Interventions for replacing missing teeth: different types of dental implants (Review)

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  1 Implant failure: 1 year.
  2 Implant failure: 3 years.
  3 Implant failure: 5 years.
  4 Implant failure: 10 years.
Analysis 1.2. Comparison 1 Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws, Outcome
  1 Implant failure: 1 year.
  2 Implant failure: 3 years.
  3 Implant failure: 5 years.
  4 Implant failure: 10 years.
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  3 Implant failure: 5 years.
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ABSTRACT

Background

Dental implants are available in different materials, shapes and with different surface characteristics. In particular, numerous implant designs and surface modifications have been developed for improving clinical outcome. This is an update of a Cochrane review first published in 2002, and previously updated in 2003, 2005 and 2007.

Objectives

Primary: to compare the clinical effects of different root-formed osseointegrated dental implant types for replacing missing teeth for the following specific comparisons: implants with different surface preparations, but having similar shape and material; implants with different shapes, but having similar surface preparation and material; implants made of different materials, but having similar surface preparation and shape; different implant types differing in surface preparation, shape, material or a combination of these.

Secondary: to compare turned and roughened dental implants for occurrence of early implant failure (before prosthetic loading) and occurrence of peri-implantitis.

Search methods

We searched the following electronic databases: the Cochrane Oral Health Group's Trials Register (to 17 January 2014), the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library 2013, Issue 12), MEDLINE via OVID (1946 to 17 January 2014) and EMBASE via OVID (1980 to 17 January 2014). We placed no restrictions on the language or date of publication when searching the electronic databases.

Selection criteria

We included any randomised controlled trial (RCT) comparing osseointegrated dental implants of different materials, shapes and surface properties having a follow-up in function of at least one year. Outcome measures were success of the implants, radiographic peri-implant marginal bone levels changes and incidence of peri-implantitis.
Data collection and analysis

At least two review authors independently conducted screening, risk of bias assessment and data extraction of eligible trials in duplicate. We expressed results using fixed-effect models (if up to three studies were present in a meta-analysis) or random-effects models (when there were more than three studies) using mean differences (MD) for continuous outcomes and risk ratios (RR) for dichotomous outcomes with 95% confidence intervals (CI). We reported the following endpoints: one, three, five and 10 years after functional loading.

Main results

We identified 81 different RCTs. We included 27 of these RCTs, reporting results from 1512 participants and 3230 implants in the review. We compared 38 different implant types with a follow-up ranging from one to 10 years. All implants were made of commercially pure titanium or its alloys, and had different shapes and surface preparations. We judged two trials to be at low risk of bias, 10 to be at unclear risk of bias and 15 to be at high risk of bias. On a ‘per participant’ rather than ‘per implant’ basis, we found no significant differences between various implant types for implant failures. The only observed statistically significant difference for the primary objective regarded more peri-implant bone loss at Nobel Speedy Groovy implants when compared with NobelActive implants (MD -0.59 mm; 95% CI -0.74 to -0.44, different implant shapes). The only observed statistically significant difference for the secondary objective was that implants with turned (smoother) surfaces had a 20% reduction in risk to be affected by peri-implantitis than implants with rough surfaces three years after loading (RR 0.80; 95% CI 0.67 to 0.96). There was a tendency for implants with turned surfaces to fail early more often than implants with roughened surfaces.

Authors' conclusions

Based on the results of the included RCTs, we found no evidence showing that any particular type of dental implant had superior long-term success. There was limited evidence showing that implants with relatively smooth (turned) surfaces were less prone to lose bone due to chronic infection (peri-implantitis) than implants with much rougher surfaces (titanium-plasma-sprayed). These findings were based on several RCTs, often at high risk of bias, with few participants and relatively short follow-up periods.

Plain Language Summary

Interventions for replacing missing teeth: different types of dental implants

Review question

To compare the effects of different dental implants. These are implanted into bone and vary primarily in their shape, material and type of surface.

Background

Missing teeth can sometimes be replaced with dental implants into the jaw, as bone can grow around the implant. A crown, bridge or denture can then be attached to the implant. Many implant modifications have been developed trying to improve the long-term success rates of implants, and different types have been heavily marketed. More than 1300 types of dental implants are available, in different materials, shapes, sizes, lengths and with different surface characteristics or coatings.

Study characteristics

This review of existing studies was carried out by the Cochrane Oral Health Group and the evidence is current up to 17 January 2014. We searched scientific databases for randomised controlled trials (studies where people are randomly put into one of two or more treatment groups) comparing different types of dental implants in people who were followed up for at least one year.

We found 27 trials based in a wide range of countries - six in Italy; five in New Zealand, five in Sweden, three in the Netherlands, two in Korea, one in Turkey, one in Germany, one in Switzerland and three multicentre European trials. Most took place at university dental clinics or hospitals, four were run in private practice and, in the multicentre European trials, a few were also in private practice.

There were comparisons made of 38 implant types with different surface characteristics, shapes, degree of titanium (metal) purity and titanium alloys (mixtures of metal). The main outcome of the trials was failure of the implant to work.

Key results
The review found there was not enough evidence from trials to demonstrate superiority of any particular type of implant characteristic or implant system over another.

There was no evidence showing that any particular type of dental implant had greater long-term success. There was limited evidence showing that implants with relatively smooth surfaces were less prone to lose bone due to chronic infection (peri-implantitis) than implants with much rougher surfaces. However, the evidence suggests they may fail earlier than implants with roughened surfaces.

Quality of the evidence

Two trials were at low risk of bias, 10 were at unclear risk of bias and 15 were at high risk of bias.

Most of the trials were underpowered, which means that there were not enough participants in the studies to be able to draw firm conclusions. Caution should be exercised when generalising the results of the included trials to ordinary clinical conditions.
## SUMMARY OF FINDINGS FOR THE MAIN COMPARISON

**Implant type A compared with implant type B for implant failure and bone loss**

**Patient or population:** adults with missing teeth  
**Settings:** dental clinics  
**Intervention:** implant A  
**Comparison:** implant B

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk</td>
<td>Corresponding risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implant failure</td>
<td>-</td>
<td>-</td>
<td>See comments</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bone level change</td>
<td>-</td>
<td>-</td>
<td>See comments</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

There were numerous comparisons between different implants that varied by surface preparation, shape, material and type, only 1 of these varying for each comparison. Most of the comparisons were single studies. There were no statistically significant differences for implant failure.
only 1 statistically significant difference for bone level change from 1 single study, which indicated more bone loss for Nobel Active than Nobel Speedy Groovy (MD 0.59 mm; 95% CI 0.44 to 0.74)

*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) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; MD: mean difference.

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.
BACKGROUND

Description of the condition
Missing teeth may result in a functional and aesthetic deficit and have traditionally been replaced with dentures or bridges. Dental implants offer an alternative; they are inserted into the jawbones and used to support dental prostheses. Dental implants rely on the maintenance of a direct structural and functional connection between living bone and the implant surface; this is termed osseointegration and was first described by Brånemark (Brånemark 1977). Osseointegration has undoubtedly been one of the most significant scientific breakthroughs in dentistry over since the early 1960s.

Description of the intervention
Osseointegrated dental implants are available in different materials, body shapes, diameters, lengths, platforms, surface properties and coatings. In particular, the area of implant surface modifications and coatings has been subjected to aggressive marketing aimed at establishing the superiority of a given surface over the others. In implant dentistry, the word ‘machined’ has frequently been used as a description of a turned, milled or polished surface. However, a machined surface can be anything produced by a machine and surfaces produced with electro discharge, polish, ground, honed and sand blasting are all examples of machined surfaces (Stout 1990). Numerous surface modifications including turned, blasted, acid-etched, porous-sintered, oxidised, plasma-sprayed, laser modified, hydroxyapatite-coated surfaces, highly hydrophilic or a combination of these procedures have been developed and are currently used with the aim of enhancing clinical performance. In addition, different materials are used to manufacture dental implants including: titanium with various degree of purity, titanium alloys (e.g. Ti6Al4V) and ceramics (e.g. zirconia). It has been estimated that dentists have to choose from more than 1300 types of implants that vary in form, material, dimension, surface properties and interface geometry (Binon 2000).

Originally, Brånemark implants had machined (turned) surfaces. Turned surfaces are those originally formed by the milling (machining) procedure of the titanium bar and are considered to be smooth surfaces. It was believed that rougher surfaces could improve the osseointegration process by allowing more bone to be in contact with the implant surface determining also an increased mechanical retention. Following this concept, many procedures were developed to roughen implant surfaces; however, one potential drawback was empirically observed: a suspected increased incidence of peri-implantitis when compared with implants with turned surfaces (Esposito 1997). Peri-implantitis can be defined as “a site specific, plaque-induced infection with progressive loss of the bone supporting a functioning implant” (Esposito 1999). This chronic infection affects at least 16% of people rehabilitated with implants having turned surfaces after nine to 14 years in function in one retrospective evaluation (Roos-Jansåker 2006). Turned implant surfaces are those considered to be less susceptible to peri-implantitis, and there is the potential risk that implants with roughened surfaces could be at higher risk for peri-implantitis.

Why it is important to do this review
In addition, because of the aggressive marketing, it is unclear whether there are implant surface modifications, implant shapes or particular materials that can actually improve clinical results. If this is the case, then clinicians and patients could choose which dental implant system to use, if not, it would still be useful to know that many modifications do not substantially alter the clinical outcomes. It would be also very useful to understand to which degree the roughening of implant surfaces could be advantageous in the long term.

OBJECTIVES

Primary objectives
To compare the clinical effects of different root-formed osseointegrated dental implant types for replacing missing teeth for the following specific comparisons:
1. implants with different surface preparations, but having similar shape and material;
2. implants with different shapes, but having similar surface preparation and material;
3. implants made of different materials, but having similar surface preparation and shape;
4. different implant types differing in surface preparation or shape or material, or a combination of these.

Secondary objectives
To compare turned and roughened dental implants for occurrence of early implant failure (before prosthetic loading) and occurrence of peri-implantitis.

METHODS

Criteria for considering studies for this review
Types of studies

Any randomised controlled trial (RCT) of parallel group and split-mouth design comparing identical dental implants positioned in the same way differing only for:

- surfaces;
- shapes;
- material.

Any RCT comparing different dental implant systems. We excluded quasi-randomised trials.

Types of participants

People who received osseointegrated root-formed dental implants followed up for at least one year after functional loading.

Types of interventions

Different dental implants (shape, material and surface characteristics) for replacing missing teeth.

Types of outcome measures

Primary outcome

- Biological or mechanical implant failure defined as:
  - biological failure: implant mobility and removal of stable implants dictated by progressive marginal bone loss or infection. Biological failures were divided in early (failure to establish osseointegration) and late failures (failure to maintain the established osseointegration). Failures that occurred before prosthesis delivery or, in the case of immediate or early-loaded implants a few months after prosthesis insertion, were considered early failures. Implant mobility could be assessed manually or with instruments such as Periotest or resonance frequency (Ostell), with the prosthesis removed with the exception of single implants;
  - mechanical failure: implant fracture and any other mechanical complication not allowing use of the implant.

Secondary outcomes

- Radiographic peri-implant marginal bone level changes on periapical radiographs taken with a paralleling technique. The baseline radiographs had to have been taken at implant placement.
- Occurrence of peri-implantitis defined as implants affected by progressive peri-implant marginal bone loss with signs of infection (only for the secondary objective).

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 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 (Higgins 2011). Details of the MEDLINE search are provided in Appendix 1. We linked the EMBASE search to the Cochrane Oral Health Group's filter for identifying clinical trials (Appendix 2).

Electronic searches

We searched the following electronic databases:

- the Cochrane Oral Health Group's Trials Register (to 17 January 2014) (Appendix 3);
- the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library 2013, Issue 12) (Appendix 4);
- MEDLINE via OVID (1946 to 17 January 2014) (Appendix 1);

Language

We did not place any restrictions on language or date of publication when searching the electronic databases.

Unpublished studies

We wrote to all the authors of the identified RCTs, we checked the bibliographies of all identified RCTs and relevant review articles, and we used 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 groups.com); however, we discontinued this due to poor yield.

Handsearching

Details of the journals being handsearched by the Cochrane Oral Health Group's ongoing programme are given on the website: www.ohg.cochrane.org.

We identified the following journals as being potentially important to be handsearched for this review: British Journal of Oral and Maxillofacial Surgery, Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, European Journal of Oral...
Data collection and analysis

Study selection
At least two review authors independently scanned the titles and abstracts (when available) of all reports identified through the electronic searches. 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, we obtained the full report. At least two review authors independently assessed the full reports to establish whether they met the inclusion criteria or not. We resolved disagreements by discussion. Where resolution was not possible, we consulted a third review author. We assessed risk of bias and extracted data of all studies meeting the inclusion criteria. We recorded studies rejected at this or subsequent stages in the Characteristics of excluded studies table, and gave reasons for exclusion.

Data extraction and management
At least two review authors independently extracted data using specially designed data extraction forms. We had piloted the data extraction forms on several papers and modified them as required before use. We resolved any disagreements by discussion and consulted a third review author where necessary. We contacted authors for clarification or missing information.

For each trial, we recorded the following data:
- year of publication, country of origin and source of study funding;
- details of the participants including demographic characteristics, source of recruitment and criteria for inclusion;
- details of the type of intervention;
- details of the outcomes reported, including method of assessment, and time intervals.

Assessment of risk of bias in included studies
Two review authors independently undertook the risk of bias assessment of the included trials in duplicate as part of the data extraction process. In the case that the paper to be assessed had one or more review authors in the authors list, only those review authors not involved in the trial evaluated it.

We used the recommended approach for assessing risk of bias in studies included in Cochrane reviews (Higgins 2011). It is a two-part tool, addressing the six specific domains (namely, sequence generation, allocation concealment, blinding of the outcome assessor, 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. This is achieved by answering pre-specified questions about the adequacy of the study in relation to the entry.

Summarising risk of bias for a study
After taking into account the additional information provided by the authors of the trials, we grouped studies into the following categories. We assumed that the risk of bias was the same for all outcomes and each study was assessed as follows.

<table>
<thead>
<tr>
<th>Risk of bias</th>
<th>Interpretation</th>
<th>Within a study</th>
<th>Across studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk of bias</td>
<td>Plausible bias unlikely to seriously alter the results</td>
<td>Low risk of bias for all key domains</td>
<td>Most information was from studies at low risk of bias</td>
</tr>
<tr>
<td>Unclear risk of bias</td>
<td>Plausible bias that raises some doubt about the results</td>
<td>Unclear risk of bias for 1 or more key domains</td>
<td>Most information was from studies at low or unclear risk of bias</td>
</tr>
<tr>
<td>High risk of bias</td>
<td>Plausible bias that seriously weakens confidence in the results</td>
<td>High risk of bias for 1 or more key domains</td>
<td>The proportion of information from studies at high risk of bias was sufficient to affect the interpretation of results</td>
</tr>
</tbody>
</table>
Measure of treatment effect
For dichotomous outcomes, we expressed the estimate of effect of an intervention as risk ratios (RR) together with 95% confidence intervals (CIs). For continuous outcomes, we used mean differences (MD) and standard deviations to summarise the data for each group and express it as MD and 95% CIs.

