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Interventions for replacing missing teeth: dental implants in zygomatic bone for the rehabilitation of the severely deficient edentulous maxilla.

Cochrane Database of Systematic Reviews 2013, Issue 9. Art. No.: CD004151.

DOI: [10.1002/14651858.CD004151.pub3](https://doi.org/10.1002/14651858.CD004151.pub3).

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TABLE OF CONTENTS

HEADER	1
ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
SUMMARY OF FINDINGS	3
BACKGROUND	4
OBJECTIVES	4
METHODS	5
RESULTS	7
DISCUSSION	7
AUTHORS' CONCLUSIONS	7
ACKNOWLEDGEMENTS	7
REFERENCES	8
APPENDICES	9
WHAT'S NEW	11
HISTORY	11
CONTRIBUTIONS OF AUTHORS	11
DECLARATIONS OF INTEREST	11
SOURCES OF SUPPORT	11
DIFFERENCES BETWEEN PROTOCOL AND REVIEW	12
INDEX TERMS	12

[Intervention Review]

Interventions for replacing missing teeth: dental implants in zygomatic bone for the rehabilitation of the severely deficient edentulous maxilla

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ABSTRACT

Background

Dental implants are used for replacing missing teeth. Placing dental implants is limited by the presence of adequate bone volume permitting their anchorage. Several bone augmentation procedures have been developed to solve this problem. Zygomatic implants are long screw-shaped implants developed as a partial or complete alternative to bone augmentation procedures for the severely atrophic maxilla. One to three zygomatic implants can be inserted through the posterior alveolar crest passing through the maxillary sinus, or externally to it, to engage the body of the zygomatic bone. A couple of conventional dental implants may also be needed in the frontal region of the maxilla to stabilise the prosthesis. The potential main advantages of zygomatic implants could be that bone grafting may not be needed and a fixed prosthesis could be fitted sooner. Another specific indication for zygomatic implants could be maxillary reconstruction after maxillectomy in cancer patients.

Objectives

To assess the effects of zygomatic implants with and without bone augmenting procedures in comparison with conventional dental implants in augmented bone for the rehabilitation with implant-supported prostheses of severely resorbed maxillae.

Search methods

We searched the following electronic databases: the Cochrane Oral Health Group's Trials Register (to 17 June 2013), the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2013, Issue 5), MEDLINE via OVID (1946 to 17 June 2013) and EMBASE via OVID (1980 to 17 June 2013). Personal contacts and all known zygomatic implant manufacturers were contacted to identify unpublished trials. No restrictions were placed on the language or date of publication when searching the electronic databases.

Selection criteria

Randomised controlled trials (RCTs) including participants with severely resorbed maxillae, who could not be rehabilitated with conventional dental implants, treated with zygomatic implants with and without bone grafts versus participants treated with bone augmentation procedures and conventional dental implants, with a follow-up of at least one year in function.

Data collection and analysis

Two review authors would have extracted data from eligible studies and assessed their risk of bias independently and in duplicate. The results of included studies were to be combined in meta-analyses using random-effects models where there were more than four studies, and fixed-effect models where there were less than four studies. We would have expressed the estimate of the intervention effect as mean

difference for continuous outcomes and risk ratio for dichotomous outcomes, with 95% confidence intervals. Heterogeneity was to be investigated including both clinical and methodological factors.

Main results

We did not identify any RCTs which were eligible for inclusion in this review.

Authors' conclusions

There is a need for RCTs in this area to assess whether zygomatic implants offer some advantages over alternative bone augmentation techniques for treating atrophic maxillae.

PLAIN LANGUAGE SUMMARY

Interventions for replacing missing teeth: dental implants into the cheekbone for people with no teeth and insufficient bone in the upper jaw to anchor implants

Review question

This review, carried out by authors of the Cochrane Oral Health Group, was produced to assess the beneficial and harmful effects of long tooth implants passing through the sinus and into cheekbone as an alternative to procedures designed to build up missing bone in the jaw such as bone grafting. The review question was intended to look at three options for this treatment.

