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TABLE OF CONTENTS

ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
BACKGROUND	3
OBJECTIVES	3
METHODS	3
RESULTS	5
DISCUSSION	5
AUTHORS' CONCLUSIONS	6
ACKNOWLEDGEMENTS	6
REFERENCES	7
CHARACTERISTICS OF STUDIES	9
APPENDICES	9
WHAT'S NEW	11
HISTORY	11
CONTRIBUTIONS OF AUTHORS	11
DECLARATIONS OF INTEREST	12
SOURCES OF SUPPORT	12
INDEX TERMS	12

[Intervention Review]

Magnification devices for endodontic therapy

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ABSTRACT

Background

After the introduction of microsurgical principles in endodontics involving new techniques for root canal treatment, there has been a drive to enhance the visualisation of the surgical field. It is important to know if the technical advantages for the operator brought in by magnification devices such as surgical microscopes, endoscopes and magnifying loupes, are also associated with advantages for the patient in terms of improvement of clinical and radiographic outcomes. This version updates the review published in 2009.

Objectives

To evaluate and compare the effects of endodontic treatment performed with the aid of magnification devices versus endodontic treatment without magnification devices. We also aimed to compare the different magnification devices used in endodontics with one another.

Search methods

The following electronic databases were searched: the Cochrane Oral Health Group Trials Register (to 13 October 2015), the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*, 2015, Issue 9), MEDLINE via OVID (1946 to 13 October 2015) and EMBASE via OVID (1980 to 13 October 2015). We searched the US National Institutes of Health Trials Register (<http://clinicaltrials.gov>) and the WHO Clinical Trials Registry Platform for ongoing trials. No restrictions were placed on the language or date of publication when searching the electronic databases.

Selection criteria

We considered all randomised controlled trials (RCTs) and quasi-randomised controlled trials comparing endodontic therapy performed with versus without one or more magnification devices, as well as randomised and quasi-randomised trials comparing two or more magnification devices used as an adjunct to endodontic therapy.

Data collection and analysis

We conducted screening of search results independently and in duplicate. We obtained full papers for potentially relevant trials. The Cochrane Collaboration statistical guidelines were to be followed for data synthesis.

Main results

No trials met the inclusion criteria for this review.

Authors' conclusions

No article was identified in the current literature that satisfied the criteria for inclusion. It is unknown if and how the type of magnification device affects the treatment outcome, considering the high number of factors that may have a significant impact on the success of endodontic surgical procedure. This should be investigated by further long-term, well-designed RCTs that conform to the CONSORT statement (www.consort-statement.org/).

PLAIN LANGUAGE SUMMARY**Magnification devices for endodontic therapy****Review question**

Do magnification devices improve the success of root canal treatments (endodontic therapy)?

Background

Endodontic therapy is a treatment on the infected pulp of a tooth to remove the infection and the pain it causes. As the instruments for this treatment have become more complicated and precise, it is widely accepted practice that magnification devices should be used, with the hope that this will improve outcomes of the therapy for patients. There are different types of magnification devices that may differ in their ability to increase the success of treatments. However, there is little data to support the use of magnification devices, or help dentists decide which is the best one.

Search

This version updates the review published in 2009. We searched the literature up to 13 October 2015.

Key results

We did not find any studies that met the inclusion criteria for this review.

Quality of the evidence

This review showed that there is no evidence available to assess whether magnification devices improve the success of endodontic therapy. There is therefore a need for further research to help clinicians and patients to make informed choices about treatment options.

BACKGROUND

The objective of successful endodontic therapy is thorough mechanical and chemical cleansing of the entire root canal system, followed by its complete obturation with an inert filling material (Vertucci 1984). Creating an ideal access opening is one of the most important steps to ensure a successful endodontic procedure. At the same time, the inability to identify and adequately treat all the canals of the endodontic system is a major cause for treatment failure and persistence of disease (Weine 1969; Sjogren 1990; Wolcott 2002; Dugas 2003).