Unit of analysis issues
The statistical unit was the participant and not the implant unless the clustering of the implants within the participants had been taken into account in the analysis.

Dealing with missing data
We contacted trial authors to retrieve missing data where necessary. If we could not reach agreement, we excluded data until further clarification was available. We would have used methods for estimating missing standard deviations in Section 7.7.3 of the Cochrane Handbook for Systematic Reviews of Interventions if required (Higgins 2011).

Assessment of heterogeneity
We would have assessed the significance of any discrepancies in the estimates of the treatment effects from the different trials by means of Cochran's test for heterogeneity and heterogeneity would have been considered significant if P value < 0.1. We would have used the I² statistic, which describes the percentage total variation across studies that is due to heterogeneity rather than chance, to quantify heterogeneity with an I² statistic over 50% being considered substantial heterogeneity.

Assessment of reporting biases
If there had been sufficient numbers of trials (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 we had identified asymmetry, we would have examined possible causes.

Data synthesis
We only performed a meta-analysis if there were studies of similar comparisons reporting the same outcome measures. We combined RRs for dichotomous data, and MDs for continuous data, using fixed-effect models. We used random-effects models when there were more than three studies in a meta-analysis. We combined data from split-mouth studies with data from parallel group trials using the method outlined by Elbourne (Elbourne 2002), using the generic inverse variance method in Review Manager (RevMan 2012). We used the techniques described by Follmann to estimate the standard error of the difference for split-mouth studies, where the appropriate data were not presented and could not be obtained (Follmann 1992). We would have calculated numbers needed to treat for an additional beneficial outcome (NNTB) for people affected by implant failures. We followed the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions for RCTs with parallel design with zero-cell counts (Higgins 2011). We added the fixed value of 0.5 to all cells with zero-cell counts and calculated RRs using Review Manager software (RevMan 2012). If there were no events in both arms, we undertook no calculations, because in this situation the study does not provide any indication of the direction or magnitude of the relative treatment effect. We presented data that could not be meta-analysed in an additional table.

Subgroup analysis and investigation of heterogeneity
We would have assessed clinical heterogeneity by examining the types of participants and interventions for all outcomes in each study. We planned the following subgroup analyses only for trials included to answer the primary hypothesis; however, we found insufficient studies in the meta-analysis to undertake this.
1. Whether implants were placed in mandibles or maxillae.
2. Whether implants were placed in partially or fully edentulous jaws.
3. Different number of placed implants (for instance overdentures supported by two versus overdentures supported by four implants).
4. Whether the implants were immediately placed in tooth extraction sockets or not.
5. Whether the implants were placed in anterior or posterior areas of the jaw.
6. Whether the implants were placed in augmented (grafted or regenerated) bone or not.
7. Whether the implants were placed with a submerged or non-submerged technique.
8. Whether the implants were loaded at different times: immediate loading (up to one week) and conventional loading (three months or more for mandibles and six months or more for maxillae).
9. Different prosthetic designs (for instance overdentures versus screw-retained dentures or implant-supported bridges versus bridges supported by both implants and teeth).
10. Whether the trial was supported by implant manufacturer(s) or not.

Sensitivity analyses
We planned to undertake sensitivity analyses to examine the effect of the risk of bias on the overall estimates of effect. In addition, we planned to examine the effect of including unpublished literature...
on the review’s findings. However, we found too few trials in the meta-analyses to undertake these analyses to investigate to what extent the risk of bias might have influenced the results. We will do this in future updates as soon as a sufficient number of trials having different risk of bias are available.

Presentation of main results
We produced ‘Summary of findings’ tables for the main outcomes of this review using GRADEpro software. We assessed the quality of the body of evidence by considering 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. We categorised the quality of the body of evidence for each of the primary outcomes as high, moderate, low or very low.

RESULTS

Description of studies

Results of the search
The search for this review was part of a wider search for all eligible trials for the series of Cochrane reviews on dental implants. This search is conducted every six months and has so far included about 8600 records.

Included studies
See Characteristics of included studies table.

We identified 27 trials to be included in the review (Batenburg 1998; Astrand 1999; Moberg 2001; Tawse-Smith 2001; Astrand 2002; Gatti 2002; Heydenrijk 2002; Tawse-Smith 2002; Payne 2003; Payne 2004; Wennström 2004; Fröberg 2006; Lang 2007; Lee 2007; Schincaglia 2007; Crespi 2009; Kielbassa 2009; Prosper 2011; Heberer 2011; Al-Nawas 2012; Esposito 2012; Esposito 2013a; Pozzi 2014).

Characteristics of trial setting and investigators
- Of the 27 included trials, six were conducted in Italy (Gatti 2002; Schincaglia 2007; Crespi 2009; Prosper 2009; Esposito 2012; Pozzi 2014), five in New Zealand (Tawse-Smith 2001; Tawse-Smith 2002; Payne 2003; Payne 2004; Alsabeeha 2011), five in Sweden (Astrand 1999; Moberg 2001; Astrand 2002; Wennström 2004; Fröberg 2006), three in the Netherlands (Batenburg 1998; Heydenrijk 2002; den Hartog 2011), two in Korea (Lee 2007; Song 2009), one in Turkey (Akoglu 2011), one in Germany (Heberer 2011), and one in Switzerland (Esposito 2013a). Three were multicentre European trials (Lang 2007; Kielbassa 2009; Al-Nawas 2012).
- Sixteen trials had a parallel group study design and 11 had a split-mouth design (Astrand 2002; Wennström 2004; Fröberg 2006; Lee 2007; Schincaglia 2007; Prosper 2009; Song 2009; Heberer 2011; Al-Nawas 2012; Esposito 2013a; Pozzi 2014).
- All trials were conducted at university dental clinics or hospitals with eight exceptions: four trials were conducted in private practices (Gatti 2002; Fröberg 2006; Esposito 2012; Esposito 2013a) and four multicentre trials in which a few centres were private practices (Lang 2007; Prosper 2009; Al-Nawas 2012; Pozzi 2014). All studies included adults only.

Characteristics of interventions
Thirty-eight implant types with different surface characteristics, shapes, degree of titanium purity and titanium alloys were compared.

1. Ankylos Plus® grit-blasted and high temperature etched surface, titanium grade 2 cylindrical screws with internal conical connection (Dentsply-Friadent, Mannheim, Germany) (Crespi 2009) (Figure 1; Figure 2).
Figure 1. Ankylos Plus® grit-blasted and high-temperature etched surface, titanium grade 2 cylindrical screws with internal conical connection (Dentsply-Friadent, Mannheim, Germany).

Figure 2. Radiographic image: Ankylos Plus® grit-blasted and high-temperature etched surface, titanium grade 2 cylindrical screws with internal conical connection (Dentsply-Friadent, Mannheim, Germany).

1. Astra® turned titanium grade 3 cylindrical screws with internal connection (Astra Tech AB, Mölndal, Sweden) (Wennström 2004) as in Figure 3 but with turned surface (Figure 4).
1. Astra® TiO\textsubscript{2}-blast titanium grade 3 cylindrical screws with internal connection (Astra Tech AB) (Astrand 1999; Wennström 2004; Lee 2007; Akoglu 2011) (Figure 3; Figure 4).

2. Astra® TiO\textsubscript{2}-blast titanium grade 3 tapered screws with internal connection (Astra Tech AB) (Lee 2007) (Figure 5; Figure 6).
Figure 5. Astra® TiO2-blast titanium grade 3 tapered screws with internal connection (Astra Tech AB).

Figure 6. Radiographic image: Astra® TiO2-blast titanium grade 3 tapered screws with internal connection (Astra Tech AB).

1. Brånemark® Standard turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden) (Batenburg 1998; Moberg 2001) (Figure 7; Figure 8).

Figure 7. Brånemark® Standard turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).
1. Brånemark® Mark II turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB) (Astrand 1999; Astrand 2002; Gatti 2002) (Figure 9; Figure 10).

Figure 8. Radiographic image: Brånemark® Standard turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

Figure 9. Brånemark® Mark II type turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).
Figure 10. Radiographic image: Brånemark® Mark II type turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB).

1. Brånemark® conical transmucosal turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB) (Gatti 2002) (Figure 11).

Figure 11. Brånemark® conical transmucosal turned titanium grade 1 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

1. Brånemark® Mark III turned titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB) (Fröberg 2006) (Figure 12; Figure 13).
Figure 12. Brånemark® Mark III type turned titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

Figure 13. Radiographic image: Brånemark® Mark III type turned titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

1. Brånemark® Mark III TiUnite oxidised titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB) (Fröberg 2006) (Figure 14; Figure 15).
Figure 14. Brånemark® Mark III TiUnite oxidised titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

Figure 15. Radiographic image: Brånemark® Mark III TiUnite oxidised titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

1. Brånemark® Mark IV turned titanium grade 4 screws with external hexagon (Nobel Biocare AB) (Schincaglia 2007) (Figure 16; Figure 17).
1. Bränemark® Mark IV TiUnite oxidised titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB) (Payne 2004; Schincaglia 2007) (Figure 18; Figure 19).
Figure 18. Brånemark® Mark IV TiUnite oxidised titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

Figure 19. Radiographic image: Brånemark® Mark IV TiUnite oxidised titanium grade 4 cylindrical screws with external hexagon (Nobel Biocare AB, Göteborg, Sweden).

1. NobelActive® TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB) (Kielbassa 2009; Pozzi 2014) (Figure 20; Figure 21).
Figure 20. NobelActive® TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB, Göteborg, Sweden).

Figure 21. Radiographic image: NobelActive® TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB, Göteborg, Sweden).

1. NobelActive® TiUnite oxidised titanium grade 4 tapered screws with external hexagon (Nobel Biocare AB) (Kielbassa 2009) (Figure 22).
1. NobelReplace® Tapered Groovy TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB) (Kielbassa 2009; den Hartog 2011) (Figure 23; Figure 24).

Figure 23. NobelReplace® Tapered Groovy TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB, Göteborg, Sweden).
1. Replace® Select Tapered TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB) (den Hartog 2011) (Figure 25; Figure 26).

Figure 24. Radiographic image: NobelReplace® Tapered Groovy TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB, Göteborg, Sweden).

Figure 25. Replace® Select Tapered TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB, Göteborg, Sweden).
1. Nobel Speedy Groovy TiUnite oxidised titanium grade 4 tapered screws with external connection (Nobel Biocare AB) (Pozzi 2014) (Figure 27; Figure 28).

Figure 27. Nobel Speedy Groovy TiUnite oxidised titanium grade 4 tapered screws with external connection (Nobel Biocare AB, Göteborg, Sweden).
Figure 28. Radiographic image: Nobel Speedy Groovy TiUnite oxidised titanium grade 4 tapered screws with external connection (Nobel Biocare AB, Göteborg, Sweden).

Figure 29. Implantium® sand-blasted, large grit, acid-etched (SLA) titanium grade 4 cylindrical screws with microthreads 0.5 mm below the top of the implant and internal connection (Dentium, Seoul, Korea) (Song 2009) (Figure 29).

Figure 30. Implantium® SLA titanium grade 4 cylindrical screws with microthreads to top of the implant and internal connection (Dentium) (Song 2009) (Figure 30).
Figure 30. Implantium® SLA titanium grade 4 cylindrical screws with microthreads to top of the implant and internal connection (Dentium, Seoul, Korea).

Figure 31. IMZ® TPS (titanium plasma-sprayed) titanium grade 2 cylindrical screws with internal interlocking connection (Friedrichsfeld AG, Mannheim, Germany) (Batenburg 1998; Heydentjik 2002) (Figure 31; Figure 32).

1. IMZ® TPS (titanium plasma-sprayed) titanium grade 2 cylindrical screws with internal interlocking connection (Friedrichsfeld AG, Mannheim, Germany) (Batenburg 1998; Heydentjik 2002) (Figure 31; Figure 32).
Figure 32. Radiographic image: IMZ® TPS (titanium plasma-sprayed) titanium grade 2 cylinders with internal interlocking connection (Friedrichsfeld AG, Mannheim, Germany).

1. ITI® TPS titanium grade 4 cylindrical screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland) (Astrand 2002; Heydenrijk 2002; Payne 2003) (Figure 33; Figure 34).

Figure 33. ITI® TPS titanium grade 4 cylindrical screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland).
1. ITI® TPS titanium grade 4 cylindrical hollow screws with internal connection (Institut Straumann AG) (Batenburg 1998; Moberg 2001) (Figure 35).

Figure 35. Radiographic image: ITI® TPS titanium grade 4 cylindrical hollow screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland).

1. ITI® SLA titanium grade 4 cylindrical solid screws with internal connection with a 2.8-mm turned neck (Institut Straumann AG) (Lang 2007; Akoglu 2011; Heberer 2011) (Figure 36; Figure 37).
Figure 36. ITI® SLA/ SLActive titanium grade 4 cylindrical screws with internal connection with a 2.8 mm turned neck (Institut Straumann AG, Waldenburg, Switzerland).

Figure 37. Radiographic image: ITI® SLA/ SLActive titanium grade 4 cylindrical screws with internal connection with a 2.8 mm turned neck (Institut Straumann AG, Waldenburg, Switzerland).

1. ITI® SLA solid titanium grade 4 tapered screws with internal connection (Institut Straumann AG) (Lang 2007) (Figure 38; Figure 39).
Figure 38. ITI® SLA/ SLActive/ Roxolid solid titanium grade 4 tapered screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland).

Figure 39. Radiographic image: ITI® SLA/ SLActive/ Roxolid solid titanium grade 4 tapered screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland).

1. ITI® SLActive solid titanium grade 4 cylindrical screws with internal connection (Institut Straumann AG) (Heberer 2011) (Figure 36; Figure 37).
2. ITI® SLActive solid titanium grade 4 tapered screws with internal connection (Institut Straumann AG) (Al-Nawas 2012) (Figure 38; Figure 39).
3. ITI® Roxolid™ SLActive solid titanium grade 4 tapered screws with internal connection (Institut Straumann AG) (Al-Nawas 2012) (Figure 38; Figure 39).
4. MegaGen EZ Plus titanium grade 4 tapered screw with internal connection (MegaGen Implant, Gyeongbuk, South Korea) (Esposito 2012) (Figure 40).
1. MegaGen EZ Plus Xpeed titanium grade 4 tapered screw with internal connection (MegaGen Implant) (Esposito 2012) (Figure 41).