- (1) As a complete alternative to any procedures designed to build up missing bone in the jaw.
- (2) As a partial alternative, for example some building up of the bone would still be needed in the front parts of the jaw.
- (3) How long tooth implants can help retain any artificial palate (prosthesis or obturator) that may be needed after surgery to remove the roof and/or hard palate of the mouth (maxillectomy).

Background

Sometimes there is not enough bone in the upper jaw in which to secure dental implants. Sometimes bone is taken from somewhere else in the person's body, or bone substitutes are used. An alternative approach is to place one to three long screw-shaped implants into the sinus and the cheekbone (zygomatic implants). This may mean that bone grafting is unnecessary. The implants can then be used to build and secure artificial teeth.

Study characteristics

A search was done on 17 June 2013 and the review team found no trials comparing the outcomes of zygomatic implants with conventional bone grafting.

Key results

There are no comparative trials evaluating the effectiveness of long implants passing through the sinus and into the cheekbone as an alternative to bone augmentation procedures.

Quality of the evidence

Not applicable.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Zygomatic implants versus conventional implants

Patient or population: people requiring dental implants

Settings: dental practice

Intervention: zygomatic implants

Comparison: conventional implants

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Conventional	Zygomatic				
Prosthesis failure	Low risk population			0		No trials
	10 per 1000 ¹			(0)		
	High risk population					
	100 per 1000					

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval (CI)) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

GRADE Working Group grades of evidence.

High quality (⊕⊕⊕⊕): further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality (⊕⊕⊕#): further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality (⊕⊕##): further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality (⊕###): we are very uncertain about the estimate.

¹ The assumed risk is based on RCTs included in other Cochrane implant reviews ([Esposito 2009](#); [Esposito 2010](#)).

BACKGROUND

Description of the condition

Dental implants are now commonly used for replacing missing teeth in various clinical situations. Dental implants are surgically inserted in the jawbones. However, the possibility of placing dental implants is limited by the presence of adequate bone volume permitting their anchorage. In many clinical situations, in particular for edentulous patients with heavily resorbed jawbones and patients who underwent traumatic bone loss or resective surgery for oral cancer, there is insufficient bone to allow implant placement. Unfortunately, these people have more problems to adapt to conventional dentures, since dentures cannot be easily stabilised in the mouth due to lack of retention and therefore these people have serious difficulties in eating and speaking.

In order to solve this problem several bone augmentation procedures have been developed. In principle the missing bone is taken from a donor site (for example the iliac crest), transplanted where needed and then implants are placed. Sometimes, major bone grafting operations have to be undertaken under general anaesthesia requiring patients to be hospitalised for a few days. Some degree of morbidity related to the donor site must be expected and two to three surgical interventions may be needed before the implants can be functionally used. Sometimes patients have to wait more than one year before a denture can be fixed to the implants and the total cost of the treatment is high. More information about the effectiveness of various bone augmentation procedures can be found elsewhere (Esposito 2009; Esposito 2010).

Description of the intervention

At the beginning of the 1990s a long screw-shaped implant was developed by Professor P-I Brånemark as an alternative to bone augmentation procedures: the zygomatic implant (Stevenson 2000). Zygomatic implants are generally inserted through the alveolar crest and maxillary sinus to engage the body of the zygomatic bone (cheekbone). More recently, depending on the local anatomy, to favour an exit of the implant in a less palatal position and to minimise the risks of complications such as sinusitis, zygomatic implants are also placed laterally to the sinus without opening the maxillary sinus cavity (Aparicio 2011; Maló 2012; Davó 2013b).

The placement of zygomatic implants require highly experienced and skilful surgeons, and often the opening of large windows in the maxillary sinus to properly visualise the correct implant placement. Implants are generally placed as posteriorly as possible (near the position of the second premolars) close to the alveolar crest, but they tend to be located more palatally than the actual position of the teeth. Up to three zygomatic implants can be placed on each side of the maxilla. The operation requires general anaesthesia or conscious sedation and local anaesthesia for pain control.

