

# Surgical versus non-surgical endodontic re-treatment for periradicular lesions (Review)

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## ABSTRACT

### Background

Though success rates of endodontic initial treatment have been improving over the years, persistence of periapical disease is far from being a rare condition. The most common therapeutical options for the re-treatment of teeth with periapical pathosis are non-surgical orthograde treatment and surgical treatment. Selection between alternative treatments should be based on assessment of respective benefits (mainly healing) and risks from studies consistent with a high level of evidence.

### Objectives

To test the null hypothesis of no difference in outcome between surgical and non-surgical therapy for endodontic re-treatment of periradicular lesions.

### Search strategy

The Cochrane Oral Health Group Trials Register, CENTRAL, MEDLINE and EMBASE were searched with appropriate search strategies. Handsearching included eight dental journals. The bibliographies of relevant clinical trials and relevant articles were checked for identifying studies outside the handsearched journals. Seven manufacturers of instruments in the field of endodontics or endodontic surgery or both, as well as the authors of the identified randomised controlled trials (RCTs) were contacted in order to identify unpublished or ongoing RCTs. No language restriction was placed. The last electronic search was conducted on 3rd April 2007.

### Selection criteria

All RCTs about re-treatment of teeth with periapical pathosis in which both surgical and non-surgical approaches were used and having a follow up of at least 1 year were considered for the analysis.

### Data collection and analysis

A quality assessment of the included RCTs was carried out and the authors were contacted for missing information. We independently extracted the data in duplicate. We followed the Cochrane Oral Health Group's statistical guidelines.

### Main results

Three RCTs were identified, two of them reporting different data from the same clinical study. The risk of bias was judged as moderate for one study and high for the other one. 126 cases were followed up for at least 1 year, and 82 had a follow up of 4 years. At the 1-year follow up the success rate for surgical treatment was slightly better than non-surgical (risk ratio (RR) 1.13; 95% confidence interval (CI) 0.98 to 1.30). When the follow up was extended to 4 years (only one RCT made it) the outcome for the two procedures became similar.

### Authors' conclusions

The finding that healing rates can be higher for cases treated surgically as compared to those treated non-surgically, at least in the short term, is based on two RCTs only. A single RCT reported that in the medium to long term healing rates for the two procedures are very similar. There is currently scarce evidence for a sound decision making process among alternative treatments for the re-treatment of a periradicular pathosis. More well-designed RCTs should be performed with follow up of at least 4 years, and with a consistent sample size, to detect a true difference in the long term between the outcomes of the two alternative treatments, if any exist.

## PLAIN LANGUAGE SUMMARY

Surgical versus non-surgical endodontic re-treatment for periradicular lesions

There is no apparent advantage of using a surgical or non-surgical approach for the re-treatment of periapical lesions in terms of long-term outcome. Though cases treated surgically display a slightly superior healing rate after 1 year follow up, such difference disappears in the long term. Surgical treatment is associated with greater discomfort in the early post-operative period. High quality, long-term randomised studies with great statistical power and standardization of any possible factor potentially affecting the outcome are needed to detect differences between the outcomes of the two treatments, if any exist.

## BACKGROUND

In recent years the number of people seeking endodontic treatment has dramatically increased because of conservative tendency towards root canal treatment over tooth extraction (Ruddle 2002). The aim of root canal treatment is to clean and disinfect the root canal system in order to reduce the number of micro-organisms, remove necrotic tissue, and finally seal the system to prevent re-contamination. Success rates up to 97% have been reported for endodontic initial treatment (Friedman 2004) but failure may occur after treatment. The persistence of micro-organisms within the root canal system may induce an inflammatory and immune response within the periradicular (periapical) tissues resulting in local bone destruction. Furthermore, contamination of the periradicular tissues by micro-organisms and root filling material may initiate a foreign body reaction, thereby impairing tissue healing.

Large cross-sectional studies from different countries have reported that the prevalence of apical periodontitis and other post-treatment periradicular diseases can exceed 30% of all root-filled teeth population (Boucher 2002; Eriksen 2002; Friedman 2002; Dugas 2003). These data suggest a considerable need for treatment of this condition. Re-treatment planning must include a careful evaluation of periapical condition, so that a decision can be made among non-surgical (orthograde) re-treatment, surgical (retrograde) procedure or tooth extraction (Ruddle 2002).

Some studies reported that once the disease is addressed, extraction is the first-choice treatment (Hoen 2002). However, this trend is disappointing, in view of the possibility to conservatively treat the disease by orthograde re-treatment or apical surgery (Friedman 2002). Surveys among general practitioners and endodontists have shown considerable variability in selecting between orthograde re-treatment and surgery, suggesting that the procedure selection process is subjective and inconsistent (Smith 1981; Hulsmann 1994; Friedman 2002; Hoen 2002; Kvist 2002; Friedman 2004). To a large extent, this variability may depend not only on individual differences in the assessment of disease severity, but also on the ambiguity of information found in the literature regarding the outcome of endodontic re-treatment (Kvist 1999; Farzaneh 2004; Paik 2004; Wang 2004; Mead 2005).