Figure 41. MegaGen EZ Plus Xpeed titanium grade 4 tapered screw with internal connection (MegaGen Implant, Gyeongbuk, South Korea).

1. Neoss sand-blasted, acid-etched titanium grade 4 cylindrical screws with internal connection (Neoss Ltd, Harrogate, UK) (Alsabeeha 2011) (Figure 42; Figure 43).
1. Seven TPS titanium grade 4 screws with external hexagon (Sweden & Martina, Padua, Italy) (Crespi 2009) (Figure 44).
1. Southern® sand-blasted titanium grade 4 cylindrical screws with external hexagon (Southern Implants, Irene, South Africa) (Tawse-Smith 2001; Tawse-Smith 2002; Payne 2003; Payne 2004; Alsabeeha 2011) (Figure 45).

Figure 45. Southern® sand-blasted titanium grade 4 cylindrical screws with external connection (Southern Implants, Irene, South Africa).

1. Southern® sand-blasted titanium grade 4 8-mm wide tapered screws with external hexagon (Southern Implants) (Alsabeeha 2011) (Figure 46).
1. SPI® Element implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Thommen Medical, Waldeburg, Switzerland) (Esposito 2013a) (Figure 47; Figure 48).

Figure 46. Southern® sand-blasted titanium grade 4 8mm wide tapered screws with external connection (Southern Implants, Irene, South Africa).

Figure 47. SPI® Element implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Thommen Medical, Waldeburg, Switzerland).
Figure 48. Radiographic image: SPI® Element implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Thommen Medical, Waldeburg, Switzerland).

1. SPI® Element implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Thommen Medical) treated with a monolayer of permanently bound multi-phosphonic acid molecules (Nano Bridging Molecules, Gland, Switzerland) (Esposito 2013a) (Figure 49; Figure 50).

Figure 49. SPI® Element implant SurfLink treated titanium grade 4 cylindrical screw with internal connection (Thommen Medical, Waldeburg, Switzerland).
Figure 50. Radiographic image: SPI® Element implant SurfLink treated titanium grade 4 cylindrical screw with internal connection (Thommen Medical, Waldeburg, Switzerland).

1. Steri-Oss® HL series, 3.8-mm diameter acid-etched titanium grade 5 cylindrical screws with external hexagon (Steri-Oss, Yorba Linda, CA, USA) (Tawse-Smith 2001; Tawse-Smith 2002) (Figure 51; Figure 52).

Figure 51. Steri-Oss® HL series, 3.8 mm in diameter acid-etched titanium grade 5 cylindrical screws with external connection (Steri-Oss, Yorba Linda, CA, USA).
Figure 52. Radiographic image: Steri-Oss® HL series, 3.8 mm in diameter acid-etched titanium grade 5 cylindrical screws with external connection (Steri-Oss, Yorba Linda, CA, USA).

1. SwissPlus® sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Zimmer Dental Inc. Calsbad, USA) (Akoglu 2011) (Figure 53).

Figure 53. SwissPlus® sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Zimmer Dental Inc. Calsbad, USA).

1. WINSIX® implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Winsix Ltd, London, UK) (Prosper 2009) (Figure 54).
Figure 54. WINSIX® implant sand-blasted acid-etched titanium grade 4 tapered screw with internal connection (Winsix Ltd, London, UK).
1. WINSIX® implant sand-blasted acid-etched titanium grade 4 tapered screw with internal connection (Winsix Ltd) (Prosper 2009) (Figure 55).

Figure 55. WINSIX® implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Winsix Ltd, London, UK).

Participant inclusion criteria
We included people with the following edentulism types.

- Edentulous maxillae (Payne 2004). In this trial, maxillae were treated either with a ridge expansion osteotomy or a combined ridge split and osteotomy procedure, depending on the ridge buccal-palatal width and the degree of ridge resorption. Autogenous bone grafts were used to fill intraosseous grooves of the ridge split-cases.
- Fully or partially edentulous maxillae (Esposito 2012).
- Partially edentulous jaws (Wennström 2004; Lee 2007; Crespi 2009; Kielbassa 2009; Prosper 2009; Song 2009; Heberer 2011; Esposito 2013a). In one trial, implants were placed in fresh extraction sockets without any bone augmentation procedure (Crespi 2009).
- Partially edentulous maxillae (Astrand 2002).
- Partially edentulous posterior mandibles (Schincaglia 2007; Pozzi 2014).
- Single implants in both jaws (Lang 2007), or in the anterior maxilla (den Hartog 2011). In one trial, implants were placed in fresh extraction sockets that could be augmented with anorganic bovine bone and bioresorbable barriers (Lang 2007).
Loading time

- Immediate loading (Gatti 2002; Fröberg 2006; Schincaglia 2007; Crespi 2009; Kielbassa 2009).
- Early loading (Tawse-Smith 2002; Payne 2003; Payne 2004; den Hartog 2011). More specifically: two weeks (Payne 2003); six weeks (Tawse-Smith 2002; Alsabeeha 2011); six to 10 weeks in the mandible and nine to 14 weeks in the maxilla (Heberer 2011; Esposito 2012); eight weeks (Akoglu 2011; Al-Nawas 2012); and 12 weeks after placement (Payne 2004; den Hartog 2011).
- Conventional loading (at least three months in the mandible and six months in the maxilla) (Batenburg 1998; Astrand 1999; Moberg 2001; Tawse-Smith 2001; Heydenrijk 2002; Wennström 2004; Fröberg 2006; Lee 2007; Prosper 2009; Song 2009; Esposito 2013a; Pozzi 2014).

Prosthetic design

- Screw-retained cross-arch fixed prostheses on four to six implants (Astrand 1999; Moberg 2001; Fröberg 2006; Heberer 2011).
- Bar-retained overdentures supported by two implants (Batenburg 1998; Heydenrijk 2002), or four implants (Gatti 2002), or on unspecified number of implants (Heberer 2011).
- Overdentures retained by one ball or locator attachment (Alsabeeha 2011), two locator attachments (Al-Nawas 2012), two ball attachments (Tawse-Smith 2001; Tawse-Smith 2002; Payne 2003; Akoglu 2011), or three ball attachments (Payne 2004).
- Single crowns and fixed prostheses supported up to six implants (Esposito 2012).
- Crowns cemented on single implants (Lang 2007; Crespi 2009; Kielbassa 2009; Prosper 2009; den Hartog 2011; Esposito 2013a; Pozzi 2014).

Characteristics of outcome measures

The primary outcome (biological and mechanical failures) was recorded in all trials with one exception (Wennström 2004), for which the author did no reply whether they removed or not the screw-retained partial fixed prostheses to evaluate implant stability. Occurrence of peri-implantitis was mentioned in only four trials comparing implants with turned surfaced with implants with roughened surfaces (Astrand 1999; Moberg 2001; Astrand 2002; Schincaglia 2007). Another trial reported the number of people who had lost implants for peri-implantitis at 10 years, but not on the occurrence of peri-implantitis and when it occurred (Batenburg 1998). No reply to our request of clarification was provided.

The secondary outcomes (bone level measurements) were recorded in all trials. However, in four trials, peri-implant bone level measurements were fully or partially performed on panoramic radiographs (Moberg 2001; Gatti 2002; Heberer 2011; Al-Nawas 2012), in 10 trials, baseline radiographs were taken at implant loading (Batenburg 1998; Tawse-Smith 2001; Astrand 2002; Tawse-Smith 2002; Payne 2004; Wennström 2004; Lee 2007; Song 2009; Akoglu 2011; Alsabeeha 2011), and in one trial, they were not presented as mean values but as frequencies (Prosper 2009). Such bone level measurements were considered to be inaccurate either for the quality of the radiographs or for not using the proper baseline and were not included in the present analyses. In one trial, the measurements of 78 implant surfaces out of 178 were missing, therefore the radiographic data were not used (Fröberg 2006). In two trials, bone level assessment was calculated on a site basis (only for three year data Kielbassa 2009) and the authors were not able to supply the required data (participant basis) (Heydenrijk 2002; Kielbassa 2009). The five-year data of another trial were not used since the authors published separate data for maxillae and mandibles (Astrand 1999), while we requested combined data, which were not supplied. The three-year data of a split-mouth study could not be used since we did not have the standard deviation of the difference (Astrand 2002). Bone level changes data were not yet available for one ongoing study (Lang 2007).

Duration of follow-up after implant loading

- One year (Payne 2004; Lang 2007; Kielbassa 2009; Song 2009; Alsabeeha 2011; Heberer 2011; Al-Nawas 2012; Esposito 2012; Esposito 2013a; Pozzi 2014).
- Fifteen months (den Hartog 2011).
- Eighteen months (Fröberg 2006; Prosper 2009).
- Two years (Gatti 2002; Crespi 2009).
- Three years (Moberg 2001; Astrand 2002; Lee 2007; Schincaglia 2007).
- Ten years (Batenburg 1998; Tawse-Smith 2001; Tawse-Smith 2002; Payne 2003).

Sample size

Only seven studies undertook a priori sample size calculations (Astrand 1999; Astrand 2002; Schincaglia 2007; Kielbassa 2009; Song 2009; den Hartog 2011; Pozzi 2014). The sample size was calculated to detect a true difference of 0.3 mm in Astrand 2002, 0.4 mm in Astrand 1999, and 0.5 mm in den Hartog 2011; Pozzi 2014 in marginal bone levels thought to be of clinical significance. Another study calculated the sample size considering the implant as statistical unit but this was not correct (Schincaglia 2007). It was unclear how the sample size was calculated in two studies (Kielbassa 2009; Song 2009).
One multicentre study did not report any sample size calculation, but we believe the sample to be sufficiently large (208 participants) to detect a statistically significant difference, if any (Lang 2007).

Inclusion/exclusion criteria

For more details, see the Characteristics of included studies table.

Main inclusion criteria

- People with edentulous mandibles of 8 to 15 mm of bone height (Payne 2003).
- People with edentulous mandibles of 13 to 15 mm of bone height (Tawse-Smith 2001; Tawse-Smith 2002).
- People with edentulous mandibles of 15 to 25 mm of bone height not requiring augmentation procedures (Astrand 2011).
- People with edentulous maxillae (Payne 2004).
- People with edentulous maxillae not needing augmentation procedures (Astrand 1999).
- People with severely resorbed edentulous mandibles (Batenburg 1998; Heydenrijk 2002).
- People with edentulous maxillae (Payne 2004).
- People with edentulous jaws not needing augmentation procedures (Astrand 2002).
- People with fully or partially edentulous jaws not needing augmentation procedures (Kielbassa 2009; Esposito 2012), following removal of a malignant tumour and radiotherapy (Heberer 2011).
- People with partially edentulous maxillae not needing augmentation procedures (Astrand 1999).
- People with partially edentulous maxillae requiring placement of implants at least 9 mm long (Gatti 2002), with sufficient bone width to allow placement of 3.3-mm implants not requiring augmentation procedures (Al-Nawas 2012).
- People with edentulous mandibles (Moberg 2001; Fröberg 2006; Alsabeeha 2011).
- People with partially edentulous mandibles (Tawse-Smith 2001; Tawse-Smith 2002).
- People with edentulous mandibles requiring at least two implants (Lee 2007; Song 2009). Wennström 2004 included only participants with a history of periodontitis.
- People with partially edentulous maxillae not needing augmentation procedures requiring at least two implants (Pozi 2014).
- People with bilateral partially edentulous posterior mandibles requiring at least two implants each (Schincaglia 2007).
- People requiring one or two immediate post-extractive maxillary implants in the aesthetic zone (premolar to premolar) (Crespi 2009).
- People requiring immediate post-extractive maxillary single implants in the aesthetic zone (premolar to premolar) between two adjacent teeth (Lang 2007).
- People requiring maxillary single implants in the aesthetic zone (first premolar to first premolar) between two adjacent teeth in healed sites (den Hartog 2011).

Main exclusion criteria

- Severe intermaxillary skeletal discrepancy (Gatti 2002).
- Severe clenching and bruxism (Astrand 2002; Gatti 2002; Crespi 2009; Kielbassa 2009; Prosper 2009; Al-Nawas 2012).
- Any history of bruxism (Tawse-Smith 2001; Tawse-Smith 2002; Payne 2003; Payne 2004).
- Drug or alcohol abuse or both (Moberg 2001; Astrand 2002; Gatti 2002; Crespi 2009; Kielbassa 2009; Prosper 2009; Akoglu 2011; Al-Nawas 2012; Esposito 2012).
- Uncontrolled diabetes (Gatti 2002; Wennström 2004; Fröberg 2006; Kielbassa 2009; Al-Nawas 2012; Esposito 2013a; Pozi 2014).
- Smoking more than 10 cigarettes per day (Gatti 2002; Lang 2007; Crespi 2009; Al-Nawas 2012; Pozi 2014).
- Smoking more than 20 cigarettes per day (Astrand 2002).
- Current steroid treatment (Astrand 2002; Gatti 2002).
- Current chemotherapy treatment (Astrand 2002; Gatti 2002).
- Very soft bone (Tawse-Smith 2001; Tawse-Smith 2002; Payne 2003; Alsabeeha 2011).
- Grafted or regenerated bone (Payne 2004; Schincaglia 2007; Kielbassa 2009; Akoglu 2011; Al-Nawas 2012; Esposito 2012).
- Extremely resorbed maxillae (Payne 2004).
- Sites with interproximal or buccal bone defects (Crespi 2009).
- Extraction sites less than three months (Schincaglia 2007; Esposito 2012).
- Insertion torque less than 35 Ncm (Pozi 2014), or less than 20 Ncm and implant stability quotient less than 60 (Schincaglia 2007).
- Different opposing occlusion bilaterally (Schincaglia 2007).
- Untreated periodontitis (Wennström 2004; Prosper 2009; Al-Nawas 2012; Esposito 2012; Esposito 2013a; Pozi 2014).
- Periodontal bone loss greater than 20% at the adjacent teeth (Lang 2007).
- Full-mouth plaque and bleeding scores greater than 25% at baseline (Lang 2007).
- Teeth to be replaced affected by periodontal disease (Lang 2007).
- Presence of clinically active periodontal disease as expressed by probing pocket depths of 4 mm or greater and bleeding on probing (index score >1) (den Hartog 2011).
- Presence of symptomatic periapical radiolucencies, acute
abscesses or chronic sinus tracts at the implant site (Lang 2007; Crespi 2009; den Hartog 2011; Esposito 2012; Esposito 2013a).

- Lack of primary implant stability (Lang 2007).
- Less than 2 mm of keratinised mucosa (Lang 2007; Akoglu 2011).
- Signs or symptoms of temporomandibular disorders (Prosper 2009).
- Poor general health (Heberer 2011).
- People who could not be restored with a retrievable prosthesis to allow for individual implant stability assessment (Esposito 2012).
- Treatment with intravenous bisphosphonates (Esposito 2012; Esposito 2013a; Pozzi 2014).

