Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: a systematic review


CRD summary
The authors conducted meta-analyses and narrative syntheses. They concluded that long-term survival of fixed partial dentures was inferior to that of endodontically treated teeth and implant-supported single crowns, and that extraction without replacement was associated with inferior psychosocial outcomes. Given the considerable limitations of the included studies, the authors' tentative conclusions are appropriate and likely to be reliable.

Authors' objectives
To compare the outcomes, benefits, and harms of root canal therapy and restoration (RCTR), extraction followed by an implant-supported single crown (ISC) or fixed partial denture (FPD) and extraction without replacement.

Searching
MEDLINE, Cochrane (specific database not stated) and EMBASE were searched for articles published in English from January 1966 to September 2006. Search terms were reported. Additional articles were identified by handsearching journals, citation mining and consulting with experts.

Study selection
Studies of adult patients with periodontally sound teeth having pulpal and/or periradicular pathosis were eligible for inclusion. Women represented a small majority (where reported).

Studies were eligible if initial treatments were root canal therapy and/or alternatives. Treatments for single teeth in the included studies were root canal therapy and restoration, extraction followed by implant-supported single crown or fixed partial denture and extraction without replacement. Implants were threaded and cylindrical regardless of surface type. Follow-up periods had to be at least two years from obturation for root canal therapy and restoration, implant placement for implant-supported single crown and cementation for fixed partial denture. Studies had to report a minimum of 25 treatments (not patients); treatment units were root canal therapy and restoration teeth (not roots), individual implant-supported single crowns and three- to four-unit fixed partial dentures. Included treatments were administered by specialists, general practitioners and dental students in private practice, teaching hospitals or dental schools.

The outcomes of eligible studies were clinical, biological, psychosocial, economic and benefits and harms. Primary outcomes in the included studies were success and survival of root canal therapy and restoration teeth, implant-supported single crowns, fixed partial dentures and various effects of extraction without replacement; secondary outcomes were primarily psychosocial. Success and psychosocial outcomes were variously defined. Assessment methods were radiographic, clinical and questionnaire.

Eligible studies were comparative, noncomparative, prospective, retrospective and longitudinal.

Studies were excluded if root canal therapy and restoration followed trauma, periodontal disease was moderate or severe, implants were for completely edentulous patients and treatments were outdated.

Studies were independently selected in two stages by two investigators in each of three teams that represented endodontics, implants and fixed prosthodontics. Disagreements were resolved by consensus. An independent committee reviewed the selections in a third stage.

Assessment of study quality
Study quality was assessed by considering aspects such as randomisation, concealment of treatment allocation, blinding and handling of patient dropouts. An overall quality rating score was assigned to each study. Reviewers in...
each of three teams independently assessed the included studies; disagreements were resolved by consensus.

**Data extraction**
The number of successful and surviving teeth, implants and prostheses (partial dentures) was recorded. Success and survival rates were either extracted directly or calculated by the reviewers. Crude and cumulative estimates of rates were combined when the distinction was unclear. Wilson score 95% confidence intervals (CIs) for rates were calculated. To categorise clinical outcomes, follow-up periods were extracted and grouped into three intervals: two to four years; four to six years; and more than six years. Descriptions of psychosocial and very limited economic findings were extracted and tabled without grouping.

**Methods of synthesis**
Pooled and weighted success and survival rates with corresponding 95% CIs were calculated for primary outcomes per follow-up interval, except for fixed partial denture survival and extraction without replacement. Pooled estimates were based on DerSimonian and Laird random-effects models; weighted estimates were a function of sample size.

Statistical heterogeneity was assessed using Cochran's Q and $I^2$ statistics and with Forest plots.

Studies of the effects of extraction without replacement and of psychosocial and economic effects of root canal therapy and restoration, implant-supported single crowns and fixed partial dentures were narratively synthesised.

**Results of the review**
This review included 144 studies of varying designs: randomised control trials, non-randomised control trials and case-series designs (which predominated). Sample sizes ranged from: 29 to 1,462,936 endodontically treated teeth; 28 to 979 implants; and 31 to 1,637 prostheses.