According to the current concepts of evidence-based health care,

selection between alternative treatments is based on the assessment of their respective benefits and risks from studies consistent with a high level of evidence (Sackett 1997; Friedman 2002). Such studies are those that conform to rigorous designs and well-defined methodology (Fletcher 1988; Sackett 1997). The main benefit considered in evaluating the outcome of both surgical and non-surgical procedures for the re-treatment is the probability of healing (Friedman 2002). The success of re-treatment can be assessed by histological, clinical or radiographic evaluation of healing (or a combination of the above), after a given follow-up period, as reported in many clinical studies.

The outcome of endodontic therapy is generally assessed 1 year after treatment and is categorized as follows: (a) 'success', that includes two subcategories: 'complete healing' (radiographic and clinical normalcy) and 'incomplete healing' (clinical normalcy combined with reduced radiolucency and scar formation); (b) 'uncertain healing' (persistence of radiolucency in the absence of clinical signs and symptoms, or presence of clinical signs/symptoms (clinical questionable) associated with a not complete radiographic healing); (c) 'failure' (presence of clinical signs and symptoms combined with reduced or persistent radiolucency) (Rud 1972; Molven 1987; Gutmann 1991). Jesslen and coworkers determined that the validity of a 1-year follow up is predictable in over 95% of the cases (Jesslen 1995). When the 1-year outcome is recorded as 'uncertain healing', the tooth should be re-evaluated yearly up to 4 years after treatment and then recorded as success or failure (Molven 1996).

This review aims at comparing the success rates of surgical versus non-surgical endodontic therapy for the re-treatment of periapical lesions, based on the reports of randomised clinical trials, in order to provide clinicians with the best evidence-based information for their decision making process.

## OBJECTIVES

To assess the effects of surgical versus non-surgical endodontic therapy for the re-treatment of teeth with periapical pathosis.

The following null hypothesis was tested:

There is no difference in outcome between surgical and non-surgical therapy for endodontic re-treatment of teeth with periapical disease.

## CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

### Types of studies

All randomised controlled trials (RCTs) about re-treatment of teeth with periapical pathosis in which both surgical and non-surgical approaches were used.

### Types of participants

Patients with one or more teeth endodontically treated that present with a periapical condition requiring endodontic re-treatment.

### Types of intervention

- (1) Surgical procedure (endodontic surgery, periradicular surgery, apicectomy, retrograde therapy) and
  - (2) Non-surgical procedure (orthograde therapy)
- for the re-treatment of teeth with periapical pathosis.

### Types of outcome measures

The main outcome sought in this systematic review was the success of the re-treatment at 1-year follow up, as determined by clinical assessment of signs and symptoms, combined with examination of periapical radiographs to evaluate radiographical healing.

The outcome was recorded when available at the following time points:

- 1 year after re-treatment
- between 1 and 4 years after re-treatment
- more than 4 years after re-treatment.

Unexpected events/outcomes were documented if identified in included RCTs.

## SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: methods used in reviews.

The search strategy aimed at identifying all published randomised controlled trials (RCTs) dealing with the subject of this review. For the identification of studies to be included in, or considered for this review, detailed search strategies were developed for each database searched. These were based on the search strategy developed for MEDLINE (OVID) but revised appropriately for each database, to take account of differences in controlled vocabulary and syntax rules. The MEDLINE search strategy combined a sensitive search strategy for RCTs revised from phases 1 and 2 of the Cochrane Sensitive Search Strategy for RCTs (as published in Appendix 5b in the *Cochrane Handbook for Systematic Reviews of Interventions*, version 4.2.6, updated

September 2006). The subject search used a combination of controlled vocabulary and free text terms based on the following search strategy for searching MEDLINE via OVID:

- #1 randomized controlled trial.pt.
- #2 controlled clinical trial.pt.
- #3 randomized controlled trials.sh.
- #4 random allocation.sh.
- #5 double blind method.sh.
- #6 single blind method.sh.
- #7 or/1-6
- #8 (ANIMALS not HUMAN).sh.
- #9 7 not 8
- #10 clinical trial.pt.
- #11 exp clinical trials/
- #12 (clin\$ adj25 trial\$).ti,ab.
- #13 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj25 (blind\$ or mask\$)).ti,ab.
- #14 placebos.sh.
- #15 placebo\$.ti,ab.
- #16 random\$.ti,ab.
- #17 research design.sh.
- #18 or/10-17
- #19 18 not 8
- #20 19 not 9
- #21 9 or 19
- #22 exp "Tooth Root"/
- #23 exp Periapical Diseases/
- #24 Tooth Apex/
- #25 (((tooth adj root\$) or (root\$ adj6 teeth) or (tooth adj6 apex\$) or (teeth adj6 apex\$) or (teeth adj6 apices) or periapical\$ or peri-apical\$ or periradicular or peri-radicular) and (disease\$ or abscess\$ or granuloma\$ or lesion\$ or cyst\$ or infect\$ or inflamm\$ or pathosis)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- #26 or/22-25
- #27 Apicoectomy/
- #28 (endodontic\$ and (treat\$ or therap\$ or surgery or surgical\$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- #29 (apical\$ and (surgery or surgical\$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- #30 (surgery or surgical\$ or non-surgical\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- #31 (apicectom\$ or apicoectom\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- #32 ((orthograd\$ adj6 fill\$) or (retrograd\$ adj6 fill\$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- #33 ((root adj6 treat\$) or (root adj6 therap\$) or (root-end adj6 resect\$) or (root-end adj6 fill\$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]