Recent developments in dental technology have improved the clinician's ability to treat elusive regions within the oral cavity, increasing the efficiency and the quality of root canal treatment. For example, in endodontic surgery the advent of microsurgical instruments has involved technical changes in the approach to root canal preparation. Along with the diffusion of such instruments, the use of well-focused illumination and magnification devices has been recommended as a standard of care (Kim 1997).

The most common magnification devices that have been introduced in endodontics are loupes, surgical microscopes (Pecora 1993; Khayat 1998; Rubinstein 1999; Castellucci 2003) and, more recently, endoscopes (Bahcall 1999; Bahcall 2000; Von Arx 2002; Bahcall 2003). Working with such devices has become a widely accepted practice in conventional and surgical endodontics. Besides increasing the accuracy of the endodontic procedure, these devices are claimed to improve diagnostic capability due to a better visualisation of the treatment field. For example, they allow identification of the presence of isthmuses, accessory canals or microfractures of the root, which are otherwise difficult to recognise and treat (Coelho de Carvalho 2000; Schwartze 2002; Slaton 2003; Von Arx 2003a; Rampado 2004; Von Arx 2005).

The use of loupes and microscopes has been shown to improve clinicians' working posture and therefore reduce the occurrence of repetitive stress injuries related to bad posture (Behle 2001; Perrin 2002). It is interesting to investigate whether the technical advantages for the operator using magnification devices are also associated with advantages for the patients, in terms of higher treatment success rate, reduced treatment time, and lower total costs.

OBJECTIVES

To assess and compare the effects of endodontic treatment performed with the aid of magnification devices versus endodontic treatment without magnification devices. We also aimed to compare the different magnification devices used in endodontics (surgical microscopes, endoscopes and magnifying loupes) with one another.

METHODS

Criteria for considering studies for this review

Types of studies

We considered all RCTs and quasi-randomised controlled trials comparing endodontic therapy performed with versus without one or more magnification devices, as well as randomised and quasi-randomised trials comparing two or more magnification devices used as an adjunct to endodontic therapy.

Types of participants

Patients of any age who received endodontic therapy and were followed up for at least one year after treatment.

Types of interventions

Surgical or non-surgical endodontic treatment performed with the aid of one or more types of magnification devices, compared with the same kind of intervention performed without visual enhancers. We also included trials comparing one magnification device with another.

Types of outcome measures

Primary outcomes

We were primarily interested in the success of the treatment at one year follow up, as determined by clinical assessment of signs and symptoms, combined with examination of periapical radiographs to evaluate radiographical healing.

The outcome of endodontic therapy is generally assessed one year after treatment and is categorised as follows:

- 'success' that includes two sub-categories: 'complete healing' (radiographic and clinical normalcy) and 'incomplete healing' (clinical normalcy combined with reduced radiolucency and scar formation);
- 'uncertain healing' (persistence of radiolucency in the absence of clinical signs and symptoms, or presence of clinical signs/symptoms associated with incomplete radiographic healing);
- 'failure' (presence of clinical signs and symptoms combined with reduced or persistent radiolucency) (Rud 1972; Molven 1987; Gutmann 1991). Jesslen 1995 determined that the validity of a one year follow up is predictable in over 95% of the cases. When the one year outcome is recorded as 'uncertain healing', the tooth should be re-evaluated yearly up to four years after treatment and then recorded as success or failure (Molven 1996).

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

- one year after treatment
- between one and four years after treatment
- more than four years after treatment.

Unexpected events/outcomes would have been documented if identified in included RCTs.

Secondary outcomes

Secondary outcomes were related to advantages of using a given magnification device in the clinical procedure, that may lead to a preference of the operator for one versus another device, or to the feasibility of treating a particular clinical situation with greater accuracy:

- the possibility and ease of removing broken instruments from the canal;
- the quality of visualisation of root canal anatomy and morphology (detection of dentinal cracks or identification of unusual anatomical features, such as the presence of isthmuses, that may affect the clinical procedure);
- the quality of root-end filling (only for the retrograde treatment);
- the possibility of perforation repair;

(e) the total time required for completing the clinical procedure.