Excluded studies


Risk of bias in included studies

The agreed risk of bias of the included trials after having incorporated the information provided by the authors is summarised in Figure 56 and Figure 57.
Figure 57. Risk of bias summary: review authors' judgements about each risk of bias domain for each included study.

<table>
<thead>
<tr>
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<th>Random sequence generation (selection bias)</th>
<th>Allocation concealment (selection bias)</th>
<th>Blinding of performance (bias and detection bias)</th>
<th>Blinding of outcome (outcome bias)</th>
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Sequence generation

Fifteen (56%) trials described an adequate method of sequence generation and we assessed them as being at low risk of bias for this domain (Batenburg 1998; Astrand 2002; Payne 2003; Payne 2004; Fröberg 2006; Lang 2007; Lee 2007; Kielbassa 2009; Prosper 2009; Alsabeeha 2011; den Hartog 2011; Al-Nawas 2012; Esposito 2012; Esposito 2013a; Pozzi 2014). It was unclear from the trial report and communication with authors whether sequence generation for 11 studies (41%) had an adequate method and we assessed these studies as being at unclear risk of bias for this domain (Astrand 1999; Moberg 2001; Tawse-Smith 2001; Gatti 2002; Heydenrijk 2002; Tawse-Smith 2002; Schincaglia 2007; Crespi 2009; Song 2009; Akoglu 2011; Heberer 2011). One study (3%) used a method of randomisation that induced an unbalanced number of implants of the two types (Wennström 2004).

Allocation concealment

Allocation concealment was reported as having been done adequately in eight (30%) of the included studies (Wennström 2004; Lang 2007; Akoglu 2011; Alsabeeha 2011; den Hartog 2011; Esposito 2012; Esposito 2013a), whereas for 15 trials (55%) (Batenburg 1998; Moberg 2001; Tawse-Smith 2001; Astrand 2002; Gatti 2002; Heydenrijk 2002; Tawse-Smith 2002; Payne 2003; Payne 2004; Fröberg 2006; Lee 2007; Crespi 2009; Prosper 2009; Song 2009; Heberer 2011; Al-Nawas 2012), no and we assessed these studies as being at unclear risk of bias for this domain. Allocation concealment procedures were implemented in three trials (55%) (Batenburg 1998; Moberg 2001; Tawse-Smith 2001; Gatti 2002; Heydenrijk 2002; Tawse-Smith 2002; Schincaglia 2007; Crespi 2009; Song 2009; Akoglu 2011; Heberer 2011). One study (3%) used a method of randomisation that induced an unbalanced number of implants of the two types (Wennström 2004).

Blinding of outcome assessors

For four trials (15%), outcome assessors were blinded (Lang 2007; Heberer 2011; Esposito 2012; Esposito 2013a), whereas for 15 trials (55%) (Batenburg 1998; Moberg 2001; Tawse-Smith 2001; Astrand 2002; Heydenrijk 2002; Tawse-Smith 2002; Payne 2003; Payne 2004; Wennström 2004; Fröberg 2006; Schincaglia 2007; Crespi 2009; Akoglu 2011; den Hartog 2011; Pozzi 2014), it was unclear whether outcome assessors were blinded and we assessed these studies at unclear risk of bias for this domain.

Incomplete outcome data

There were low numbers of drop-outs in all but four trials (Tawse-Smith 2002; Payne 2003; Fröberg 2006; Kielbassa 2009), which were assessed as at high risk of bias. All outcome data were reported in 21 trials (78%) (Batenburg 1998; Moberg 2001; Tawse-Smith 2001; Astrand 2002; Gatti 2002; Tawse-Smith 2002; Payne 2003; Payne 2004; Lang 2007; Schincaglia 2007; Lee 2007; Crespi 2009; Kielbassa 2009; Prosper 2009; Song 2009; Akoglu 2011; den Hartog 2011; Heberer 2011; Esposito 2012; Esposito 2013a; Pozzi 2014). It was unclear from the trial report and communication with authors whether sequence generation for 11 studies (41%) had an adequate method and we assessed these studies as being at unclear risk of bias for this domain. Allocation concealment procedures were implemented in three trials (55%) (Batenburg 1998; Moberg 2001; Tawse-Smith 2001; Gatti 2002; Heydenrijk 2002; Tawse-Smith 2002; Schincaglia 2007; Crespi 2009; Song 2009; Akoglu 2011; Heberer 2011). One study (3%) used a method of randomisation that induced an unbalanced number of implants of the two types (Wennström 2004).

Selective reporting

We assessed all but four of the trials (85%) included in this review as being at low risk of selective reporting bias because they all reported most of the main outcomes of this review (Moberg 2001; Wennström 2004; Lang 2007; Prosper 2009). In one trial, not all evaluated outcomes were presented (Lang 2007), in one trial, data were not given for participants in which implants failed (Prosper 2009), and one trial comparing Astra implants with a turned versus a TiO2-blasted surface did not disclose how many implants of each type were placed and presented the various outcomes data of the two different surfaces combined, rendering the comparison useless (Wennström 2004). Therefore, we assessed these trials as at low risk of bias for this domain.

Other potential sources of bias

In 21 of the trials (78%), we identified no other potential source of bias (Batenburg 1998; Moberg 2001; Tawse-Smith 2001; Payne 2003; Payne 2004; Wennström 2004; Fröberg 2006; Lang 2007; Lee 2007; Schincaglia 2007; Crespi 2009; Kielbassa 2009; Prosper 2009; Song 2009; Alsabeeha 2011; den Hartog 2011; Heberer 2011; Al-Nawas 2012; Esposito 2012; Esposito 2013a; Pozzi 2014).
We scored two trials (7%) at high risk of bias: the planned publication at five years was cancelled by the authors and the authors justified this as the sponsored implants were no longer commercially available (Astrand 2002). However, this publication would have contained crucial information on the occurrence or outcome of peri-implantitis. In one trial, most of the failed Steri-Oss implants were placed by a surgeon who placed only Steri-Oss implants and who was judged, afterwards, to have insufficient clinical experience; therefore, the effect of the different implant systems is confounded by the different degree of surgical experience of different operators (Tawse-Smith 2002). We scored four trials (15%) at unclear risk of bias, because in one trial, eight participants treated with Brånemark implants were scored as having type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) versus one participant in the Astra group (Astrand 1999). For two trials, the amount of information presented was insufficient to judge on the comparability of controls and test groups at entry (Hedénrijk 2002; Akoglu 2011), and in one trial, we judged the sample size of five participants per group to be insufficient (Gatti 2002).

Overall risk of bias

The final 'Risk of bias' assessment, after incorporating the additional information kindly provided by the authors of the trials is summarised in Figure 56 and Figure 57. For each trial, we assessed whether it was at low, unclear or high risk of bias. We judged two trials (7%) to be at low risk (Esposito 2012; Esposito 2013a), 10 trials (37%) to be at unclear risk of bias and 15 trials (56%) to be at high risk of bias.

Effects of interventions

See: Summary of findings for the main comparison Implant type A compared with implant type B for implant failure and bone loss; Summary of findings 2 Turned implants compared with roughened implants for early implant failure and peri-implantitis

Primary objectives

We presented implant failures and marginal bone level changes at one, three, five and 10 years in the following subgroups. Data for single studies are presented in additional tables (Table 1; Table 2; Table 3; Table 4; Table 5).

1. Trials comparing implants with different surface preparations, but having similar shape and material (six trials)

We included six trials in the following comparisons (Wennström 2004; Fröberg 2006; Schincaglia 2007; Heberer 2011; Esposito 2012; Esposito 2013a).

Astra cylindrical implants: turned versus TiO2-blasted surface (Tiobalst)

One trial with a split-mouth design compared one Astra cylindrical implant with a turned surface versus one to three implants with a TiO2-blasted surface (Figure 3; Figure 4) supporting screw-retained fixed prostheses in partially edentulous participants for five years (Wennström 2004). Fifty-one participants were included and four participants dropped out after the first year post-loading. The number of the two implants types was imbalanced since more TiO2 implants were placed, but the numbers of each implant types were not disclosed. It is unknown whether implant stability was assessed with the prostheses removed. One turned implant failed early and another three implants with an unknown surface type fractured. The data of this study could only be used for the first part of the secondary objective.

Brånemark Mark III implants: turned versus oxidised surface (TiUnite)

One trial with a split-mouth design compared three Brånemark Mark III implants with turned surfaces (Figure 12) versus three Brånemark Mark III with TiUnite oxidised surfaces (Figure 14) supporting screw-retained metal-ceramic cross-arch prostheses for one year (Fröberg 2006). The implants were immediately loaded. Fifteen participants were included. There were no baseline differences for position, implant stability quotient or implant length between the two groups. There were no withdrawals or failures.

Brånemark Mark IV implants: turned versus oxidised surface (TiUnite)

One trial with a split-mouth design compared two or three Brånemark Mark IV implants with turned surfaces (Figure 16) versus two Brånemark Mark IV with a TiUnite oxidised surfaces (Figure 18) supporting screw-retained metal-ceramic prostheses for three years (Schincaglia 2007). The implants were immediately loaded. Ten participants were included. There were no baseline differences for position, insertion torque values or implant length between the two groups with the exception that two out of 10 prostheses supported by the turned implants included three implants. There were no withdrawals. One implant with a turned surface failed three months after placement. Another turned implant displayed rotational mobility one month after placement, but was re-tightened and put out of occlusion. Two months later the implant was stable and was used to support the definitive restoration. There was no statistically significant difference for failures and marginal bone level changes (Table 1) of the different surfaces.

ITI regular neck: SLA standard versus SLActive surface

One trial with a split-mouth design compared ITI SLA standard (regular neck) (Figure 36; Figure 37) versus ITI SLActive surfaces
One trial with a split-mouth design compared one Astra TiO2-Astra cylindrical versus Astra conical implants (Pozzi 2014).

MegaGen EZ Plus implants with blasted surface: standard versus calcium-incorporated (Xpeed) surface
One trial with a parallel group design compared MegaGen EZ Plus implants with blasted surfaces: standard (Figure 40) versus calcium-incorporated (Xpeed) (Figure 41) supporting fixed prostheses for one year (Esposito 2012). The implants were early loaded. Sixty participants were included. There were no baseline differences for sex, age, length of the implant used or bone quality between the two groups. There were no withdrawals or failures. There was no statistically significant difference for marginal bone level changes of the different surfaces (Table 1).

SPI Element implants with sand-blasted acid-etched surface: standard versus SurfLink-modified surface
One trial with a split-mouth design compared one SPI Element implant with sand-blasted acid-etched surface (Figure 47; Figure 48) versus one identical implant with a SurfLink-modified surface (Figure 49; Figure 50) supporting single cement-retained metal-ceramic crowns for one year (Esposito 2013a). The implants were conventionally loaded. Twenty-three participants were included. There were no baseline differences for position, insertion torque values or implant length between the two groups. There was one withdrawal and no failures. There was no statistically significant difference for marginal bone level changes of the different surfaces (Table 1).

2. Trials comparing implants with different shapes, but having similar surface preparation and material (seven trials)
We included seven trials in the following comparisons (Gatti 2002; Lang 2007; Lee 2007; Kielbassa 2009; Prosper 2009; Song 2009; Pozzi 2014).

Astra cylindrical versus Astra conical implants
One trial with a split-mouth design compared one Astra TiO2-blast titanium cylindrical screw without microthreads on the coronal portion (Figure 3) versus one Astra TiO2-blast titanium tapered screw with microthreads on the coronal portion (Figure 5), placed adjacent to each other for three years (Lee 2007). Thirty-four participants (22 maxillae and 12 mandibles) were originally included. There were no baseline differences for implant length, bone quality and quantity between the two groups. There were no withdrawals or failures.

Brånemark Mark II type versus Brånemark conical transmucosal implants
One trial with a parallel group design compared four Brånemark Mark II type screws (Figure 9) versus four Brånemark conical transmucosal screws (Figure 11) supporting mandibular overdentures for two years (Gatti 2002). The implants were immediately loaded. Five participants were included in each group. There were no baseline differences for sex, age and length of the implant used between the two groups. There were no withdrawals or failures.

Implantium microthreads at the top versus Implantium microthreads 0.5 mm below the top
One trial with a split-mouth design compared one Implantium screw-shaped threaded implant with microthreads at the coronal portion of the implant (Figure 29) versus one Implantium screw-shaped implant with microthreads 0.5 mm below the coronal portion of the implant (Figure 30) for one year (Song 2009). The implants were placed adjacent to each other and were conventionally loaded. Twenty participants were originally included. There were no baseline differences for length of the implant used between the two groups. There were no withdrawals or failures.

ITI cylindrical versus ITI tapered implants
One trial with a parallel group design compared single immediate post-extractive ITI SLA implants of cylindrical (Figure 36) versus tapered (Figure 38) design for one year (Lang 2007). One hundred and four participants were included in each group. There were no baseline differences for age, sex, smokers, full mouth plaque and bleeding scores, and implant location, between the two groups. There were no withdrawals or failures.

NobelActive external connection versus NobelActive internal connection implants
One trial with a parallel group design compared NobelActive tapered implants with external connection (Figure 22) versus NobelActive transmucosal tapered implants with internal connection (Figure 20) for three years (Kielbassa 2009). Sixty-four participants were included in the internal connection group and 53 participants were included in the external connection group. There were no baseline differences for age, sex, smokers, full mouth plaque, bleeding scores and implant location between the two groups. Nine participants dropped out from the external connection group versus 18 participants from the internal connection group. Three participants lost one implant with external connection versus five participants who lost five implants with internal connection. There was
no statistically significant difference for failures or for marginal bone level changes between the implant shapes after one year of function (Table 2).

**NobelActive external connection versus NobelReplace implants**

One trial with a parallel group design compared NobelActive tapered implants, variable-thread design and external connection (Figure 22) versus NobelReplace standard tapered implants (Figure 23) for three years (Kielbassa 2009). Fifty-three participants were included in the external connection group and 60 participants were included in the NobelReplace group. There were no baseline differences for age, sex, smokers, full mouth plaque, bleeding scores and implant location between the two groups. Nine participants dropped out in the NobelActive external connection group versus 18 participants in the NobelReplace group. There were three implant failures in three participants from the NobelActive external connection group and six failures in five participants from the NobelReplace group, including two implants that fractured at insertion. There was no statistically significant difference for failures or for marginal bone level changes between the implant shapes after one year of function (Table 2).