#34 endodontics/  
#35 or/27-34  
#36 retreatment/  
#37 (re-treat\$ or retreat\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]  
#38 or/36-37  
#39 26 and 35 and 38  
#40 21 and 39

### Databases to be searched

The following electronic databases were searched:  
Cochrane Oral Health Group Trials Register (date of last search: 29th March 2007)  
Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2007, Issue 1)  
MEDLINE (1966 to 3rd April 2007)  
EMBASE (1974 to 3rd April 2007).

### Language

No language restriction was placed. In case of need for translations, these were provided by appropriate departments of our university.

### Unpublished studies

Seven manufacturers of instruments for either orthograde therapy or endodontic surgery or both, and the authors of the identified RCTs were contacted in order to identify unpublished or ongoing RCTs.

### Handsearching

All issues of the following journals were handsearched as being of particular importance to this review:

- *International Endodontic Journal*
- *Journal of Endodontics*
- *Dental Traumatology* (formerly *Dental Traumatology and Endodontics*)
- *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics*
- *International Journal of Oral and Maxillofacial Surgery*
- *Journal of Oral and Maxillofacial Surgery*
- *British Journal of Oral and Maxillofacial Surgery*
- *British Dental Journal*
- *Endodontic Topics*.

Where these journals have not already been searched as part of the Cochrane Journal Handsearching Programme, the journals were handsearched by two review authors (Massimo Del Fabbro (MDF) and Silvio Taschieri (ST)).

The bibliographies of all identified RCTs and relevant review articles were searched for identification of studies outside the handsearched journals.

## METHODS OF THE REVIEW

The titles and abstracts (when available) of all reports identified through the searches were scanned independently by two review authors (Massimo Del Fabbro (MDF) and Silvio Taschieri (ST)). Full reports were obtained for trials appearing to meet the inclusion criteria or for which there was insufficient information in the title and abstract to make a clear decision. The full reports obtained from all the electronic and other methods of searching were assessed independently, in duplicate, by two review authors to establish whether the trials met the inclusion criteria or not. Disagreements were resolved by discussion. All studies meeting the inclusion criteria underwent validity assessment and data extraction. All studies rejected at this or subsequent stages were recorded in the 'Characteristics of excluded studies' table and reasons for exclusion were recorded.

### Quality assessment

The quality assessment of included trials was undertaken independently and in duplicate by the two review authors as part of the data extraction process.

Included trials were assessed on three main quality criteria:

- (1) concealed allocation of treatment, recorded as: (a) adequate, (b) unclear, (c) inadequate, as described in the *Cochrane Handbook for Systematic Reviews of Interventions* 4.2.6 (updated September 2006);
- (2) completeness of information on reasons for withdrawal by trial group, recorded as (a) adequate, (b) unclear, (c) inadequate, as described in the *Cochrane Handbook for Systematic Reviews of Interventions* 4.2.6 (updated September 2006);
- (3) further quality assessment was carried out to assess the randomisation method, sample size calculations, definition of exclusion/inclusion criteria, adequate definition of success criteria, comparability of control and treatment groups at entry, and calibration of evaluator(s).

Authors of the randomised controlled trials (RCTs) were contacted for clarification or to provide missing information whenever possible.

In order to summarise the validity of studies, they were grouped into the following categories.

- (A) Low risk of bias (plausible bias unlikely to seriously alter the results) if all of the criteria were met.
- (B) Moderate risk of bias (plausible bias that raises some doubt about the results) if one or more criteria were partly met (if authors responded that they had made some attempts to conceal the allocation of patients or to give an explanation for withdrawals, but these attempts were not judged to be ideal, these criteria were categorized as 'partly').
- (C) High risk of bias (plausible bias that seriously weakens confidence in the results) if one or more criteria were not met, as described in the *Cochrane Handbook for Systematic Reviews of Interventions* 4.2.6 (updated September 2006).

Blind outcome assessment was not assessed as a quality criteria.

In fact, the outcome evaluators cannot be blinded to treatment when evaluating radiographs, that disclose if one or the other treatment has been applied (in surgical treatment root-end is resected). Evaluators can be blinded only to patients. The quality assessment criteria were pilot tested using several articles.