Search methods for identification of studies

To identify studies for this review, we developed detailed search strategies for each database searched. These were based on the search strategy developed for MEDLINE (Ovid) but revised appropriately for each database. The search strategy used a combination of controlled vocabulary and free text terms and was linked with the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised trials (RCTs) in MEDLINE: sensitivity-maximising version (2008 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of the *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 (updated March 2011) (Higgins 2011). Details of the MEDLINE search are provided in Appendix 3. The search of EMBASE was linked to the Cochrane Oral Health Group filter for identifying RCTs.

Electronic searches

We searched the following databases:

- The Cochrane Oral Health Group Trials Register (to 13 October 2015) (see Appendix 1);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*, 2015, Issue 9) (see Appendix 2);
- MEDLINE via OVID (1946 to 13 October 2015) (see Appendix 3);
- EMBASE via OVID (1980 to 13 October 2015) (see Appendix 4).

No restrictions were placed on the language or date of publication when searching the electronic databases. All the references lists of the included studies were checked manually to identify any additional studies.

Searching other resources

We searched the following databases for ongoing trials, see Appendix 5 for details of the search strategies:

- US National Institutes of Health Trials Register (<http://clinicaltrials.gov>) (to 13 October 2015);
- The WHO Clinical Trials Registry Platform (<http://apps.who.int/trialsearch/default.aspx>) (to 13 October 2015).

All issues of the following journals were handsearched to 31 January 2009:

- *International Endodontic Journal*
- *Journal of Endodontics*
- *Dental Traumatology* (formerly *Dental Traumatology and Endodontics*)
- *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*
- *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*

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

Data collection and analysis

Selection of studies

The titles and abstracts of all reports identified through the searches were scanned independently by two review authors. 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 would have undergone 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.

Data extraction and management

Data would have been extracted by two review authors independently using standardised data extraction forms. The data extraction forms were piloted on several papers and modified as needed before use. Any disagreement would have been resolved by discussion and a third review author was consulted where necessary. If agreement had not been reached data would have been excluded until further clarification was provided.

For each trial, the following data would have been 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 of materials and instruments used for root canal system management.
- Details of the type of intervention.
- Details of the type of magnification device(s) adopted.
- Details of the outcomes reported, including method of assessment and time intervals after intervention.
- Any kind of advantage or disadvantage reported in relation to the use of a given magnification device. In particular, we considered the possibility of detection and treatment of peculiar anatomic features of importance for proper canal treatment that are otherwise not identifiable.

Assessment of risk of bias in included studies

Two review authors would have independently undertaken an assessment of the risk of bias in included studies by following the recommendations as described in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). Any inconsistencies between the review authors would have been discussed and resolved, and if necessary, a third review author consulted. Where uncertainty could not be resolved, we had planned to make an effort to contact authors directly for clarification.

A specific tool for assessing risk of bias in each included study would have been adopted. This comprises a description and a judgement for each entry in a risk of bias table, where each entry addresses a specific feature of the study:

- (1) Random sequence generation (selection bias)
- (2) Allocation concealment (selection bias)

(3) Blinding (performance bias and detection bias). In some instances it will not be possible to blind participants and researchers but we would expect that the outcome assessors and data analysts would be blinded.

(4) Incomplete outcome data (attrition bias)

(5) Selective reporting (reporting bias)

(6) Other bias

Each entry would have been assessed as at low risk of bias, high risk of bias, or unclear risk of bias (lack of information or uncertainty over the potential for bias). We had planned to summarise an assessment of the overall risk of bias involving the consideration of the relative importance of different domains.