**NobelActive internal connection versus NobelReplace implants**

One trial with a parallel group design compared NobelActive tapered implants, variable-thread design and internal connection (Figure 22) versus NobelReplace standard tapered implants (Figure 23) for three years (Kielbassa 2009). Sixty-four participants were included in the NobelActive internal connection group and 60 participants were included in the NobelReplace group. There were no baseline differences for age, sex, smokers, full mouth plaque, bleeding scores and implant location between the two groups. Nine participants dropped out in the NobelActive external connection group versus 18 participants in the NobelReplace group. There were three implant failures in three participants from the NobelActive internal connection group and six failures in five participants from the NobelReplace group, including two implants that fractured at insertion. There was no statistically significant difference for failures or for marginal bone level changes between the implant shapes after one year of function (Table 2).

**WINSIX cylindrical versus WINSIX tapered implants**

One trial with a split-mouth design compared WINSIX cylindrical screws (Figure 31) versus WINSIX tapered screws (Figure 32) inserted into healed sites and conventionally loaded for two years (Prosper 2009). Sixty-eight participants were included. Each participant received three tapered implants and three cylindrical implants. Of these implants, one was placed submerged, one non-submerged and one was platform switched. There were no baseline differences for implant location between the two groups. At one year, there were two withdrawals and four WINSIX cylindrical implants failed versus two WINSIX tapered implants. There was no statistically significant difference for failures (Table 2).

### 3. Trials comparing implants with different materials, but having similar surface preparation and shape (one trial)

One trial was included in the following comparison (Al-Nawas 2012).

**ITA SLActive implants: titanium grade 4 versus titanium-13zirconium (Roxolid)**

One trial with a split-mouth design compared one ITI SLActive (titanium grade 4) implant (Figure 38; Figure 39) versus one ITI SLActive Roxolid (titanium-13zirconium) implant (Figure 38; Figure 39) supporting overdentures on two locators for one year (Al-Nawas 2012). The implants were early loaded after six to eight weeks. Ninety-two participants were included. There were no baseline differences for position, implant stability quotient and implant length between the two groups. There were four withdrawals. One Roxolid implant failed versus two implant failures in two participants in the SLActive group. There was no statistically significant difference for failures between the implant materials after one year of function (Table 3).

### 4. Trials comparing implants with different surface preparation or shape or material, or a combination (13 trials)

Thirteen trials were included in the following comparisons (Batenburg 1998; Astrand 1999; Moberg 2001; Tawse-Smith 2001; Astrand 2002; Heydenrijk 2002; Tawse-Smith 2002; Payne 2003; Payne 2004; Crepi 2009; Akoglu 2011; Alsabeeha 2011; den Hartog 2011).
Ankylos Plus (Dentsply) versus Seven (Sweden & Martina) implants

One trial with a parallel group design compared Seven (Figure 44) versus Ankylos Plus implants (Figure 1) for two years (Crespi 2009). Implants were placed flapless into post-extractive sites and were immediately loaded. There were 24 in the Seven group and 21 participants in the Ankylos group. There were no baseline differences for age, sex, smokers, full mouth plaque and bleeding scores, and implant location between the two groups. There were no failures or withdrawals. There were no statistically significant differences for marginal bone loss (Table 4).

Astra TiO₂-blast cylindrical versus turned Brånemark Mark II implants

One trial with a parallel group design compared submerged Astra (Figure 3) versus submerged Brånemark screws (Figure 9) in totally edentulous participants for five years (Astrand 1999). Thirty-three fully edentulous participants (17 maxillae and 16 mandibles) were originally included in each group. There were no baseline differences for sex, bone quantity and length of the implant used between the two groups. However, eight participants treated with Brånemark implants were scored as having type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) versus one participant in the Astra group. There were two withdrawals after the third year due to death from the Astra group. Ten Brånemark implants failed in five participants (one participant lost five implants and the prosthesis) versus three Astra implant failures in two participants (two failures in the same participant were due to implant fracture: one between one-year and three-year follow-ups and the other thereafter). Two additional Astra implants in the same participant were successfully treated for peri-implantitis (suppuration combined with advanced bone loss). There were no statistically significant differences for failure or marginal bone level changes between the implant systems after five years of function (Table 4).

Astra TiO₂-blast versus ITI SLA titanium implants

One trial with a parallel group design compared two submerged Astra (Figure 3) versus two non-submerged ITI implants (Figure 36) placed in the intraforaminal region supporting overdentures in edentulous mandibles for five years (Akoglu 2011). Twelve participants were included in each group. It is unclear whether important baseline differences existed between the two groups. The implants were early loaded eight weeks after placement. There were no drop-outs or failures.

Astra TiO₂-blast versus SwissPlus (Zimmer) cylindrical implants

One trial with a parallel group design compared two submerged Astra (Figure 3) versus two non-submerged SwissPlus implants (Figure 53) placed in the intraforaminal region supporting overdentures in the edentulous mandible for five years (Akoglu 2011). Twelve participants were included in each group. It is unclear whether important baseline differences existed between the two groups. The implants were early loaded eight weeks after placement. There were no drop-outs or failures.

Brånemark versus IMZ (Friedrichsdorf) implants

One trial with a parallel group design compared two submerged Brånemark (Figure 7) versus two IMZ submerged implants (Figure 31) supporting overdentures in edentulous mandibles for 10 years (Batenburg 1998). Thirty participants were included in each group. There were no baseline differences for sex, mean edentulous period, mandibular bone quantity and height between the two groups. Three participants in the Brånemark group could not attend the five-year examination due to sickness. One participant in the IMZ group died between the 5-year and 10-year follow-up. One Brånemark and four IMZ implants failed. One Brånemark and one IMZ implant failed at abutment connection, while the other three IMZ implants failed for peri-implantitis between years seven and 10. There was no statistically significant difference for failures after 10 years of function (Table 4).

Brånemark Mark II versus ITI TPS hollow screw implants

Two trials compared submerged Brånemark Mark II versus non-submerged ITI TPS implants (Batenburg 1998; Moberg 2001). One trial with a parallel group design compared two Brånemark Mark II screws implants (Figure 7) versus two ITI TPS hollow screws implants (Figure 35) supporting mandibular overdentures for 10 years (Batenburg 1998). Thirty participants were included in each group. There were no baseline differences for sex, mean edentulous period, mandibular bone quantity and height between the two groups. Two participants of the ITI group died, one prior to the one-year examination and the other prior to the three-year examination. Three participants in the Brånemark group and one in the ITI group could not attend the five-year examination due to sickness. One Brånemark implant failed prior to the abutment connection operation. There was no statistically significant difference for failures between the implant systems after 10 years of function (Analysis 1.4).

One trial with a parallel group design compared Brånemark Mark II screws (Figure 7) versus ITI TPS hollow screws (Figure 35) supporting mandibular fixed prostheses for three years (Moberg 2001). Twenty participants were included in each group. There were no baseline differences for participant sex, age and location of implants between two groups. Three participants died prior to the three-year examination (one in the Brånemark group and two in the ITI group). Two Brånemark implants failed (one early failure and one for peri-implantitis between years one and two). One ITI implant failed for peri-implantitis at two years. However, two
additional ITI implants were affected by peri-implantitis at the three-year examination and were under treatment. Their outcome was unknown at the time of reporting. There was no statistically significant difference for failures between the implant systems after three years of function (Analysis 1.2).

We performed a meta-analysis of the two above studies (Batenburg 1998; Moberg 2001). There was no statistically significant difference for failures between the implant systems after three years of function (Analysis 1.2).

**Brånemark Mark II versus ITI TPS solid screw implants**

One split-mouth trial compared Brånemark Mark II screws (Figure 9) versus ITI TPS solid screws (Figure 33) supporting maxillary partial screw-retained prostheses for three years (Astrand 2002). Twenty-eight participants were included. There were no baseline differences for implant length, bone quality and quantity between the two groups. Two participants dropped out before the three-year follow-up. Two Brånemark implants failed (early failures) in the same participant and two ITI implants failed for peri-implantitis in two different participants: one implant failed at one year and the other after three years. An additional five ITI implants showed clinical signs of peri-implantitis and the fate of two of these ITI implants was considered questionable. There was no statistically significant difference for failures after three years of function between implant systems (Table 4).

**Brånemark Mark IV TiUnite versus Southern (Southern Implants) regular implants**

One trial with a parallel group design compared non-submerged narrow diameter implants with roughened surfaces (Brånemark Mark IV TiUnite (Figure 18) versus Southern screws (Figure 45) for the treatment of totally edentulous maxillae using three unsplinted implants supporting an overdenture for one year (Payne 2004). Maxillae were treated with either a ridge expansion osteotomy or a combined ridge split and osteotomy procedure, depending on the ridge bucco-palatal width. Autogenous bone grafts were used to fill intraosseous defects of the ridge split-cases. The implants were early loaded 12 weeks after placement. Twenty participants were included in each group. It is unclear whether important baseline differences existed between the two groups. Two participants dropped out: one from the Brånemark group (only one implant of three could be placed) and one from the Southern group (death). Fifteen implants failed in 11 participants (five Brånemark and 10 Southern implants). There was no statistically significant difference for failure between the implant systems after one year of function (Table 4).

**IMZ titanium TPS versus ITI TPS hollow implants**

One trial with a parallel group design compared two submerged IMZ TPS cylinders (Figure 31) versus two non-submerged ITI TPS hollow screws (Figure 35) supporting overdentures in edentulous mandibles for 10 years (Batenburg 1998). Thirty participants were included in each group. There were no baseline differences for sex, mean edentulous period, mandibular bone quantity and height between the two groups. Two participants from the ITI group died, one prior to the one-year examination and the other prior to the three-year examination. At the five-year examination, one additional participant of the ITI group was ill and could not attend the examination and one participant in the IMZ group died between the 5-year and 10-year follow-up. One IMZ implant failed prior to the abutment connection operation while another three IMZ implants failed for peri-implantitis between years seven and 10. There was no statistically significant difference for failures after 10 years of function (Table 4).

**IMZ titanium TPS versus ITI TPS solid implants**

One trial with a parallel group design compared two submerged IMZ TPS cylinders (Figure 33) versus two non-submerged ITI TPS solid screws (Figure 31) supporting overdentures in edentulous mandibles for five years (Heydenrijk 2002). Twenty participants were included in each group. It was unclear whether there were any baseline differences for the two groups. Two participants dropped out from ITI group (one died before the three-year follow-up and the other become ill after the three-year follow-up), and one from the IMZ group (moved abroad after the three-year follow-up). One IMZ implant failed (late failure). There was no statistically significant difference for failures between the implant systems after five years of function (Table 4).

**ITI SLA versus Southern implants**

One trial with a parallel group design compared two unsplinted non-submerged ITI SLA screws (Figure 33) versus two unsplinted non-submerged Southern screws (Figure 45) in totally edentulous mandibles supporting overdentures for 10 years (Payne 2003). Implants were early loaded two weeks after placement. Twelve participants were included in each group. There were no baseline differences for age, number of years edentulous, number of previous dentures, bone quality and quantity between the two groups. One participant dropped out from the ITI group and two participants died. From the Southern group, one participant dropped out and two died at the 10-year point. No implants failed and there was no statistically significant difference for marginal bone level changes 10 year after loading (Table 4).

**ITI SLA titanium implants versus SwissPlus (Zimmer) cylindrical implants**

One trial with a parallel group design compared two non-submerged ITI (Figure 36) versus two non-submerged SwissPlus implants (Figure 53) placed in the intraforaminal region supporting overdentures in the edentulous mandible for five years (Akoglu
Two trials with a parallel group design included 12 participants in bone quality and quantity between the two groups. There were no baseline differences (Tawse-Smith 2002). There were no baseline differences for age, implant location and whether or not a pre-implant augmentation procedure was required between the two groups. One NobelReplace Select implant failed five months after placement (Table 4). There was no statistically significant difference for marginal bone level changes (Table 4).

NobelReplace Select Tapered versus NobelReplace Groovy implants

One trial with a parallel group design compared single NobelReplace Select tapered (Figure 25) versus single NobelReplace Groovy implants (Figure 23) for one year (den Hartog 2011). We excluded a third group of 31 participants treated with NobelPerfect Groovy because implants were placed more supracrestally, making the comparison unreliable. Thirty-one participants were included in each group. There were no baseline differences for age, implant location and whether or not a pre-implant augmentation procedure was required between the two groups. One NobelReplace Select implant failed five months after placement (Table 4). There was no statistically significant difference for marginal bone level changes (Table 4).

Southern regular versus Steri-Oss implants

Two trials with a parallel group design compared non-submerged Southern (Figure 45) versus non-submerged Steri-Oss screws (Figure 51) for the treatment of totally edentulous mandibles using two unplanted implants supporting an overdenture (Tawse-Smith 2001; Tawse-Smith 2002). The design of the two trials was identical with the exception that in one trial the implants were conventionally loaded at 12 weeks (Tawse-Smith 2001), whereas in the other the implants were early loaded at six weeks (Tawse-Smith 2002). In both trials, Steri-Oss implants were described as having a turned surface, but after having analysed the surface of one implant, kindly provided by the authors, it was realised that the implant surface was chemically treated. One trial with a parallel group design included 12 participants in each of the two groups followed up to 10 years (conventional loading at 12 weeks) (Tawse-Smith 2001). There were no baseline differences in bone quality and quantity between the two groups. There were four drop-outs over a 10-year period: three in the Steri-Oss group (two drop-outs and one death) and one in the Southern group (death). There was one early implant failure in the Steri-Oss group. There was no statistically significant difference for failures between the implant systems after 10 years of function (Analysis 2.1; Analysis 2.2; Analysis 2.3; Analysis 2.4); however, the CI indicated Southern implants failed from 10% more up to 98% less than Steri-Oss implants at each follow-up to 10 years after function (P value = 0.06; risk ratio (RR) 0.14; 95% CI 0.02 to 1.10 at 10 years).

Southern regular versus turned Neoss implants

One trial with a parallel group design (Alsabeeha 2011) compared a single non-submerged Southern regular (Figure 45) versus Neoss implants (Figure 42) placed in the midline for the treatment of totally edentulous mandibles supporting an overdenture for one year. Twelve participants were included in each group. No baseline differences for age, number of years being edentulous, number of previous dentures, bone quality and quantity between the two groups. One participant dropped out from the Southern group. One implant failed in the Southern group. There was no statistically significant difference for implant failures (Table 4).

Southern wide versus turned Neoss implants

One trial with a parallel group design compared non-submerged Southern wide (Figure 46) versus Neoss implants (Figure 42) for the treatment of totally edentulous mandibles using a single implant placed in the midline supporting an overdenture for one year (Alsabeeha 2011). Twelve participants were included in each group. There were no baseline differences for age, number of years being edentulous, number of previous dentures, bone quality and bone quantity between the two groups. There were no drop-outs or failures.

