noble metal); (2) the prefabricated post and core was used for the post/core placement; (3) the custom abutment and porcelain fused to metal crown (high noble metal) were used for implant restoration; (4) the pontic for the fixed partial denture was porcelain fused to high noble metal; (5) the extraction did not require surgical procedures, such as a flap elevation for the removal of bone and/or tooth; and (6) the specialist for nonsurgical retreatment and endodontic microsurgery was assumed to be an endodontist, for extraction an oral surgeon, for crown lengthening and implant fixtures a periodontist, and for crown a post/core, pontic and implant abutments, and a prosthodontist.

The fee for nonsurgical retreatment was \$944.65 for general practitioners and \$1,256.48 for endodontists. The crown-lengthening fee was \$553.08 for general dentists and \$924.20 for periodontists. The

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