Data synthesis

The following procedures would have been conducted: In order to standardise statistical calculations using Review Manager (RevMan) software, we had planned to dichotomise the outcomes, similar to a previous Cochrane Review (Del Fabbro 2007). All cases classified as complete or incomplete healing plus cases classified as uncertain healing in the absence of clinical signs and symptoms would have been considered as 'successful'. Those cases classified as failures plus those classified as uncertain healing in the presence of signs and symptoms would have been considered as 'unsuccessful'. The participant would have been considered as the unit of analysis. Those participants that had multiple teeth treated would have been classified as unsuccessful if they experienced at least one unsuccessful case.

We had planned to follow statistical analyses outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), and, for each trial, risk ratios along with 95% confidence intervals would have been calculated to estimate the effect of interventions. Clinical heterogeneity would have been assessed by examining the types of participants, teeth, interventions and outcomes in each study. We would have conducted meta-analysis only if studies of similar comparisons reporting the same outcome measures were found. We had planned to combine risk ratios for dichotomous data using the random-effects model. An intention-to-treat analysis was also planned, considering as unsuccessful all participants who received treatment but in the trial were excluded from the analysis at any time for any reason.

Subgroup analysis and investigation of heterogeneity

If sufficient data were available, we had intended to conduct the following subgroup analyses: participant age group and severity of external root resorption.

Sensitivity analysis

If a sufficient number of trials had been included in this review, we had planned to conduct sensitivity analyses to assess the robustness of our review results by repeating the analysis with the following adjustments: exclusion of studies with unclear or inadequate allocation concealment, unclear or inadequate blinding of outcomes assessment and completeness of follow-up.

RESULTS

Description of studies

The electronic search retrieved 1234 studies. No further trial was identified by handsearching (the last handsearch was performed

on 31st January 2009). From the analysis of the abstracts of these studies, only three trials (Von Arx 2003; Tsesis 2005; Taschieri 2008) were identified as potentially eligible for inclusion in this review. There was agreement among the review authors after reading the full text of the three eligible trials that none of them could be included. Tsesis 2005 and Von Arx 2003 were excluded as they were not randomised trials. Taschieri 2008 evaluated three magnification devices: an endoscope, magnification loupes and a microscope (information provided by the authors). This study was excluded because the sample size calculation prior to the beginning of the study was undertaken on a tooth basis while group allocation occurred on a participant basis. Another reason for exclusion was the presence of participants with multiple teeth treated that had a greater chance of experiencing a negative outcome with respect to those that had a single tooth involved. Finally, molar teeth were not included in the first two years of the enrolment period while they were included in the third year. See the [Characteristics of excluded studies](#) table.

Risk of bias in included studies

No study could be included in the present review.

Effects of interventions

None of the studies fulfilled our inclusion criteria and therefore no data analysis was conducted.

DISCUSSION

The use of magnification devices in dentistry is becoming more and more common, with the aim of improving the quality of treatment. After the introduction of microsurgical principles in endodontics, involving new techniques for the root canal therapy, there has been a search for ways to enhance the visualisation of the surgical field. The use of well-focused illumination and magnification devices was recommended as a standard of care in endodontic therapy (Kim 2004; Cohen 2006). In the endodontic literature, many *in vitro* studies have been published, showing that magnification devices, such as the microscope or the endoscope, allow the identification of microstructures not visible with the naked eye (Coelho de Carvalho 2000; Gorduysus 2001; Baldassari-Cruz 2002; Schwartz 2002; Slaton 2003; Von Arx 2003a; Zaugg 2004). As a natural consequence it has been suggested that such devices can be useful, at least in theory, for improving clinical outcomes because all phases of the root/root-end management can be performed with greater accuracy. However, as we found in this review, there is a lack of clinical prospective comparative studies evaluating the outcome of endodontic treatment using different magnification devices. All of the trials dealing with endodontic surgery that we identified, had to be excluded for reasons presented in [Characteristics of excluded studies](#).