Southern regular versus Southern wide

One trial with a parallel group design compared non-submerged Southern regular (Figure 45) versus Southern wide implants (Figure 46) for the treatment of totally edentulous mandibles using a single implant placed in the midline supporting an overdenture for one year (Alsabeeha 2011). Twelve participants were included in each group. There were no baseline differences for age, number of years being edentulous, number of previous dentures, bone quality and bone quantity between the two groups. One participant dropped out from the Southern regular group. One implant failed in the Southern regular group. There was no statistically significant difference for implant failures (Table 4).
Secondary objectives

Turned versus roughened surfaces

Early implant failure

Seven studies provided data for early implant failure (Batenburg 1998; Astrand 1999; Moberg 2001; Astrand 2002; Wennström 2004; Fröberg 2006; Schincaglia 2007). All these trials, with one exception in which there were no failures (Fröberg 2006), showed at least one early failure of implants with a turned surface versus no or few failures for implants with roughened surfaces. The meta-analysis comparing early implant failures between various implants with turned and roughened surfaces demonstrated no heterogeneity (RR 2.79; 95% CI 0.87 to 8.90; P value = 0.08) (Analysis 3.1). The CI for this relative failure rate went from the roughened surfaces failure rate being only 10% worse than the turned surfaces to being up to nine times better.

Peri-implantitis

At three years (four trials)

One meta-analysis comparing the occurrence of peri-implantitis between various implants with turned and roughened surfaces at three years included four trials (Analysis 3.2) (Astrand 1999; Moberg 2001; Astrand 2002; Schincaglia 2007). Considering the participant as the unit for the analysis, there was evidence that more implants with rough surfaces were affected by peri-implantitis (RR 0.80; 95% CI 0.67 to 0.96; P value = 0.01). Implants with turned surfaces had a 20% reduction in risk of being affected by peri-implantitis. For the other trial, no data were presented and the authors did not reply to our request for information (Batenburg 1998).

At five years (one trial)

Only one trial was available comparing the occurrence of peri-implantitis between various implants with turned and roughened surfaces at five years (Astrand 1999). There was no statistically significant difference for the occurrence of peri-implantitis between the implants with turned and roughened surfaces (Table 5). For another trial, no data were presented and the author did not reply to our request for information (Batenburg 1998).

At 10 years (one trial)

One trial with a parallel group design reported the number of participants who had lost implants because of peri-implantitis between implants with turned and roughened surfaces at 10 years (Batenburg 1998). There was no statistically significant difference for implant lost for peri-implantitis between the implants with turned and roughened surfaces (Table 5).
### ADDITIONAL SUMMARY OF FINDINGS

**Turned implants compared with roughened implants for early implant failure and peri-implantitis**

**Patient or population:** adults with missing teeth  
**Settings:** dental clinics  
**Intervention:** turned implants  
**Comparison:** roughened implants

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect (95% CI)</th>
<th>No of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk</td>
<td>Corresponding risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roughened implants</td>
<td>Turned implants</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Early implant failure     | 50 per 1000                             | 140 per 1000             | RR 2.79 (0.87 to 8.90)      | 285 (6)                        | ⊕⊕⃝⃝ low  
1 Downgraded as 4 studies at high risk of bias and 2 unclear.  
2 Downgraded for imprecision (low sample size/event rates).  
3 Downgraded as 3 studies at high risk of bias and 1 unclear. |
| Peri-implantitis          | 50 per 1000                             | 40 per 1000              | RR 0.80 (0.67 to 0.96)      | 144 (4)                        | ⊕⊕⃝⃝ low  
1 Downgraded as 4 studies at high risk of bias and 2 unclear.  
2 Downgraded for imprecision (low sample size/event rates).  
3 Downgraded as 3 studies at high risk of bias and 1 unclear. |

*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) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; RR: risk ratio.
DISCUSSION

Summary of main results
In order to evaluate the possible effects of different implant characteristics, a trial should be designed in a way that only the characteristic of interest (i.e. surface roughness or implant shape or implant material) is different and all the other parameters are identical. Trials evaluated the following comparisons.

Different implant surfaces
Six trials evaluated the potential effect of different implant surfaces, with only two trials comparing the same surfaces. There was no evidence to suggest that one implant surface had a lower failure rate or led to lower marginal bone changes than another.

Different implant shapes
Seven trials evaluated the potential effect of 13 different implant shapes, with no trials comparing the same shapes. After one year, no significant differences for implant failures between the tested different implant designs were observed. The only statistical significant difference observed regarded one trial comparing peri-implant marginal bone loss at Nobel Speedy Groovy implants with NobelActive implants, which showed that Nobel Speedy Groovy implants lost 0.59 mm more bone than NobelActive implants one year after loading (Pozzi 2014).

Different implant materials
Only one trial compared implants made of two different materials: titanium grade 4 versus a titanium-13zirconium alloy (Roxolid), but there was no difference in failure rate or bone loss (Al-Nawas 2012).

Different implant systems
Thirteen trials compared different implant systems with a combination of different surface characteristics, shapes, dimensions, purity of titanium, surgical protocols (submerged versus non-submerged etc.). There was no evidence to suggest that one implant system led to fewer implant failures or less bone loss than another implant system.

Early failures between implants with turned and roughened surfaces
Seven trials compared early implant failures between implants with turned and roughened surfaces. Although not statistically significant, the limits of the confidence interval from the meta-analysis went from the turned surfaces being 10% worse than the roughened surfaces to being nine times better.

Occurrence of peri-implantitis between implants with turned and roughened surfaces
Four trials presented data on the occurrence of peri-implantitis between implants with turned and roughened surfaces at three years after loading, one at five years, and one trial provided the information of how many implants failed for peri-implantitis up to 10 years after loading. At three years, the meta-analysis showed that implants with turned surfaces had a 20% reduction in risk of being affected by peri-implantitis; however, the five-year and 10-year data did not show any evidence of a difference.

Overall completeness and applicability of evidence
There was insufficient evidence to draw any useful conclusions, as most of the trials were underpowered. The generalisation of the results of the included trials to ordinary clinical conditions should be considered with caution. In general, treatments were administered by experienced clinicians and the follow-up regimens were strict. It is unlikely that dentists with non-comparable experience could match similar positive results. The observation that the inclusion of a less trained surgeon might have influenced the result of one trial support this suggestion (Tawse-Smith 2002).

Quality of the evidence
The most striking aspect is that only 27 out of 81 identified randomised controlled trials (RCTs) could be included in the present review. This was due to several problems, the most common being: studies were not RCTs or were quasi-random trials, data were presented in a way we could not use or insufficient data were presented, too short follow-up (less than one year after loading), lack of proper assessment of the primary outcome measure (stability of individual implants), study discontinuation or evaluating implants for other application (orthodontics). In addition, peri-implant bone level change data of many included trials could not be used because they were not recorded from the proper baseline (implant placement) but at later stages (loading) when a substantial portion of bone loss already occurred or because they were presented at implant level and not participant level. In a previous investigation, it was found that the design, analysis and reporting of RCTs on oral implants was generally poor (Esposito 2001a), which may explain why so many trials had to be excluded from the present review.

The quality assessment of the included trials is summarised in Figure 56 and Figure 57. Figure 56 represents a summary of the overall judgement of the risk of bias, which tries to quantify the potential risk of bias of the included trials, whereas Figure 57 describes our judgement about each of the six risk of bias domains for each included study. We assessed only two trials as being at
low risk of bias (Esposito 2012; Esposito 2013a), assessed 15 as at high risk of bias.

The source of study funding, in particular when trials were sponsored by implant manufacturers, is a potential source of bias. Fifteen (58%) out of 27 included trials reported that they were commercially funded. It is possible that there could be bias in this area. However, these studies would probably not have taken place unless there was commercial funding and is difficult to evaluate this aspect objectively. Ideally, independent studies should be conducted. We did not classify trials sponsored by manufacturers as unclear risk of bias when they compared their own different implant types, even though there might be a tendency of overestimating the outcome of the new implants type.

The primary outcome measure in this review was the success of the implants, both from a biological (successful osseointegration and lack of infection) and a biomechanical (no fracture or deformation rendering the implant useless) point of view. In order to ascertain in a reliable way if an implant is clinically osseointegrated, its stability ought to be evaluated with the prosthesis removed (with the exception of single implants) otherwise implant failures can be underestimated (Grondahl 1997). Here the decision was to exclude those trials in which individual implant stability was not tested after removing the prostheses.

The assessment of radiographic bone level changes around implants is a secondary or surrogate or predictive outcome measure that is commonly used. A predictive outcome can be defined as a measure of the disease process. Predictive outcome measures cannot be recommended as primary parameters to evaluate effectiveness of dental implants; however, they may be useful diagnostic tools for the early detection of potential problems, allowing early treatment to preserve healthy conditions (Esposito 2001b). Primary or true outcomes such as implant failures are often rare and distant events, whereas, surrogate endpoints are in general sensitive predictors for the true outcomes. The problem of using mean marginal bone level assessments is that a severe marginal bone loss affecting few implants is diluted by the averaging process. In addition, once an implant has failed, its values are removed from the calculations, suddenly improving the bone level measurements. These limitations of the mean marginal bone level measurements may delay an early detection of a statistically significant difference. One possible way to overcome this problem is to dichotomise the bone level measurements, establishing an arbitrary threshold level of severe bone loss (for instance 5 mm), and to count how many participants had at least one implant affected by such severe bone loss. Implants that failed because of progressive bone loss should remain in the bone change calculations, even though it is rarely performed in practice.

In this review update, we decided to include only those radiographic assessments that presented radiographs taken at implant placement as baseline data in order to evaluate more appropriately the bone level changes at different implant types, since most of the bone resorption occurs just after implant placement/loading. We excluded one trial (Tymstra 2011), and only partially included another (den Hartog 2011), because similar implants with different shapes were systematically placed at different levels with respect to the bone crest. In addition, bone levels measurements were taken using different reference points when the same reference point could have been used. While authors followed the manufacturer guidelines for placing the implants, the different implant positions are likely to effect marginal bone level changes. The aim of this review was to evaluate the possible effect of different implant characteristics. To achieve this it is imperative that, whenever possible, implants are placed in a similar position to exclude all other possible confounding factors. The excluded trials reported statistically more bone loss one year after loading at NobelPerfect Groovy implants of 0.8 mm (den Hartog 2011) and 1.8 mm (Tymstra 2011).

Investigators should design studies carefully deciding on either a parallel group or a split-mouth design on outset, not combining the two different study designs in the same study. Split-mouth studies should ideally have equal numbers of implants in each group placed per participant. The analysis of these studies should be a ‘paired’ analysis, taking the pairing of the implants within participants into account. Another commonly encountered problem is that both split-mouth and parallel group studies are analysed at the level of the implant, not taking the clustering of the implants within a participant into account. Finally, the data of the two different groups should be reported separately and compared, and the data should not be combined in a single group. The design and analysis of these studies is frequently complex and it is recommended that statisticians are involved in the initial planning stages and protocol writing for these studies.

None of the trial authors characterised the implant surfaces themselves. This is understandable since they relied on the information provided by the manufacturers or published in other studies. However, after having analysed the surface of some implants, we realised that the surface description of the Steri-Oss implants reported in two trials did not correspond to what we actually found (Tawse-Smith 2001; Tawse-Smith 2002). In fact, the surface was acid-etched and not turned as described in the articles. Such a finding was indeed unexpected. In experimental research, it is recommended that authors characterise in detail the surface properties of their implants. We feel that the same recommendation could be given for clinical trials where the implant characteristics could be described in detail and possibly independently verified.

Potential biases in the review process

One of the review authors was an author on two included and one excluded trial. We ensured that other review authors independently undertook the risk of bias for these trials.
Agreements and disagreements with other studies or reviews
We identified no other systematic reviews with similar objectives and methodology.

Authors’ Conclusions

Implications for practice
Based on the results of the included randomised controlled trials (RCTs), there was no evidence showing that any particular type of dental implant has superior long-term success over another type of implant. There was limited evidence showing that implants with relatively smooth (turned) surfaces are less prone to lose bone due to chronic infection (peri-implantitis) than implants with much rougher surfaces (titanium-plasma-sprayed). These findings were based on several RCTs, often at high risk of bias, with few participants and relatively short follow-up periods.

Implications for research
More well-designed, long-term RCTs are required to understand if there is any design, surface modification or material able to improve the effectiveness of oral implants significantly. It is recommended that such trials include:

- test and control implants placed in the same way when possible;
- a sufficient number of participants to disclose a true difference, if any;
- a proper group allocation concealment;
- independent outcome assessors when blinding is not possible to minimise detection bias;
- a sufficient duration (five years or more).

Such trials should be reported according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (www.consort-statement.org). Ideally, these trials should investigate only one aspect, such as the role of various degrees of surface roughness or the role of calcium-phosphate coatings, or some specific implant design or materials thus minimising the numerous confounding factors such as different implant shapes or clinical procedures.