#### **Data extraction**

Data were extracted by two review authors (MDF, ST) independently using properly designed data extraction forms. The data extraction forms were piloted on several papers and modified as needed before use. Any disagreement was resolved by discussion. For each trial the following data were recorded.

- Date of the study, year of publication, country of origin and source of study funding.
- Details of the participants including demographic characteristics, criteria for inclusion, type and location of teeth, type and size of periapical lesion, presence or absence of a post in the canal, type of materials and instruments used for root canal system management.
- Details on the type of intervention.
- Details of the outcomes reported, including method of assessment and time intervals after intervention.

#### **Data synthesis**

In order to standardize statistical calculations using RevMan, the outcomes were dichotomized. All cases classified as complete or incomplete healing plus cases classified as uncertain healing in the absence of clinical signs and symptoms were considered as 'successful'. Those cases classified as failures plus those classified as uncertain healing in the presence of signs and symptoms were considered as 'unsuccessful'. It was planned to perform both patient-based and tooth-based analyses.

The Cochrane Oral Health Group's statistical guidelines were followed and, for each trial, risk ratios along with 95% confidence intervals were calculated to estimate the effect of interventions.

Clinical heterogeneity was assessed by examining the types of participants, interventions and outcomes in each study. Only if studies of similar comparisons reporting the same outcome measures were found a meta-analysis was attempted. Risk ratios were combined for dichotomous data using a fixed-effect model. The significance of discrepancies in the estimates of the treatment effects from different trials was assessed by means of Cochran's test for heterogeneity. Where significant heterogeneity ( $P < 0.1$ ) was detected, the significance of the treatment effects would have been re-assessed by using a random-effects model.

Sensitivity analysis was undertaken to examine the effect of randomisation and concealed allocation on the overall estimates of effect.

## **DESCRIPTION OF STUDIES**

Summary details are given in the 'Characteristics of included studies' and 'Characteristics of excluded studies' tables. The electronic search strategy provided 17 trials. The last electronic search was conducted on 3rd April 2007. No further trial was retrieved by handsearching. From the analysis of the abstracts of these trials only three of them (Danin 1996; Kvist 1999; Kvist 2000) were judged as eligible for inclusion in this review. Two of these trials (Kvist 1999; Kvist 2000) report different aspects of the same clinical study. Both authors were contacted for clarification of some aspects of their studies and provided adequate replies. Both studies were conducted at university clinical settings in Sweden. The last sentence of the discussion section of the article by Danin reported that the study was "currently being enlarged and the observation period prolonged", but unfortunately the author confirmed to us that this was not done. He also said they tried to recall patients after about 10 years but could reach a very limited number of them.

## **METHODOLOGICAL QUALITY**

Random allocation was performed by a number sequence computer-generated table in the Danin 1996 study, and by using the 'minimization method' as described by Pocock (Pocock 1983) in the Kvist 1999 study, considering three randomisation factors: size of the periapical radiolucency, quality of seal, and length of root filling with respect to apical position. In both studies allocation to treatment groups was not concealed.

Reasons for withdrawal from the study or for exclusion of initially selected patients were clearly described. Kvist provided a detailed table that explained unclear data and allowed to perform data analysis on the outcome of his study. In his article in fact only a diagram was present showing healing rates over time for the two treatment groups (Kvist 1999).

Sample size calculation was not performed prior to the beginning of the study in both cases.

Definition of the inclusion/exclusion criteria was considered adequate for Kvist 1999 and unclear for Danin 1996.

Comparability of control and treatment groups was adequate for Kvist 1999 while in Danin 1996 no specific mention was made regarding this point but the same proportion of teeth with small lesions (smaller than 5 mm diameter) was present in the two groups. Both studies adopted adequate criteria for healing assessment.

There was perfect agreement of quality assessment between the two raters. The Danin 1996 study was judged at high risk of bias while the Kvist 1999 study was judged at moderate risk of bias.

## **RESULTS**

### **1-year treatment success rate**

Kvist 1999 compared surgical and non-surgical treatments at 6-month, 1-, 2- and 4-year follow-up periods. The results in the article were summarized only by a diagram but the author provided us with numerical data that were considered for the present analysis. Danin 1996 provided the outcome of surgical and non-surgical re-treatment at 1-year follow up only. Data of these two studies were dichotomized according to what has been described in the 'Data synthesis' section of this review. At 1 year surgically treated cases showed a slightly higher healing rate than non-surgically treated cases, as showed in Figure 1 (Comparison 01; Outcome 01) (risk ratio (RR) 1.13; 95% confidence interval (CI) 0.98 to 1.30). Since heterogeneity was found between studies' results ( $P = 0.05$ ), data were re-assessed by using a random-effects model (Figure 4) (Comparison 01; Outcome 04), that provided similar results (RR 1.19; 95% CI 0.76 to 1.87).