One of the purposes of the present review was to evaluate secondary outcomes that could be related to the preference of the operator for a specific type of magnification device in a given clinical situation. Such outcomes were reported in the [Types of outcome measures](#) section: the feasibility of removing broken instruments from the canal, the quality of visualisation of root canal anatomy and morphology, the quality of root-end filling, the possibility of perforation repair and the total time required for completing the clinical procedure. However, no study specifically compared these variables, while some of them were sporadically

reported but never statistically assessed. For example, in one of the excluded articles (Taschieri 2008), it is reported that, based on the operators' experience, the time required for completing the surgical procedure is on average four to five minutes longer for the endoscope as compared to other magnification devices, due to the need for repeated cleaning of the lens. No trial has been undertaken, however, looking at any of the above mentioned secondary variables. In the absence of differences in the clinical outcomes, a precise assessment of these secondary variables may be important for the choice of a specific magnification device, and should be addressed in specifically designed trials.

Although the use of magnification devices is a widely discussed issue amongst endodontists, the overall quality of studies regarding this topic is poor, as has been found by other reviews (Paik 2004; Mead 2005; Torabinejad 2005). The proportion of randomised studies is very low, as well as the number of prospective non-randomised studies for both apical surgery and endodontic (orthograde) treatment. Another review highlighted that there is a wide variability of successful outcomes for endodontic surgery as reported in the endodontic literature (Friedman 2004). Such variability could be at least in part explained by the presence of a large number of factors that may affect the result of apical surgery (for example, surgical procedures and materials, operator skill, success criteria adopted, radiographic and clinical evaluators experience, patient demographics and systemic condition, tooth type, location and anatomy, size of the lesion, follow-up duration). Therefore, the use of a specific magnification device per se may not be so critical in determining the success of the treatment. However, many studies report that the adoption of magnification devices has several technical advantages for the clinician, because they allow the identification of microscopic anatomical structures otherwise undetectable by the naked eye, and that may be important for improving the quality of the treatment. Therefore, even though clinical outcomes may not be affected by the type of magnification device used, the technical advantages particular to any of them may represent a technical 'plus' for the clinician in specific clinical situations, increasing his or her self-confidence in patient care.

Aside from the technical reasons or the individual preferences that may justify the adoption of a given magnification device, it should be acknowledged that the disclosure of dentinal cracks or the identification of peculiar anatomical features, such as the presence of isthmuses, may affect the clinical procedure allowing a more complete and accurate root canal system management. It can be hypothesised that the latter might be associated with a decreased recurrence of post-treatment disease, thereby reducing the need for endodontic re-treatment. This point also should be specifically investigated by future studies.

AUTHORS' CONCLUSIONS

Implications for practice

There is no evidence to support or refute a difference in clinical outcomes when either a microscope, endoscope or surgical loupes are adopted during endodontic surgery.

The literature is comprised mainly of *in vitro* studies, with no high quality trials that meet the inclusion criteria for this review. In the absence of any evidence from randomised controlled trials, clinicians should base their decisions on clinical experience in conjunction with patients' preferences, where appropriate.

Implications for research

No randomised controlled trial was identified in the current literature that satisfied the criteria for inclusion in this review. In order to understand if there is a significant advantage in using magnification devices or not in endodontics, or to quantify the superiority of a given magnification device over the others in specific clinical situations, more long-term well-designed RCTs must be performed.

Given the total absence of RCTs comparing the clinical outcome of endodontic treatment (both surgical and non-surgical) using or not using a magnification device, this type of study should be prioritised. Randomised trials comparing different magnification devices in orthograde endodontic treatment are also urgently needed.

It is necessary that such trials investigate the effect that a given magnification device may have on the treatment of molar teeth. It seems important to explore this because endodontic treatment for molar teeth is typically more challenging than for other tooth types, and therefore it might represent a specific indication for the adoption of visual enhancers.

Ideally, such studies should attempt to standardise all parameters potentially affecting the outcome. In particular, factors such as the patient's clinical and demographic characteristics, tooth type and location, the operator's skill, clinical procedures, instrumentation and materials, radiographic techniques and success criteria should be standardised. In these studies it is not only treatment success that should be evaluated, but also any type of outcome that could make a difference in the choice between different magnification devices, such as the possibility of detecting important anatomical structures, the quality of visualisation, the learning curve or the total time required for completing the procedure. Such trials should also be reported in a standardised way, according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (www.consort-statement.org/).