Zygomatic implants can be left to heal submerged for up to six months (Davó 2009), though, more recently, it was shown that they could be successfully loaded immediately (Davó 2008a; Davó 2008b; Davó 2013a; Davó 2013b). The major potential advantages of zygomatic implants are that bone augmentation procedures may not be needed and patients can be rehabilitated with a fixed prosthesis within the same day. It is believed that two zygomatic implants are not sufficient to hold a fixed bridge, and that at

least two additional conventional implants should be placed in the anterior portion of the maxilla (Bedrossian 2001). This can only be accomplished if there is sufficient bone in the anterior portion of the maxilla, otherwise bone grafting is still needed. An alternative is to place two or three zygomatic implants in each zygoma (Davó 2008a; Davó 2013b).

The most commonly and serious reported complications with zygomatic implants are: sinusitis (up to 21% of the patients in Davó 2009); zygomatic implant failures (up to 11% of patients in Brånemark 2004); and perforation of the orbit (up to 6% of patients in Davó 2013b).

Indications for zygomatic implants could be the following.

- Treatment of severely atrophic fully edentulous maxillae without using any bone augmentation procedure. There may be two different clinical situations: (a) there is enough bone in the frontal maxillary region to allow the placement of at least two short implants; or (b) there is not enough bone in the frontal regions and two to three zygomatic implants can be used in each upper quadrant to hold a fixed prosthesis without using any conventional dental implants.
- Treatment of severely atrophic partially edentulous maxillae avoiding sinus lifting or other grafting procedures.
- Maxillary reconstruction after partial or total maxillectomy. Zygomatic implants can be used to fix maxillary obturators as an alternative to non-implant retained obturators, local and regional flaps, and microvascular free flaps (Schmidt 2004).

At the moment there are at least eight companies manufacturing fully or partially threaded titanium zygomatic implants: AS Technology, Conexão Sistemas de Prótese, Brånemark Integration, Dentoflex, Neodent, Nobelbiocare, SIN Implant System, and Southern.

Why it is important to do this review

It would be beneficial to both patients and society to determine whether zygomatic implants offer a more effective, safe and cheaper alternative to extensive bone augmentation procedures.

OBJECTIVES

To assess the effects of zygomatic implants with and without bone augmenting procedures in comparison with conventional dental implants in augmented bone for the rehabilitation with implant-supported prostheses of severely resorbed maxillae.

The following three different potential indications were to be evaluated separately.

1. Zygomatic implants as a complete alternative to any bone augmentation procedures to severely atrophic maxillae.
2. Zygomatic implants as a partial alternative to any bone augmentation procedures to severely atrophic maxillae (i.e. some augmentation procedure is still required in the frontal portion of the maxilla).
3. Zygomatic implants for retaining obturator in maxillectomy cases.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) with a parallel group or split-mouth design.

Types of participants

Participants who have an atrophic maxilla who cannot be rehabilitated with conventional dental implants due to lack of bone, including patients subjected to cancer ablation surgery and irradiation therapy. Participants can be partially or totally edentulous.

Types of interventions

Zygomatic implants with or without bone grafts versus conventional dental implants in augmented maxillae with a follow-up of at least one year in function.

Types of outcome measures

- Prosthesis could not be placed or loss of prosthesis secondary to implant failure.
- Implant failures defined as mobile implants, removal of stable implants dictated by progressive marginal bone loss or infection, implant fractures, implants which were left 'sleeping' due to wrong alignment.
- Complications.
- Patient satisfaction and, when possible, preference.
- Cost-effectiveness.

Search methods for identification of studies

For the identification of studies included or considered 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 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 1](#). The search of EMBASE was linked to the Cochrane Oral Health Group filters for identifying RCTs.

Electronic searches

We searched the following electronic databases:

- the Cochrane Oral Health Group's Trials Register (to 17 June 2013) ([Appendix 2](#));
- the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2013, Issue 5) ([Appendix 3](#));
- MEDLINE via OVID (1946 to 17 June 2013) ([Appendix 1](#));
- EMBASE via OVID (1980 to 17 June 2013) ([Appendix 4](#)).

No restrictions were placed on the language when searching the electronic databases.

Searching other resources

Unpublished studies

We intended to write to all the authors of any identified RCTs to identify unpublished studies. The bibliographies of all identified RCTs and relevant review articles were to be checked. We utilised personal contacts in an attempt to identify unpublished or ongoing RCTs. In the first version of this review, we also wrote to more than 55 oral implant manufacturers and we requested information on trials through an Internet discussion group (implantology@yahoo.com), however, we discontinued this due to poor yield.