### 2- and 4-year treatment success rates

In Kvist 1999 at the 2- and 4-year follow ups no statistically significant difference between the outcomes of the two procedures was recorded. Results are illustrated in Figures 2 (Comparison 01; Outcome 02) and 3 (Comparison 01; Outcome 03). The author reported that four surgically re-treated cases classified as healed at the 1-year follow up did show a relapse of the apical radiolucency, or presented with clinical symptoms at a later follow up. No recurrence of apical radiolucency was observed in the non-surgically treated group.

### Other variables

A later article by Kvist (Kvist 2000) reported aspects of the same study that were related to the patient's discomfort in the early post-operative period. Such variable was not initially included among the outcomes of interest for this review. However, we realized that it is important to mention this aspect as it may be of importance in the choice between alternative treatments. This article showed that surgical re-treatment was associated with significantly more pain and swelling (in terms of frequency of reporting rather than magnitude) than non-surgical re-treatment in the first week post-operatively. A greater consumption of analgesics and anti-inflammatory drugs was also recorded for the surgically treated patients as compared to the non-surgically treated group.

## DISCUSSION

This review aimed at comparing the outcomes of surgical versus non-surgical procedures for the re-treatment of periapical pathoses. Only three randomised controlled trials (RCTs) investigating the difference in treatment outcome between these two alternative treatments were identified and suitable for inclusion in this review (two of these trials report different aspects of the same clinical study). Furthermore, these studies presented differences in follow-up duration, sample size, and the radiographic success criteria adopted.

One has to consider that the success of endodontic treatment can be affected by many different factors such as patients inclusion/exclusion criteria, materials, clinical approaches, criteria for assessment of success, experience and clinical skills of operators and of evaluators, type and location of the lesion, using or not magnification devices for enhancing visual perception, or patient's quality of life after the clinical procedure.

The evolution of clinical materials and procedures in endodontics has been consistent in the last years, parallel to a constant improvement of the outcomes of endodontic treatment over the years. The overall success rates as reported in the two studies seem rather low if compared to more recent studies that adopt magnification devices and modern instrumentation and materials. The cases included in the studies by Kvist and Danin (Danin 1996; Kvist 1999; Kvist 2000) were treated between 1989 and the early 1990s, and it must be considered that the rapid development in technology could throw the validity of the conclusions of the two studies in question.

In this review the results of the two studies were manipulated in order to dichotomize data for the statistical analysis. Dichotomization was done following the criterion of functionality, early introduced by other authors (Friedman 2004). As an example, a tooth that at a given follow up displays unchanged radiolucency or uncertain radiographic healing but presents with absence of signs and symptoms should be classified as functional and dichotomized among successful cases. According to Friedman (Friedman 2004), functionally successful cases include both 'healed' and 'healing' cases. The latter cases might have a slow healing dynamics and should be followed up further over time to assess long-term evolution. This puts in evidence once more the need for long-term studies for the correct evaluation of treatment success based on healing rate in endodontics.

On the basis of the findings of the present review it is difficult to provide clinicians with guidelines for their decision making process. Surgical procedure seems associated with a faster bone healing rate (Danin 1996; Kvist 1999) but is also associated to a greater degree of discomfort with respect to non-surgical re-treatment (Kvist 2000). The initial apparent advantage of the surgical procedure over the non-surgical one disappears if the follow up is prolonged up to 4 years. This could be explained by (1) slower healing dynamics in the non-surgical group or (2) late failures (relapses of periapical radiolucency or clinical symptoms) in the surgical group. Regarding the latter event, similar observations were reported by other authors (Frank 1992) in non-controlled studies that showed about 40% relapses of the periapical lesions at a 10-year follow up for cases surgically re-treated.

One could consider that for intracanal infection non-surgical re-treatment is generally most beneficial because it seeks to eliminate the bacteria from within the root canal system. Surgery in fact can isolate, but not completely eliminate, the endodontic bacteria. This could be one of the reasons for explaining those cases that experienced a relapse of disease in the Kvist study. If the aetiology of the lesion is independent of the presence of bacteria in the

root canal system, surgery could be considered the most beneficial treatment.

More well-designed RCTs should be performed with follow up of at least 4 years, and with a consistent sample size, to detect a true difference in the long term between the outcomes of the two alternative treatments, if any exist.

## AUTHORS' CONCLUSIONS

### Implications for practice

The results of the present review would suggest that there is no apparent advantage of using a surgical or non-surgical approach for the re-treatment of periapical lesions in terms of long-term outcome. Even if a faster healing rate was observed for surgical cases, there are no scientific data that support the concept of a systematic difference in healing potential between surgical and non-surgical re-treatment.

In conclusion, the choice between a surgical and a non-surgical procedure should rely upon factors other than the mere treatment outcome: these factors should include patient's initial clinical situation, patient's preference, operator's experience and skill, complication risk, technical feasibility, and overall cost.