Acknowledgements
We want to thank:

- Paul Coulthard, Maria Gabriella Grusovin, Asbjorn Jokstad, Lawrence Murray-Curtis and Peter Thomsen for the contribution they gave to earlier versions of this review;
- Anne Littlewood (Cochrane Oral Health Group) for her assistance with literature searching;
- Luisa Fernandez Mauleffinch and Phil Riley (Cochrane Oral Health Group) for their help with the preparation of this review;
- Bilal Al-Nawas, Per Åstrand, Kurt Bütow, Roberto Calandriello, Luigi Canullo, Murat Cehreli, Laurens den Hartog, Bertil Friberg, Klaus Gottfredsen, Susanne Heberer, Marjorie Jeffcoat, Caneyt Karabuha, Pentti Kemppainen, Andrej M. Kielbassa, Niklaus Lang, Edwin McGlumphy, Antonio Fernando Martorelli de Lima, Henny Meijer, Ik-Sang Moon, Yasemin Kulak Ozkan, Alan Payne, Gerry Raghoebhar, Mario Roccuzzo, Gian Pietro Schincaglia, Andreas Stavropoulos, Andrew Tawse-Smith and Nele Van Assche for providing us with information on their trials;
- Ian Brook, Jan Clarkson, Laurens den Hartog, Bertil Friberg, Sue Furness, Anne-Marie Glenny, Jayne Harrison, Lee Hooper, Andrej M. Kielbassa, Klaus Lang, Ian Needleman, Alan Payne, Gerry Raghoebhar, Gian Pietro Schincaglia, William Shaw, Michele Nieri and Andreas Stavropoulos for reviewing various versions of this review.
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References to studies included in this review

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Al Nawas 2012  {published data only}

Alsabeeha 2011  {published data only}

Åstrand 1999  {published and unpublished data}

Åstrand 2002  {published and unpublished data}

Batenburg 1998  {published and unpublished data}

Crespi 2009  {published data only}

den Hartog 2011  {published and unpublished data}

Esposito 2012  {published and unpublished data}

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Heberer S, Kilic S, Hossamo J, Raguse JD, Nelson K. Rehabilitation of irradiated patients with modified and conventional sandblasted acid-etched implants: preliminary

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Payne 2004 [published data only]

Pozzi 2014 [published data only]

Prosper 2009 [published data only]

Schinaglia 2007 [published data only]


Song 2009 [published data only]

Tawse-Smith 2001 [published and unpublished data]

Tawse-Smith 2002 *(published data only)*

Åstrand 2003 *(published and unpublished data)*

Boerrigter 1997 *(published and unpublished data)*

Ástrand 2003 *(published data only)*

Boerrigter 1997 *(published and unpublished data)*


Canullo 2012 *(published and unpublished data)*

Cehreli 2010 *(published data only)*

da Cunha 2004 *(published data only)*

Du Preez 2007 *(published data only)*

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Interventions for replacing missing teeth: different types of dental implants (Review)

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Geurs 2002 (published data only)

Gher 1994 (published data only)

Goeneé 2007 (published data only)

Gultekin 2013 (published and unpublished data)

Joly 2003 (published data only)

Jones 1997 (published data only)

Kadkhodazadeh 2013 (published and unpublished data)

Kang 2012 (published and unpublished data)

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Kim 2010 (published data only)
Kim JJ, Lee DW, Kim CK, Park KH, Moon IS. Effect of conical configuration of fixture on the maintenance


Interventions for replacing missing teeth: different types of dental implants (Review)

Copyright © 2014 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Schätzle 2009 [published data only]

Shibli 2010 [published data only]

Shin 2006 [published data only]

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Tallarico 2011 [published data only]

Tan 2010 [published data only]

Testori 2003 [published data only]

Thoma 2014 [published and unpublished data]

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Trulhar 1997 [published data only]

Tymstra 2011 [published data only]

Van Assche 2012 [published and unpublished data]

Van Steenberghhe 2000 [published data only]


Zetterqvist 2010 *(published data only)*


References to studies awaiting assessment

Cecchinato 2013 *(published data only)*


Dellavia 2013 *(published data only)*


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Osman RB, Swain MV, Aitio M, Ma S, Duncan W. Ceramic implants (Y-TZP): are they a viable alternative to titanium implants for the support of overdentures? A randomized clinical trial. Clinical Oral Implants Research In press.

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Sanz 2013 *(published data only)*


Sanz 2014 *(published data only)*


Siddiqi 2013 *(published data only)*


Wang 2014 *(published data only)*


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Esposito 1999

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RevMan 2012 [Computer program]

Roos-Jansäker 2006

Stout 1990

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Esposito 2003

Esposito 2005a

Esposito 2007

* Indicates the major publication for the study

Interventions for replacing missing teeth: different types of dental implants (Review) 62
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CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Akoglu 2011

<table>
<thead>
<tr>
<th>Methods</th>
<th>5-year follow-up, randomised parallel group study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults with mandibular edentulism treated with 2 mandibular implants in the infratemporal region to support an overdenture. Treated in the Department of Oral Surgery and the Department of Prosthetic Dentistry, University of Marmara, Turkey. 36 enrolled and results given for 36. Exclusion criteria: drug or alcohol abuse, health condition precluding surgery, logistic or physical reasons that could affect followup, psychiatric problems, and a history of radiotherapy to the head and neck, neoplasia, or bone augmentation to the implant site.</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: Astra® TiO2-blast titanium grade 3 cylindrical screws with internal connection (Astra Tech AB, Mölndal, Sweden). Group 2: ITI® SLA titanium grade 4 cylindrical solid screws with internal connection with a 2.8-mm turned neck (Institut Straumann AG, Waldenburg, Switzerland). Group 3: Zimmer SwissPlus sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (Zimmer Dental) supporting overdentures on 2 implants connected with ball attachments.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Implant stability, complications, marginal bone level changes on standardised periapical radiographs, plaque index, sulcus bleeding index, peri-implant probing depth, peri-implant marginal bone loss, participant satisfaction.</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
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</tbody>
</table>

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “The patients were randomly divided into three groups...” Authors did not address this point in their reply.</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Low risk</td>
<td>No information provided in the original article. Authors replied: “Allocation concealment was centralised by a central office unaware of subject characteristics; and sequentially numbered, sealed, opaque envelopes were used to inform the surgeon of which implant to place at the time of implant placement.”</td>
</tr>
</tbody>
</table>
**Akoglu 2011**  
(Continued)

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the original article. Authors replied: “Outcome assessors were blind. Two prosthodontists who were not involved in the treatment of the patients performed the clinical and radiographic evaluations.” Comment: outcome assessors could not be blinded.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>All outcome data presented and no withdrawals.</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Unclear risk</td>
<td>Insufficient information to evaluate the comparability of groups at entry</td>
</tr>
</tbody>
</table>

**Al-Nawas 2012**

**Methods**

1-year follow-up, randomised split-mouth study.

**Participants**

Adults with mandibular edentulism, requiring 2 mandibular implants in the intraforaminal region support an overdenture  
Treated in multicentre clinics in Germany, Italy, Belgium, the Netherlands and Switzerland  
92 enrolled and results given for 89.  
Exclusion criteria: any medical conditions contraindicating implant surgery, a history of radiotherapy of the head and neck region, bone grafted jaws

**Interventions**

Group 1: ITI® Roxolid tapered screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland)  
Group 2: ITI® SLActive titanium grade 4 tapered solid screws with internal connection (Institut Straumann AG, Waldenburg, Switzerland) supporting overdentures on 2 implants connected with locator attachments

**Outcomes**

Marginal bone level changes on panoramic radiographs, implant stability, implant mobility, plaque index, sulcus bleeding index, complications

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>The study did not mention how random allocation was generated. Authors replied: “The random sequence</td>
</tr>
</tbody>
</table>
Allocation concealment (selection bias) | Unclear risk  
---|---  
Study reported: “Except for the material, both devices were identical and the sterile glass-tube containers were marked A or B. Blinding keys were kept centrally at the sponsor. The first implant was randomly allocated to either the right or the left intraforaminal region of the edentulous mandible, the other one placed in the contralateral side. Randomization was performed using sealed envelopes which were opened after bone exposure during surgery.”

Blinding (performance bias and detection bias)  
All outcomes | High risk  
---|---  
Study reported: “Clinical examinations were performed after 6 months, but the study was unblinded only after 12 months post-surgery.”  
Authors replied: “The outcome assessors were not specified or restricted, as outcome was recorded before unblinding... The outcome assessors were not further specified for the secondary clinical parameters. The primary criterion was “radiologic bone loss”. This one was blindly assessed by a centre which was not involved into recruitment.”  
Comment: outcome assessors for clinical outcomes were not blinded at the treatment centres with the exceptions of radiographic evaluation, which we did not use.

Incomplete outcome data (attrition bias)  
All outcomes | Low risk  
---|---  
Not all outcome data presented, 4 withdrawals out of 92 participants; 1 failure in the ITI Roxolid and 2 failures in the SLActive group.

Selective reporting (reporting bias) | Low risk  
---|---  
No selective reporting identified.

Other bias | Low risk  
---|---  
No other biases identified.
### Alsabeeha 2011

<table>
<thead>
<tr>
<th>Methods</th>
<th>1-year follow-up, randomised parallel group study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults with mandibular and maxillary edentulism, requiring a single mandibular implant in the midline to support an overdenture. Treated in the School of Dentistry, New Zealand. 36 enrolled and results given for 35. Exclusion criteria: any medical conditions contraindicating implant surgery, a history of radiotherapy of the head and neck region, bone grafted jaws and bone quality type IV (very soft bone).</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: Southern® sand-blasted titanium grade 4, 8-mm wide tapered screws with external connection (Southern Implants, Irene, South Africa)  Group 2: Southern® sand-blasted titanium grade 4 cylindrical screws with external connection  Group 3: Neoss sand-blasted acid-etched titanium grade 4 cylindrical screws with internal connection (Neoss Ltd, Harrogate, UK) single implants</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Marginal bone level changes on standardised periapical radiographs, implant stability (resonance frequency analysis), implant and prosthodontic success, complications</td>
</tr>
</tbody>
</table>

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study reported: “...the randomisation and allocation of the 36 participants into three different interventions of 12 participants each was commenced. A simple randomisation protocol using 36 sequentially numbered opaque sealed envelopes was followed ..... to ensure maximum concealment. A dental assistant not involved in the study performed the randomisation and allocation procedures.” Authors replied: “A simple randomisation procedure was performed using 36 sequentially numbered opaque sealed envelopes. In brief, three separate sets of envelopes (12 envelopes each, with each envelope containing a card denoting one of the 3 planned interventions) ......... The envelopes were shuffled repeatedly and thoroughly and then marked sequentially from 1 to 36. This protocol was performed by a dental nurse not involved in the clinical trial and not exposed to the different interventions intended.”</td>
</tr>
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</table>
### Allocation concealment (selection bias)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Risk</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>Low risk</td>
<td>Study reported: “A dental assistant not involved in the study performed the randomisation and allocation procedures.” Authors replied: “To ensure maximum concealment, a tin foil was wrapped around each card carrying the specific intervention within each envelope. The envelopes were locked up under the care of the same dental nurse carrying the randomisation procedure and were opened sequentially at the day of surgery.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Blinding (performance bias and detection bias)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Risk</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk</td>
<td>Study reported: “Blinding of outcome assessors to the interventions was not possible.” Authors replied: “The prosthodontist was the outcome assessor.” Comment: ideally, an independent outcome assessor should have performed the assessment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Incomplete outcome data (attrition bias)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Risk</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>Radiographic data of 1 participant missing, otherwise fully reported. 1 failure and 1 drop-out in the Southern regular group</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Selective reporting (reporting bias)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Risk</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>No selective reporting identified.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Other bias

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Risk</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>No other bias identified.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Astrand 1999

#### Methods

5-year follow-up randomised, parallel group study.

#### Participants

Edentulous adults treated in the University Hospital of Linkoping, Sweden 68 enrolled (34 in each group) and results given for 66. Exclusion criteria: 2 participants were excluded at the implant installation since they did not meet the inclusion criteria (insufficient bone volume with need of bone graft or guided tissue regeneration)

#### Interventions

- **Group 1:** Astra® (Astra Tech AB, Mölndal, Sweden) TiO₂-blasted submerged titanium screws.
- **Group 2:** Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark II type submerged turned titanium screws supporting fixed prostheses

#### Outcomes

- Pain from implant region, implant stability tested with superstructure removed, prostheses survival, marginal bone level changes on standardised intraoral radiographs, plaque accumulation, bleeding on probing, operation time, mechanical complications, peri-implant infections with bone loss (peri-implantitis), presence or absence of attached peri-
Astrand 1999 (Continued)

implant mucosa
1-, 3- and 5-year data used.

Notes
8 participants in the Brånemark group were scored at implant insertion as having type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) versus 1 participant in the ITI group.

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “Two randomisation schedules were generated one for implant installation in the mandible and one for the maxilla. The patients were randomised in blocks with an equal probability of receiving Astra Tech or Brånemark implants.” Authors replied: “Randomisation was carried out with equal possibilities for both types of implant. Randomisation schedules were sent to the clinics participating in the study.”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>High risk</td>
<td>Unclear from the study. Authors replied: “Randomisation schedule were sent to the clinician participating in the study, and they included the patient consecutively after this schedule. Special measures to conceal the schedules until treatment were not made.”</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>High risk</td>
<td>An independent assessor made the radiographic evaluations. Other outcome assessors not blinded.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)  All outcomes</td>
<td>Low risk</td>
<td>All outcome data provided by authors on request, 2 out of 68 participants withdrew. All failed and fractured implants accounted for, but missing baseline radiograph for 1 mandible in Astra group. Marginal bone level data, mean and standard deviation on a participant basis provided on request for each study group. 2 withdrawals in the Astra group after year 3 due to participant death</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
</tbody>
</table>

Interventions for replacing missing teeth: different types of dental implants (Review)
Copyright © 2014 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Other bias | Unclear risk | 8 participants in the Brånemark group were scored at implant insertion as having type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) versus 1 participant in the ITI group.

Astrand 2002

Methods | 3-year follow-up randomised, split-mouth study.

Participants | Adults aged 20-75 years with partially edentulous maxillae. Treated in 5 different dental clinics in Sweden. 28 enrolled and results given for 26 Exclusion criteria: known leukocyte dysfunction, uncontrolled endocrine disorders, psychotic disorders, heavy smoking habits (> 20 cigarettes/day), alcohol or drug abuse, current steroid or chemotherapy treatments, local irradiation therapy, insufficient bone volume with need of bone graft or guided tissue regeneration, heavy bruxism, current periodontitis, < 6 months healing after tooth extraction

Interventions | Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark II type submerged turned titanium screws
Group 2: ITI® (Institut Straumann AG, Waldenburg, Switzerland) non-submerged solid titanium plasma-sprayed screws supporting maxillary fixed partial prostheses

Outcomes | Pain from implant region, prostheses survival, marginal bone level changes on standardised intraoral radiographs, plaque accumulation, bleeding on probing, mechanical complications, hyperplasia of the peri-implant mucosa, peri-implant infections with bone loss (peri-implantitis) 1-year data used.

Notes | Implant stability not recorded. Data on implant failures may be underestimated and were therefore not included in the statistical calculations

Risk of bias

Bias | Authors' judgement | Support for judgement
---|---|---
Random sequence generation (selection bias) | Low risk | Study reported: "A randomisation list was generated......The study was performed in the maxilla as a split-mouth study; the Brånemark implants were used on one side, and the ITI implants were used on the contralateral side of the residual dentition according to a randomisation procedure. At this procedure, a blocking size of four was used, giving an equal probability of the patient's receiving ITI or Brånemark implants
Astrand 2002  (Continued)

<table>
<thead>
<tr>
<th>Allocation concealment (selection bias)</th>
<th>Unclear risk</th>
<th>Unclear from the study. Authors replied: “... no special measures were taken to conceal the randomisation schedules until treatment.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “The [radiographic] measurements were taken by two of the investigators working independently. In cases of a difference of &gt; 0.5 mm the radiographs were re-examined by both investigators and consensus was sought.” It was not possible to blind outcome assessors.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>All outcome data provided on request from authors, 2 participants died before the 3-year follow-up</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>High risk</td>
<td>The planned publication at 5-year was cancelled by the authors and the authors justified this as the sponsored implants not to be commercially available any longer. In our mind, this publication would have contained crucial information on the occurrence/outcome of peri-implantitis</td>
</tr>
</tbody>
</table>

Batenburg 1998

Methods 10-year follow-up randomised, parallel group study.