The mean quality rating score was 10 for root canal therapy and restoration studies and 7 for implant-supported single crown and fixed partial denture studies; the possible maximum score was 17.

Results presented next were restricted to overall weighted rather than pooled survival rates because of dissimilar sample sizes. Survival of restored teeth, implants and prostheses was similarly high within follow-up intervals, with one exception: long-term survival of restored teeth and implants was superior to that of prostheses.

**Two to four years:** Root canal therapy and restoration survival rate 94% (95% CI: 94% to 95%, p<0.05; one study); implant-supported single crown survival rate 96% (95% CI: 94% to 97%, p<0.05; 15 studies); fixed partial denture survival rate 94% (95% CI: 89% to 97%, p<0.05; one study)

**Four to six years:** Root canal therapy and restoration survival rate 94% (95% CI: 91% to 96%, p<0.05; two studies); implant-supported single crown survival rate 97% (95% CI: 95% to 98%, p<0.05; eight studies); fixed partial denture survival rate 93% (95% CI: 87% to 96%, p<0.05; one study)

**More than six years:** Root canal therapy and restoration survival rate 97% (95% CI: 97% to 97%, p<0.05; four studies); implant-supported single crown survival rate 97% (95% CI: 96% to 98%, p<0.05; six studies); fixed partial denture survival rate 82% (95% CI: 80% to 84%, p<0.05; one study)

Overall weighted success rates were not reported here because success was not comparably defined across studies.

Findings associated with extraction without replacement included the effects of shortened and interrupted dental arches and impact on quality of life, such as trauma associated with loss of visible teeth.

Further results were reported in the review.

**Cost information**
Based on an American Dental Association survey in the US, initial (not lifetime) costs were compared for simple extraction, extraction followed by an implant and extraction followed by a three-unit fixed partial denture with a high
noble metal-ceramic restoration. Additionally, costs for root canal therapy and restoration for an anterior tooth versus a molar were reported. Other economic outcomes were discussed based on very few studies. Regardless of initial costs, only root canal therapy and restoration retained a periodontally sound tooth, a considerable benefit when compared to the alternatives.

Authors’ conclusions
When comparing the effects of four interventions for periodontally sound teeth with pulpal and/or periapical pathosis, only tentative conclusions were drawn because of limitations of the included studies. Long-term survival of fixed partial dentures was inferior to that of endodontically treated teeth and implant-supported single crowns. Based on limited data, extraction without replacement was associated with inferior psychosocial outcomes when compared to the alternatives.

CRD commentary
The review questions and inclusion criteria were clearly stated. Detailed search filters and strategies were developed to ensure broad coverage of the research literature. Relevant databases were searched for English articles, which may have introduced language bias. A formal investigation of publication bias was not reported. Otherwise, steps were taken during each phase of this thorough review to control errors and bias.

Validity assessment indicated that the included studies were not of high quality and that direct treatment comparisons were very rare. Hence, the authors’ conclusions regarding relative treatment effects were appropriately tentative.

Meta-analyses appeared to be reasonable for synthesising survival rates. However, the authors presented overall success rates based on non-comparable outcomes. The authors acknowledged that interpretation was problematic.

Narrative syntheses of the effects of extraction without replacement and of psychosocial outcomes (including rare economic findings) were discussed without further classification.

Statistical heterogeneity of treatment effects was assessed. Although the authors classified studies by follow-up interval, no rationale was given for this. If appropriate, this strategy may have improved estimates of overall survival rates by controlling variability.

Given the considerable limitations of the included studies, the authors' tentative conclusions are likely to be reliable.

Implications of the review for practice and research
Practice: The authors stated that priority should be given to retaining a tooth by root canal treatment or, when replacing a tooth, to an implant-supported single crown.

Research: The authors stated that large prospective clinical trials were needed with clearly defined criteria for outcomes.

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Other publications of related interest


Salinas TJ, Eckert SE. In patients requiring single-tooth replacement, what are the outcomes of implant as compared to tooth-supported restorations? Int J Oral Maxillofac Implants 2007;22(Suppl):71-95.


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