### Implications for research

Very few randomised controlled trials have been found in this field. In order to understand if there is a significant advantage of using a surgical technique or a non-surgical approach for the treatment of periapical lesions more well-designed long-term randomised trials are urgently needed. Ideally, studies aiming at comparing different treatment procedures should attempt to standardize all parameters potentially affecting the outcome. In particular, factors such as the

initial lesion size, the patient's characteristics, tooth type and location, the operator's skill, clinical procedures, magnification devices, instrumentation and materials, radiographic techniques and success criteria should be standardized and the patient's preference should also be taken into account. Such trials should also be reported in a standardized way, according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Moher 2001) (<http://www.consortstatement.org/>).

## POTENTIAL CONFLICT OF INTEREST

None known.

## ACKNOWLEDGEMENTS

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## SOURCES OF SUPPORT

### External sources of support

- No sources of support supplied

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- No sources of support supplied

## REFERENCES

### References to studies included in this review

#### Danin 1996 *{published data only}*

Danin J, Stromberg T, Forsgren H, Linder LE, Ramskold LO. Clinical management of nonhealing periradicular pathosis. Surgery versus endodontic retreatment. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* 1996;**82**(2):213–7.

#### Kvist 1999 *{published and unpublished data}*

Kvist T, Reit C. Results of endodontic retreatment: a randomized clinical study comparing surgical and nonsurgical procedures. *Journal of Endodontics* 1999;**25**(12):814–7.

#### Kvist 2000 *{published data only}*

Kvist T, Reit C. Postoperative discomfort associated with surgical and nonsurgical endodontic retreatment. *Endodontics and Dental Traumatology* 2000;**16**(2):71–4.

### References to studies excluded from this review

#### Betti 2001

Betti LV, Bramante CM. Quantec SC rotary instruments versus hand files for gutta-percha removal in root canal retreatment. *International Endodontic Journal* 2001;**34**(7):514–9. [MedLine: 11601768].

#### Chutich 1998

Chutich MJ, Kaminski EJ, Miller DA, Lautenschlager EP. Risk assessment of the toxicity of solvents of gutta-percha used in endodontic retreatment. *Journal of Endodontics* 1998;**24**(4):213–6. [MedLine: 9641120].

#### DiBattista 1995

DiBattista P, Bissada NF, Ricchetti PA. Comparative effectiveness of various regenerative modalities for the treatment of localized juvenile periodontitis. *Journal of Periodontology* 1995;**66**(8):673–8. [MedLine: 7473009].

**Ferrari 1999**

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## TABLES

### Characteristics of included studies

Study	Danin 1996
Methods	1-year follow-up parallel group randomised trial with 38 patients. 1 patient initially assigned to the non-surgical re-treatment group was later excluded because of uncertainty as to whether the periradicular lesion was associated with the tooth in question.
Participants	Patients with periradicular pathoses with root canal filled incisors, canines, and premolars, referred for specialist treatment at the Department of Endodontics, Karolinska Institutet, Stockholm, Sweden. The mean age of the 37 patients (20 men and 17 women) was 52 years (age range 24-80 years). The distribution of cases in relation to the size of the periradicular lesion and to the quality of previous root canal filling was reported. 28 teeth were single-rooted and 9 were double-rooted.

Interventions	Orthograde re-treatment versus retrograde (surgical) re-treatment. In the first group 3 months elapsed between the first phase (preparation of the root canal) and the second one (root canal filling with resin chloroform and softened gutta-percha).
Outcomes	Patients were examined clinically and radiographically 1 year after re-treatment. Radiographs were examined by 2 different calibrated observers. Treatment outcome was assessed according to the criteria of Rud 1972: complete healing, incomplete healing, uncertain healing, unsatisfactory healing (failure). All cases with symptoms were referred to the 'failure' group. In teeth with 2 treated canals the result of the less successfully treated root was recorded. At 1 year the success rate for surgical and non-surgical re-treatments was, respectively, 58% (11/19) and 28% (5/18).
Notes	
Allocation concealment	C – Inadequate

**Study Kvist 1999**

Methods	4-year follow-up parallel group randomised trial with 99 teeth in 96 patients initially accepted. 4 patients were excluded at the final examination because they did not fulfil eligibility criteria. At the 48-month examination, of the 92 patients (95 teeth) included 3 deceased and 2 withdrawn from the study.
Participants	Consecutive patients referred for root canal re-treatment to the Clinics of Endodontics, Faculty of Odontology, Goteborg University, Sweden, in 1989 to 1992. Maxillary and mandibular incisors and canines were selected for the study. The previous root canal treatment was performed at least 4 years before, or the patients presented with clinical symptoms. 45 patients (47 teeth, mean age 53 years, age range 28-75 years, 16 men and 29 women) were re-treated surgically and 47 patients (48 teeth, mean age 52 years, age range 17-74 years, 22 men and 25 women) were re-treated non-surgically.
Interventions	Orthograde re-treatment versus retrograde (surgical) re-treatment. In the first group 2 weeks elapsed between the first phase (preparation of the root canal) and the second one (root canal filling with resin chloroform and softened gutta-percha).
Outcomes	Patients were clinically and radiographically examined 6, 12, 24, and 48 months after re-treatment. Radiographs were evaluated independently by 2 examiners. Observers used a strict definition of periapical disease and reported a positive finding (healing) only when absolutely certain. At 4 years the healing percentage for surgical and non-surgical re-treatment was, respectively, 60% and 58%.
Notes	
Allocation concealment	C – Inadequate