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Taschieri 2008	Several methodological flaws. Sample size calculation prior to the beginning of the study was undertaken on a tooth basis while group allocation occurred on a participant basis. A further concern is due to the presence of participants with multiple teeth treated that had a greater chance of experiencing a negative outcome with respect to those that had a single tooth involved. Finally, molar teeth were not included in the first two years of the enrolment period while they were included only during the third year.
Tsesis 2005	This was a prospective but not a randomised study. The first 33 participants were treated by the traditional technique without using the microscope. Subsequently, the other 33 participants were consecutively treated with the aid of the surgical microscope, after the latter was purchased. The two groups were also treated with different techniques and instrumentation.
Von Arx 2003	In this study there was no randomisation. Cases were allocated to groups according to the surgical protocol if the surgeon had or had not used an endoscope for intraoperative diagnostics.

APPENDICES

Appendix 1. The Cochrane Oral Health Group Trials Register Search Strategy

From April 2014, searches of the Cochrane Oral Health Group Trials Register were undertaken using the Cochrane Register of Studies and the search strategy below:

- 1 (endodontic* or "root canal*" or apicoectom* or apicectom*):ti,ab
- 2 (apical* and (surgery or surgical)):ti,ab
- 3 (orthograd* and fill*):ti,ab
- 4 (retrograd* and fill*):ti,ab
- 5 #1 or #2 or #3 or #4
- 6 (microscop* or endoscop* or oroscop* or loupe* or magnify or magnification):ti,ab
- 7 #5 and #6

Previous searches were undertaken using the Procite software and the search strategy below:

((endodontic* or "root canal\$" or apicoectom* or apicectom* or (apical* AND (surgery or surgical*))) or (orthograd* and fill*) or (retrograd* AND fill*)) AND (microscop* or endoscop* or oroscop* or loupe* or magnify or magnification))

Appendix 2. The Cochrane Central Register of Controlled Trials (CENTRAL) Search Strategy

- #1 ENDODONTICS/
- #2 Exp Root canal therapy
- #3 APICOECTOMY/
- #4 endodontic* [ti,ab,ky]
- #5 (apical NEAR surgery) or (apical NEAR surgical*)
- #6 (apicectom* or apicoectom*)
- #7 ((orthograd* NEAR fill*) or (root NEAR therap*) or (root-end NEAR resect*) or (root-end NEAR fill*))
- #8 ("root canal*" NEAR prepar*)
- #9 (retrograde* NEAR fill*)
- #10 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9
- #11 (microscop* or endoscope* or oroscop* or loupe*)
- #12 (magnification or magnify or magnified)
- #13 Exp MICROSCOPY
- #14 #11 or #12 or #13
- #15 #10 AND #14

Magnification devices for endodontic therapy (Review)

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Appendix 3. MEDLINE (OVID) Search Strategy

1. ENDODONTICS/
2. exp "Root Canal Therapy"/
3. Apicoectomy/
4. endodontic\$.ab,sh,ti.
5. (apical and (surgery or surgical\$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
6. (apicectom\$ or apicoectom\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
7. ((orthograd\$ adj6 fill\$) 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]
8. (("root canal\$" adj (prepar\$ or obturat\$)) or "dental pulp devitali\$").mp. [mp=title, original title, abstract, name of substance word, subject heading word]
9. (retrograd\$ adj6 fill\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- 10.or/1-9
- 11.(microscop\$ or endoscop\$ or orascop\$ or loupe\$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- 12.(magnification or magnify).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
- 13.exp Microscopy/
- 14.or/11-13
- 15.10 and 14

The above subject search was linked to the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomized trials in MEDLINE: sensitivity maximising version (2008 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of *The Cochrane Handbook for Systematic Reviews of Interventions*, Version 5.1.0 [updated March 2011].