Handsearching

Only handsearching done as part of the Cochrane Worldwide Handsearching Programme and uploaded to CENTRAL was to be included (see the [Cochrane Masterlist](#) for details of journal issues searched to date).

Data collection and analysis

Selection of studies

Two review authors scanned the titles and abstracts (when available) of all reports identified by the search strategy, independently and in duplicate. For studies appearing to meet the inclusion criteria, or for which there were insufficient data in the title and abstract to make a clear decision, the full report was to be obtained and assessed independently by two review authors to establish whether the studies met the inclusion criteria or not. Disagreements were to be resolved by discussion. Where resolution was not possible, a methodologist from the Cochrane Oral Health Group was to be consulted. All studies meeting the inclusion criteria were to undergo risk of bias assessment and data were to be extracted. Studies rejected at this or subsequent stages were to be recorded in the table of excluded studies, and reasons for exclusion recorded.

Data extraction and management

Two review authors were to extract data, independently and in duplicate, using specially designed data extraction forms. Any disagreement was to be discussed and a third review author consulted where necessary. Authors of included studies were to be contacted for clarification or missing information. Data were to be excluded until further clarification was available, if agreement could not be reached.

For each trial the following data were to be recorded.

- Year of publication, country of origin, setting and source of study funding.
- Details of the participants including demographic characteristics and criteria for inclusion.
- Details on the type of intervention.
- Details of the outcomes reported, including method of assessment and time intervals.

Assessment of risk of bias in included studies

We intended to carry out risk of bias assessment following the recommended approach in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). It is a two-part tool, addressing the six specific domains (namely sequence

generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and 'other bias'). Each domain includes one specific entry in a 'Risk of bias' table. Within each entry, the first part of the tool involves describing what was reported to have happened in the study. The second part of the tool involves assigning a judgement relating to the risk of bias for that entry, either 'low risk', 'high risk' or, where there is insufficient information on which to base a judgement, 'unclear risk'.

The risk of bias assessment of any included trials was to have been completed independently and in duplicate by two review authors as part of the data extraction process. On occasions when

the review authors were also authors of trial reports that needed to be assessed, the reports were to be independently evaluated only by review authors who had not been involved in the trials, and duplicated by a methodologist from the Cochrane Oral Health Group.

Summarising risk of bias for a study

After taking into account the additional information provided by the authors of the studies, we intended to group studies into the following categories. We assumed that the risk of bias was the same for all outcomes and each study would have been assessed as follows.

Risk of bias	Interpretation	Within a study	Across studies
Low risk of bias	Plausible bias unlikely to alter the results seriously	Low risk of bias for all domains	Most information is from studies at low risk of bias
Unclear risk of bias	Plausible bias that raises some doubt about the results	Unclear risk of bias for one or more domains	Most information is from studies at low or unclear risk of bias
High risk of bias	Plausible bias that seriously weakens confidence in the results	High risk of bias for one or more domains	The proportion of information from studies at high risk of bias is sufficient to affect the interpretation of results

Measures of treatment effect

For dichotomous outcomes, we would have expressed the estimate of effect of an intervention as risk ratios together with 95% confidence intervals. For continuous outcomes, we would have used mean differences and 95% confidence intervals to summarise the data for each study.

Unit of analysis issues

The participant would usually be the unit of analysis, apart from split-mouth studies where the sites would be the units of analysis.

Dealing with missing data

We would have contacted study authors to retrieve missing data where necessary. If agreement could not be reached, data would have been excluded until further clarification was available. Methods for estimating missing standard deviations in section 7.7.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* would have been used if required (Higgins 2011). An intention-to-treat (ITT) analysis would have been undertaken where data were available and if appropriate.

Assessment of heterogeneity

The significance of any discrepancies in the estimates of the treatment effects from the different studies was to be assessed by means of Cochran's test for heterogeneity. Heterogeneity would have been considered to be significant if the P value was less than 0.1. The I^2 statistic, which describes the percentage of total variation across studies that is due to heterogeneity rather than chance, was to be used to quantify heterogeneity, with an I^2 value over 50% indicating moderate to considerable heterogeneity.