**Study Kvist 2000**

Methods	This article reports different aspects of the study by Kvist 1999. In particular it is here examined the post-operative discomfort associated with surgical and non-surgical endodontic re-treatments.
Participants	Same as Kvist 1999.
Interventions	Same as Kvist 1999. The discomfort was assessed by means of a questionnaire.
Outcomes	Surgical re-treatment is associated with significantly greater discomfort as compared to non-surgical one in the first week post-operatively.
Notes	
Allocation concealment	C – Inadequate

**Characteristics of excluded studies**

**Study Reason for exclusion**

Betti 2001	In vitro trial comparing rotary instruments versus hand files for gutta-percha removal in non-surgical endodontic re-treatment.
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### Characteristics of excluded studies (Continued)

Chutich 1998	In vitro trial assessing the toxicity of 3 different solvents of gutta-percha in endodontic re-treatment.
DiBattista 1995	Trial comparing different regenerative modalities for the treatment of localized juvenile periodontitis.
Ferrari 1999	Trial evaluating the efficacy of a bonding system on desensitization of exposed roots with or without acid-etching with 35% phosphoric acid prior to application of the bonding agent.
Friedman 1995	Trial evaluating the success of endodontic treatment or re-treatment using a glass ionomer cement sealer. No surgical re-treatment was performed.
Heinikainen 2002	Survey based on questionnaires, not a clinical study.
Kvist T 2001	Degree thesis of one of the authors of included RCTs. In this publication the articles by Kvist & Reit 1999 and 2000 are attached.
Mead 2005	Review article, not a primary study.
Ozalp 2005	Trial comparing different root canal filling materials in primary molar pulpectomies.
Peciulienė 2001	Trial evaluating microbial flora in microbiological samples from root canals subjected to 2 different modalities of root filling of teeth with chronic apical periodontitis.
Sikri 1995	Clinical study evaluating resinifying therapy in endodontic treatment.
Siqueira 2002	Trial evaluating the incidence of post-operative pain after intracanal procedures in both endodontic treatment and orthograde re-treatment.
Staribratova 2003	In vitro study evaluating apical leakage in extracted premolars.
Zerella 2005	Trial comparing two different disinfectants in non-surgical endodontic re-treatment.

RCT = randomised controlled trial

## ANALYSES

### Comparison 01. Success rates of surgical versus non-surgical procedures

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 1-year success rate (fixed-effect model)	2	126	Relative Risk (Fixed) 95% CI	1.13 [0.98, 1.30]
02 2-year success rate	1	88	Relative Risk (Fixed) 95% CI	1.05 [0.94, 1.18]
03 4-year success rate	1	82	Relative Risk (Fixed) 95% CI	0.97 [0.83, 1.13]
04 1-year success rate (random-effects model)	2	126	Relative Risk (Random) 95% CI	1.19 [0.76, 1.87]

## COVER SHEET

<b>Title</b>	Surgical versus non-surgical endodontic re-treatment for periradicular lesions
<b>Authors</b>	Del Fabbro M, Taschieri S, Testori T, Francetti L, Weinstein RL
<b>Contribution of author(s)</b>	Conceiving the review (Silvio Taschieri (ST), Massimo Del Fabbro (MDF)). Designing and co-ordination of the review (MDF, ST). Developing the search strategy (MDF). Undertaking the searches (MDF, ST). Screening search results and retrieval of papers against inclusion criteria (MDF, ST). Appraising quality and extracting data from papers (MDF, ST). Writing to authors for additional information (MDF). Data management for the review and entering data into RevMan (MDF). Analysis and interpretation of data (MDF, ST). Writing the review (MDF).