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. or/1-8
10. exp animals/ not humans.sh.
11. 9 not 10

Appendix 4. EMBASE (OVID) Search Strategy

1. ENDODONTICS/
2. "Root Canal Therapy".mp.
3. Apicoectomy.mp.
4. endodontic\$.ab,sh,ti.
5. (apical and (surgery or surgical\$)).mp.
6. (apicectom\$ or apicoectom\$).mp.
7. ((orthograd\$ adj6 fill\$) or (root adj6 therap\$) or (root-end adj6 resect\$) or (root-end adj6 fill\$)).mp.
8. (("root canal\$" adj (prepar\$ or obturat\$)) or "dental pulp devitali\$").mp.
9. (retrograd\$ adj6 fill\$).mp.
10. or/1-9
11. (microscop\$ or endoscop\$ or orascop\$ or loupe\$).mp.
12. (magnification or magnify).mp.
13. exp Microscopy/
14. or/11-13
15. 10 and 14

The above subject search was linked to the Cochrane Oral Health Group filter for identifying RCTs in EMBASE via OVID:

1. random\$.ti,ab.
2. factorial\$.ti,ab.
3. (crossover\$ or cross over\$ or cross-over\$).ti,ab.
4. placebo\$.ti,ab.
5. (doubl\$ adj blind\$).ti,ab.

Magnification devices for endodontic therapy (Review)

6. (singl\$ adj blind\$).ti,ab.
7. assign\$.ti,ab.
8. allocat\$.ti,ab.
9. volunteer\$.ti,ab.
10. CROSSOVER PROCEDURE.sh.
11. DOUBLE-BLIND PROCEDURE.sh.
12. RANDOMIZED CONTROLLED TRIAL.sh.
13. SINGLE BLIND PROCEDURE.sh.
14. or/1-13
15. (exp animal/ or animal.hw. or nonhuman/) not (exp human/ or human cell/ or (human or humans).ti.)
16. 14 NOT 15

Appendix 5. US National Institutes of Health Trials Register (ClinicalTrials.gov) and WHO International Clinical Trials Registry Platform Search Strategy

endodontic AND magnify
 endodontic AND magnification
 "root canal" AND magnify
 "root canal" AND magnification

WHAT'S NEW

Date	Event	Description
14 January 2016	Review declared as stable	This is an empty review containing no trials, and will not be updated until a substantial body of evidence on the topic becomes available.

HISTORY

Protocol first published: Issue 2, 2006
 Review first published: Issue 3, 2009

Date	Event	Description
9 December 2015	New citation required but conclusions have not changed	This is an empty review containing no trials, and will not be updated until a substantial body of evidence on the topic becomes available.
13 October 2015	New search has been performed	New search. No studies for inclusion.

CONTRIBUTIONS OF AUTHORS

Conceiving the review (Silvio Taschieri (ST) and Massimo Del Fabbro (MDF)).
 Designing and co-ordinating the review (MDF).
 Developing search strategies and undertaking searches (MDF).
 Screening search results and retrieved papers against inclusion criteria (ST, MDF).
 Writing to authors for additional information (MDF).
 Providing additional data about papers (MDF, ST).
 Screening data on unpublished studies (MDF, ST).
 Writing the review (MDF).
 Providing general advice on the review (GL, Roberto L Weinstein (RLW)).

DECLARATIONS OF INTEREST

Massimo Del Fabbro, Silvio Taschieri and Roberto Weinstein are among the authors of some potentially eligible studies. However, none of them were involved in the assessment of eligibility of these trials.

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- Cochrane Oral Health Group Global Alliance, Other.

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INDEX TERMS

Medical Subject Headings (MeSH)

Endodontics [*instrumentation] [methods]; Endoscopes; Lenses; Microscopy [instrumentation]; Root Canal Therapy [*instrumentation] [methods]

MeSH check words

Humans