Assessment of reporting biases

If there had been a sufficient number of studies (more than 10) in any meta-analysis we would have assessed publication bias according to the recommendations on testing for funnel plot asymmetry (Egger 1997), as described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). If asymmetry had been identified, we would have examined possible causes.

Data synthesis

Meta-analyses were to be conducted only with studies of similar comparisons reporting the same outcome measures. Risk ratios were to be combined for dichotomous data, and mean differences for continuous data, using a random-effects models provided there were more than three studies in the meta-analysis (otherwise we would have used fixed-effect models). We would have calculated numbers needed to treat for an additional harm (NNTH) for participants affected by implant failures. The recommendations of the *Cochrane Handbook for Systematic Reviews of Interventions* were to be followed for studies with zero-cell counts (Higgins 2011). The fixed value of 0.5 was to be added to all cells with zero-cell counts and risk ratios calculated with the Review Manager (RevMan) software (RevMan 2012). If there were no events in both arms, we would not have undertaken any calculations because, in this situation, the study does not provide any indication of the direction or magnitude of the relative treatment effect.

Subgroup analysis and investigation of heterogeneity

Clinical heterogeneity was to be assessed by examining the types of participants, interventions and outcomes in each study with a planned subgroup analysis for various bone grafting techniques and for different groups of participants (those with severely

resorbed maxillae versus cancer patients subjected to irradiation therapy).

Sensitivity analysis

Sensitivity analyses were to be undertaken to examine the effect of concealed randomisation and outcome assessor being independent on the assessment of the overall estimates of effect. In addition, the effect of including unpublished literature on the review's findings was to be examined.

Presentation of main results

We intended to develop a 'Summary of findings' table for the main outcomes of this review using GRADEPro software. We would have assessed the quality of the body of evidence with reference to the overall risk of bias of the included studies, the directness of the evidence, the inconsistency of the results, the precision of the estimates, the risk of publication bias and the magnitude of the effect. The quality of the body of evidence of each of the main outcomes would have been categorised as high, moderate, low or very low.

RESULTS

Description of studies

We could not identify any eligible randomised controlled trials (RCTs).

Risk of bias in included studies

We could not identify any eligible (RCTs).

Effects of interventions

See: [Summary of findings for the main comparison](#) *Zygomatic implants versus conventional implants*

We could not identify any eligible (RCTs).

DISCUSSION

Summary of main results

It is somewhat disappointing to find that not a single randomised controlled trial (RCT) comparing zygomatic implants with or without bone augmentation techniques for the rehabilitation of the severely atrophic maxilla was available, though several retrospective (Stevenson 2000; Bedrossian 2002; Nakai 2003; Brånemark 2004; Malevez 2004; Schmidt 2004; Landes 2005; Davó 2008a; Davó 2008b; Davó 2009; Maló 2012) and prospective (Hirsch 2004; Davó 2013a; Davó 2013b) case series studies were published.

Overall completeness and applicability of evidence

While the scarcity of long-term clinical data can be explained by the fact that zygomatic implants are a relatively new procedure, it

is rather discouraging to observe that we were unable to identify even a single RCT testing the efficacy of zygomatic implants in comparison with traditional bone augmentation procedures. The placement of zygomatic implants requires very experienced surgeons as it is not risk-free since delicate anatomic structures such as the orbita may be involved. The main complication which seems to occur with zygomatic implants is sinusitis which may develop several years after their placement (Brånemark 2004). In case of complications, it is rather difficult to remove zygomatic implants. Therefore, we foresee a great need to conduct high quality RCTs to investigate the potential advantages of zygomatic implants before recommending the routine use of this procedure.

AUTHORS' CONCLUSIONS

Implications for practice

No randomised controlled trial (RCT) was identified so it is not possible to give reliable evidence-based advice to potential users with respect to the efficacy of zygomatic implants as an alternative to various augmentation procedures for severely deficient maxillae.