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<b>Date authors' conclusions section amended</b>	Information not supplied by author
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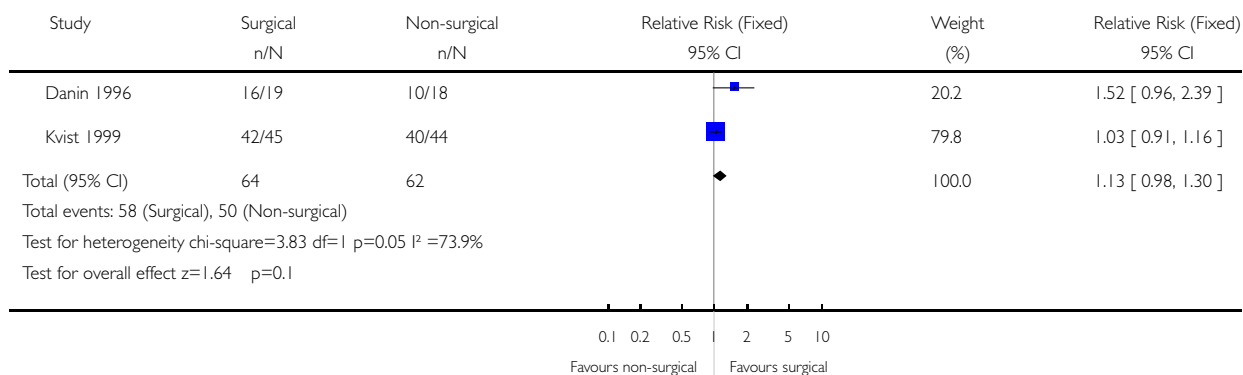
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Review: Surgical versus non-surgical endodontic re-treatment for periradicular lesions

Comparison: 01 Success rates of surgical versus non-surgical procedures

Outcome: 01 1-year success rate (fixed-effect model)

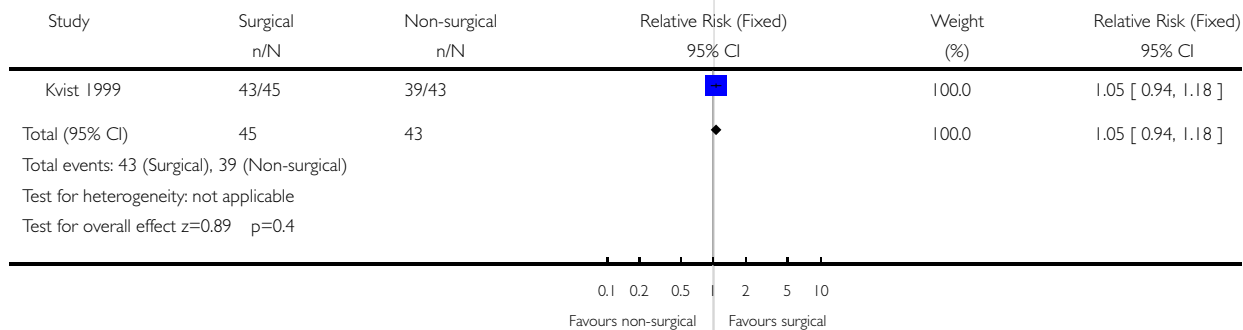


### Analysis 01.02. Comparison 01 Success rates of surgical versus non-surgical procedures, Outcome 02 2-year success rate

Review: Surgical versus non-surgical endodontic re-treatment for periradicular lesions

Comparison: 01 Success rates of surgical versus non-surgical procedures

Outcome: 02 2-year success rate

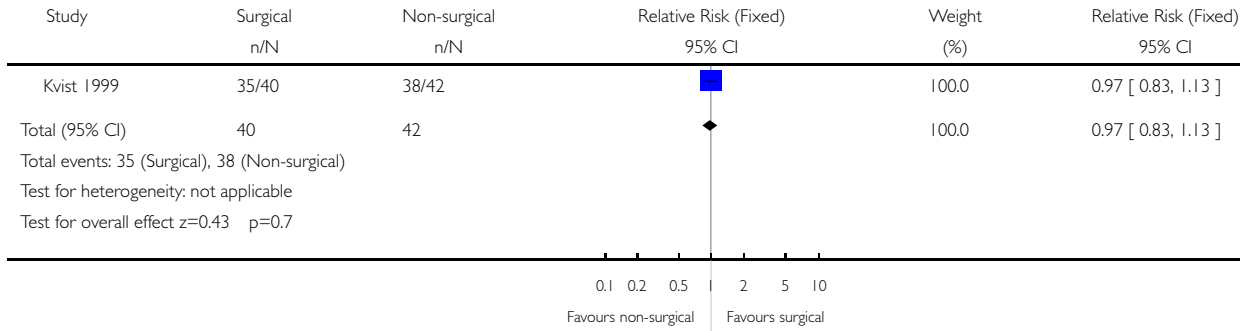


**Analysis 01.03. Comparison 01 Success rates of surgical versus non-surgical procedures, Outcome 03 4-year success rate**

Review: Surgical versus non-surgical endodontic re-treatment for periradicular lesions

Comparison: 01 Success rates of surgical versus non-surgical procedures

Outcome: 03 4-year success rate



**Analysis 01.04. Comparison 01 Success rates of surgical versus non-surgical procedures, Outcome 04 1-year success rate (random-effects model)**

Review: Surgical versus non-surgical endodontic re-treatment for periradicular lesions

Comparison: 01 Success rates of surgical versus non-surgical procedures

Outcome: 04 1-year success rate (random-effects model)