Implications for research

Even recognising the fact that zygomatic implants are a relatively new treatment modality, it is disappointing that not even one published RCT, comparing zygomatic implants with any alternative augmentation techniques, could be identified. It is therefore suggested that multicentre, properly designed RCTs should be implemented in this area, before any evidence-based recommendation on the use of zygomatic implants can be given. In order to exploit the maximum potential advantages of zygomatic implants, it may be worth assessing their performance when loaded immediately to shorten the treatment time for the patients. Complications with zygomatic implants need also to be thoroughly assessed and compared with those occurring with alternative bone augmentation procedures. It is also important that long follow-up periods are considered (definitely more than five years), since some complications such as sinusitis seem to develop at a later stage. The research agenda should give priority to the evaluation of zygomatic implants as a complete alternative to bone augmentation procedures in the severely atrophic maxilla, and as retainers of obturators in maxillectomy cases.

ACKNOWLEDGEMENTS

We wish to thank Anne Littlewood (Cochrane Oral Health Group) for her assistance with literature searching, Luisa Fernandez Mauleffinch and Joanne Leese (Cochrane Oral Health Group) for their help with the preparation of this review. We wish to thank Paul Coulthard for the contribution he gave for earlier versions of this review. We would also like to thank the following referees for their comments on the initial publication of this review: Bertil Friberg, Anne-Marie Glenny, Jayne E Harrison, Lee Hooper, Ian Needleman and Göran Widmark.

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APPENDICES

Appendix 1. MEDLINE (OVID) search strategy

1. exp Dental Implants/
2. exp Dental Implantation/ or dental implantation
3. exp Dental Prosthesis, Implant-Supported/
4. ((osseointegrated adj implant\$) and (dental or oral))
5. dental implant\$
6. (implant\$ adj5 dent\$)
7. (((overdenture\$ or crown\$ or bridge\$ or prosthesis or restoration\$) adj5 (Dental or oral)) and implant\$)
8. "implant supported dental prosthesis"
9. ("blade implant\$" and (dental or oral))
- 10.((endosseous adj5 implant\$) and (dental or oral))
- 11.((dental or oral) adj5 implant\$)
- 12.OR/1-11

The above subject search was linked to the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised 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 2. Cochrane Oral Health Group's Trials Register search strategy

Updated searches were undertaken using the Cochrane Register of Studies and the search strategy below from January 2013:

- #1 ("dental implant*" or "oral implant*" or "implant support*" or "endosseous implant*" or "blade implant*") AND (INREGISTER)
- #2 ((implant* and (oral or dental))) AND (INREGISTER)
- #3 ("subperiosteal implant*") AND (INREGISTER)
- #4 ((implant* AND overdenture*)) AND (INREGISTER)
- #5 (((overdenture* OR crown* OR bridge* OR prosthesis OR prostheses OR restoration*) AND ("dental implant*" OR "Oral implant" OR (zygoma* AND implant*))) AND (INREGISTER)
- #6 (#1 or #2 or #3 or #4 or #5) AND (INREGISTER)

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

(dental-implants OR "dental implant*" OR "oral implant*" OR dental-implantation OR dental-prosthesis-implant-supported OR "implant supported" OR "implant supported prosthesis" OR dental-implantation-endosseous-endodontic OR "endosseous implant*" OR blade-implantation OR "blade implant*" OR (implant* AND (oral OR dental)) or dental-implantation-subperiosteal OR "subperiosteal implant"

OR (implant* AND overdenture*) OR ((overdenture* OR crown* OR bridge* OR prosthesis OR prostheses OR restoration*) AND ("dental implant*" OR "Oral implant" OR (zygoma* AND implant*)))

Appendix 3. Cochrane Central Register of Controlled Trials (CENTRAL) search strategy

```
#1 DENTAL IMPLANTS explode all trees (MeSH)
#2 DENTAL IMPLANTATION explode all trees (MeSH)
#3 DENTAL PROSTHESIS IMPLANT-SUPPORTED single term (MeSH)
#4 ((osseointegrat* near implant*) and (dental* or oral*))
#5 (dental next implant*)
#6 (implant* near dent*)
#7 dental-implant*
#8 ((overdenture* near dental*) and implant*)
#9 ((overdenture* near oral*) and implant*)
#10 ((crown* near dental*) and implant*)
#11 ((crown* near oral*) and implant*)
#12 ((bridge* near dental*) and implant*)
#13 ((bridge* near oral*) and implant*)
#14 ((prosthesis near dental*) and implant*)
#15 ((prosthesis near oral*) and implant*)
#16 ((prostheses near dental*) and implant*)
#17 ((prostheses near oral*) and implant*)
#18 ((restoration* near dental*) and implant*)
#19 ((restoration* near oral*) and implant*)
#20 (implant next supported next dental next prosthesis)
#21 (blade next implant*)
#22 ((endosseous near implant*) and dental)
#23 ((endosseous near implant*) and oral*)
#24 ((dental* near implant*) or (oral* near implant*))
#25 (#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24)
```

Appendix 4. EMBASE (OVID) search strategy

```
1. tooth implantation/
2. ((implant-supported or implant$) adj support$).mp.
3. ((osseointegrated adj implant$) and (dental or oral)).mp.
4. ((dental implant$ or dental-implant or implant$) adj (dent$ or oral or tooth)).mp.
5. (((overdenture$ or crown$ or bridge$ or prosthesis or prostheses or restoration$) adj5 (dental or oral)) and implant$).mp.
6. "implant supported dental prosthesis".mp.
7. ("blade implant$" and (dental or oral or tooth or teeth)).mp.
8. ((endosseous adj5 implant$) and (dental or oral or tooth or teeth)).mp.
9. ((dental or oral or tooth or teeth) and implant$).mp.
10. or/1-9
```

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$).ti,ab.
6. (singl$ 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
```

WHAT'S NEW

Date	Event	Description
11 March 2014	Review declared as stable	This empty review will not be updated until a substantial body of evidence on the topic becomes available. If trials are conducted and found eligible for inclusion in the future, the review would then be updated accordingly.

HISTORY

Protocol first published: Issue 2, 2003

Review first published: Issue 3, 2003

Date	Event	Description
30 August 2013	New citation required but conclusions have not changed	Methods updated. New authorship. No new included or excluded studies. Conclusions not changed.
30 August 2013	New search has been performed	Search updated to June 2013.
13 June 2008	Amended	Converted to new review format.
17 August 2005	New citation required but conclusions have not changed	Substantive amendment.

CONTRIBUTIONS OF AUTHORS

Conceiving, designing and co-ordinating the review (Marco Esposito (ME)).

Developing search strategies and undertaking searches (Anne Littlewood, ME).

Screening search results and retrieved papers against inclusion criteria (ME).

Writing the review (ME).

Providing general advice on the review (Helen Worthington (HW)).

DECLARATIONS OF INTEREST

Marco Esposito: no interests to declare.

Helen Worthington: no interests to declare.

SOURCES OF SUPPORT

Internal sources

- School of Dentistry, The University of Manchester, UK.
- Manchester Academic Health Sciences Centre (MAHSC), UK.

The Cochrane Oral Health Group is supported by MAHSC and the NIHR Manchester Biomedical Research Centre

External sources

- Cochrane Oral Health Group Global Alliance, UK.

All reviews in the Cochrane Oral Health Group are supported by Global Alliance member organisations (British Orthodontic Society, UK; British Society of Paediatric Dentistry, UK; British Society of Periodontology, UK; Canadian Dental Hygienists Association, Canada; National Center for Dental Hygiene Research & Practice, USA; New York University College of Dentistry, USA; and Royal College of Surgeons of Edinburgh, UK) providing funding for the editorial process (<http://ohg.cochrane.org/>)

- National Institute for Health Research (NIHR), UK.

CRG funding acknowledgement:

The NIHR is the largest single funder of the Cochrane Oral Health Group

Disclaimer:

The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the NIHR, NHS or the Department of Health

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

None.

INDEX TERMS

Medical Subject Headings (MeSH)

*Alveolar Ridge Augmentation; *Dental Implants; Bone Transplantation; Dental Implantation, Endosseous [*methods]; Dental Prosthesis, Implant-Supported; Jaw, Edentulous [*rehabilitation]

MeSH check words

Humans