Participants Edentulous adults for at least 2 years with severely resorbed mandibles (class V-VI according to the classification of Cawood 1988). Treated in the University Hospital of Groningen, the Netherlands 90 enrolled (30 in each group) and results at 10 years given for 83 Excluded: people subjected to radiotherapy in the head and neck region or pre-prosthetic surgery or previous oral implantology were excluded

Interventions Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) submerged turned titanium screws Group 2: ITI® (Institut Straumann AG, Waldenburg, Switzerland) non-submerged hollow titanium plasma-sprayed screws
## Outcomes

Periotest and tapping the implant with superstructures removed, sensibility of lip and chin, marginal bone level changes on standardised intraoral radiographs, plaque accumulation, calculus, bleeding on probing, mucosa score, probing pocket depth, mucosa recession, width of attached peri-implant mucosa.

1-, 3-, 5- and 10-year data used.

## Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study reported: “Allocation to one of the treatment options was carried out by means of 90 envelopes, which contained a note with the implant system.” Authors replied: “patients were allocated by lot, i.e. by randomly picking one of the envelopes.”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the original article. Authors' reply did not clarify the procedure.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>Unclear risk</td>
<td>Study reported: “Bias was prevented by the fact that there was no sequence in measuring the radiographs and measurements were not performed per patient. In this way, there was no recollection by the observer as to bone loss in earlier years.” Comment: outcome assessors could not be blinded; however, it is unclear who measured the various outcomes whether an independent assessor or 1 of the operators. Authors could only have mixed the sequence of baseline and 1-year radiographs, not the other since reported the results over the years</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
<td>All outcome data presented. At the 1-year examination, 1 participant in the ITI group died. At the 5-year examination, 3 participants of the Brånemark group and 1 of the ITI group were unable to attend due to sickness. In addition, 1 participant in the...</td>
</tr>
</tbody>
</table>
ITI group died. At the 10-year examination, 3 participants of the Brånemark group and 1 of the ITI group were unable to attend due to sickness. In addition, 1 participant in the IMZ group died. Low attrition over 10 years: 7/90 participants

**Selective reporting (reporting bias)**
- Low risk
- No selective reporting identified.

**Other bias**
- Low risk
- No other bias identified.

### Crespi 2009

#### Methods
- 1-year follow-up, randomised parallel group study.

#### Participants
- Adults requiring an immediate post-extractive implants in the maxillae or mandible
- Treated in the Department of Dentistry, San Raffaele Hospital, Milan, Italy
- 45 enrolled and results given for 45.
- Exclusion criteria: chronic systemic disease, presence of dehiscence or fenestration of the residual bony walls, coagulation disorders, presence of signs of acute infection around alveolar bone at the surgical site, smokers > 10 cigarettes/day, alcohol or drug abuse, or bruxism

#### Interventions
- **Group 1:** Ankylos Plus® grit-blasted and high temperature etched surface, titanium grade 2 cylindrical screws with internal conical connection (Dentsply-Friadent, Mannheim, Germany)
- **Group 2:** 7 TPS titanium grade 4 screws with external hexagon (Sweden & Martina, Padua, Italy), immediate post-extractive and immediately loaded implants supporting single cemented crowns

#### Outcomes
- Marginal bone level changes on standardised periapical radiographs, plaque scores, bleeding index, pain, occlusion, prosthesis mobility, implant stability

#### Notes

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>No description in the article. Authors replied: “randomisation was done on patient assignment (by chance) to the group 1 or 2.” No further information was provided.</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No description in the article. Authors did not reply to our question.</td>
</tr>
</tbody>
</table>
### Crespi 2009 (Continued)

<table>
<thead>
<tr>
<th>Bias</th>
<th>Risk</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>Study clarified: “A blinded radiologist measured the changes in marginal bone height over time.” Authors replied: “The dental hygienist who measured the clinical parameters was blinded; implant stability was measured by the prosthodontist.” Comment: as the implant shapes were different, the radiographic outcome assessor could not be blinded</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals.</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other biases identified.</td>
</tr>
</tbody>
</table>

### den Hartog 2011

<table>
<thead>
<tr>
<th>Methods</th>
<th>18-month follow-up, randomised parallel group study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults requiring a single implant in the aesthetic zone (first to first maxillary premolar) between 2 adjacent teeth Treated in a University Medical Center, Groningen, the Netherlands 93 enrolled and results given for 93. Exclusion criteria: American Society of Anesthesiologists score ≥ III, presence of clinically active periodontal disease as expressed by probing depths ≥ 4 mm and bleeding on probing, presence of peri-apical lesions, sites with &lt; 6 mm mesio-distal width, smokers and a history of radiotherapy of the head and neck region</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: NobelReplace® Tapered Groovy TiUnite oxidised titanium grade 4 tapered screws with external connection (Nobel Biocare AB) Group 2: NobelReplace® Select Tapered TiUnite oxidised titanium grade 4 tapered screws with external connection Group 3: NobelPerfect® Groovy TiUnite oxidised titanium grade 4 tapered screws with external connection single implants</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Marginal bone level changes on standardised periapical radiographs, implant survival, papilla index, plaque scores, bleeding index, probing pocket depths, photographic assessments</td>
</tr>
<tr>
<td>Notes</td>
<td>The part of the trial comparing NobelPerfect Groovy with the other 2 implants was not used in the present review since NobelPerfect Groovy implants were systematically positioned at a higher position with respect to the adjacent bone. The article reported statistically significant more bone loss (0.8 mm) at NobelPerfect Groovy implants</td>
</tr>
</tbody>
</table>

### Risk of bias

<table>
<thead>
<tr>
<th>Risk of bias</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias</td>
<td>Authors' judgement</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Low risk</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>Unclear risk</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
</tr>
</tbody>
</table>
**Methods**  
1-year follow-up, randomised parallel group study.

**Participants**  
Adults with fully or partial edentulism, requiring 1-6 maxillary implants  
Treated in 2 different centres in Italy.  
60 enrolled and results given for 60.  
Exclusion criteria: any medical conditions contraindicating implant surgery, a history of radiotherapy of the head and neck region, bone grafted jaws and people that could not be restored with a retrievable prosthesis to allow for implant stability assessment

**Interventions**  
Group 1: MegaGen EZ Plus titanium grade 4 tapered screws with sand-blasted surface with internal connection (MegaGen Implant, Gyeongbuk, South Korea) standard form  
Group 2: MegaGen EZ Plus titanium grade 4 tapered screws with sand-blasted surface with internal connection (MegaGen Implant, Gyeongbuk, South Korea) modified form (calcium-incorporated surface: Xpeed) supporting early loaded screw-retained fixed prosthesis

**Outcomes**  
Prosthesis and implant success, implant stability assessed using a manual wrench with a torque of 20 Ncm, complications, marginal bone level changes on standardised periapical radiographs

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: “A computer-generated restricted random list was created by one of the authors who was not involved in patient recruitment or treatment, and had access to the random list stored in a password-protected portable computer.”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: “The randomised codes designated as ‘implant 1’ and ‘implant 2’ were enclosed in sequentially numbered, identical, opaque, sealed envelopes. Envelopes were opened sequentially after the implant sites were prepared, therefore treatment allocation was concealed to the investigators in charge of enrolling and treating the patients.”</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Low risk</td>
<td>Study clarified: “Two independent and fully blinded dentists not aware of patient allocation evaluated stability with the prostheses removed. Another independent and fully blinded dentist evaluated peri-implant marginal bone level changes.”</td>
</tr>
</tbody>
</table>
**Esposito 2012**

(Continued)

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals or failures.</td>
</tr>
<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other biases identified.</td>
</tr>
</tbody>
</table>

**Esposito 2013a**

<table>
<thead>
<tr>
<th>Methods</th>
<th>1-year follow-up randomised, split-mouth study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults with partial edentulism, requiring 2 maxillary or mandibular implants Treated in a private practice in Switzerland. 23 enrolled and results given for 22. Exclusion criteria: general contradictions to implant surgery, a history of radiotherapy of the head and neck region, uncontrolled diabetes, untreated periodontitis, pregnant, requiring augmentation procedure at implant placement, treated with intravenous bisphosphonates and requiring immediate implants</td>
</tr>
</tbody>
</table>
| Interventions | Group 1: SPI® Element implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (SPI® Element, Thommen Medical, Waldenburg, Switzerland) original form  
Group 2: SPI® Element implant sand-blasted acid-etched titanium grade 4 cylindrical screw with internal connection (SPI® Element, Thommen Medical, Waldenburg, Switzerland) modified surface (SurfLink®, Nano Bridging Molecules, Gland, Switzerland) supporting conventionally loaded cemented single implants. The SurfLink consisted of a monolayer of permanently bound multi-phosphonic acid molecules |
| Outcomes | Crown/implant failures, complications, peri-implant marginal bone level changes, marginal bleeding |

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: “A computer generated restricted random list was created for assignment of implant type.”</td>
</tr>
</tbody>
</table>
| Allocation concealment (selection bias)  | Low risk           | Study clarified: “The study centre received, at the beginning of the study, a series of numbered, identical, opaque, sealed envelopes containing the implantation site and implant type distribution for each patient. This letter was opened before the
surgery and after obtaining signed informed consent from the patient. Therefore, treatment allocation was concealed to the investigator in charge of enrolling and treating the patients."

| **Blinding (performance bias and detection bias)** | **Low risk** | Study clarified: “A quadruple-blind design (patients, operator, outcome-assessor and statistician) was adopted. Random codes were broken only after the complete statistical analyses were made. Since the SurfLink-treated implants were not distinguishable by the naked eye from the untreated control, the blinding procedure was successful. Two trained researchers evaluated the radiographs …… not involved in the SurfLink implant preparation or patient treatment, performed all radiographic assessments without knowing group allocation. Each assessment was double-checked by an experienced dentist (Dr Marco Esposito) trained in bone level assessments and final values were accepted only if both assessors agreed on the individual measurement.” |
| **Incomplete outcome data (attrition bias)** | **Low risk** | 1 baseline radiograph unreadable, otherwise no withdrawals. |
| **Selective reporting (reporting bias)** | **Low risk** | No selective reporting identified. |
| **Other bias** | **Low risk** | No other biases identified. |

### Fröberg 2006

| **Methods** | 18-month follow-up randomised, split-mouth study. |
| **Participants** | Adults with edentulous mandibles. Treated in a private dental practice in Nässjö, Sweden. 15 enrolled and results given for 15. Exclusion criteria: systemic diseases resulting in increased risk of infection and impaired healing, serious cardiac diseases, deficient homeostasis and blood dyscrasias, anticoagulant medication, psychological diseases, uncontrolled acute infections |
| **Interventions** | Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark III TiUnite oxidised Group 2: Mark III turned immediately loaded titanium screws supporting screw-retained cross-arch fixed prostheses |
### Fröberg 2006

**Outcomes**

Implant stability (resonance frequency analysis), marginal bone level changes on standardised intraoral radiographs, marginal bleeding index

**Notes**

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study reported: “The &quot;toss of a coin procedure&quot; was used to select the half of the jaw where the three turned implants had to be placed. An identical surgical procedure was then performed in the corresponding contralateral area of the mandible where the three TiUnite implants were placed.”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No description in the article. No answer to our request of clarification.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>No description in the article. No answer to our request of clarification.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>High risk</td>
<td>Not all radiographic data presented, but otherwise no withdrawals</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other biases identified</td>
</tr>
</tbody>
</table>

**Gatti 2002**

**Methods**

2-year follow-up randomised, parallel group study.

**Participants**

Edentulous adults for at least 3 months with mandibles having a residual bone height in the intraforaminal area adequate to harbour 4 implants at least 9 mm long. Treated in a private dental practice in Milan, Italy 10 enrolled (5 in each group) and results given for 10.

Exclusion criteria: severe intermaxillary skeletal discrepancy, strong gagging reflex, severe clenching or bruxism, previous implant surgery in the inter-foraminal area, drug or alcohol abuse, moderate or heavy smoking (> 10 cigarettes/day), radiotherapy in the head and neck region or treatment with antiblastic chemotherapeutics, chronic liver and renal disease, uncontrolled diabetes, haemophilia or other bleeding disorders or treatment with cumarin, metabolic bone disorders, immunocompromised conditions including human immunodeficiency virus, current steroid treatment, current pregnancy, general contraindications for surgical procedures, physical or psychiatric handicaps that could interfere with good oral hygiene, presence of mucosal disease such as lichen planus
### Gatti 2002 (Continued)

| Interventions | Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark II type non-submerged turned titanium screws  
<table>
<thead>
<tr>
<th></th>
<th>Group 2: Brånemark® conical transmucosal screws used without abutments supporting overdentures on 4 implants connected with a bar and immediately loaded</th>
</tr>
</thead>
</table>
| Outcomes      | Implant stability, marginal bone level changes on intraoral radiographs taken with a paralleling technique and on intraoral panoramic radiographs, plaque accumulation, gingival index, probing pocket depth  
|               | 1- and 3-year data used.                                                                                                                                                                           |
| Notes         |                                                                                                                                                                                                |

#### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the article. Authors replied: “Randomisation done by lot by another person other than the surgeon.”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the article. No answer to our request of clarification.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>High risk</td>
<td>No information provided in the article. Authors replied: “No blinding was done.”</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals.</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Unclear risk</td>
<td>Nothing to report with exception of the very low sample size (only 5 participants per group)</td>
</tr>
</tbody>
</table>

### Heberer 2011

<table>
<thead>
<tr>
<th>Methods</th>
<th>14-month follow-up randomised, split-mouth study.</th>
</tr>
</thead>
</table>
| Participants | Adults with ≥ 1 missing teeth following malignant tumour removal and radio-chemotherapy up to 72 Gy before implant placement. Radiotherapy was delivered in fractions of 2 Gy given daily for 5 days each week over 6 weeks. Implants were inserted at least 6 months after radiotherapy  
|          | Treated in the Charite University Medicine in Berlin, Germany  
|          | 20 enrolled and results given for 20.  
|          | Exclusion criteria: poor general health and smokers. |
### Interventions

| Group 1: 50 ITI (Institut Straumann AG, Waldenburg, Switzerland) non-submerged solid titanium screws with SLA surface |
| Group 2: 52 ITI SLActive surface non-submerged solid titanium modified surface characterised by a hydroxylated TiO2 film, early loaded at 6 weeks in mandibles and at 10 weeks in maxillas with 16 bar-supported overdentures and 4 fixed prostheses |

### Outcomes

- Implant stability, marginal bone level changes on intraoral panoramic radiographs, plaque accumulation, bleeding index, probing pocket depth

### Notes

#### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
</table>
| Random sequence generation (selection bias) | Unclear risk       | Study reported: "Test and control site were randomly assigned according to a split-mouth design."  
Author replied: "Following a randomisation list the implant were placed." |
| Allocation concealment (selection bias)    | Unclear risk       | Not described in the article.  
The authors did not reply to this question. |
| Blinding (performance bias and detection bias) All outcomes | Low risk           | Not described in the article.  
The examiner had no knowledge of what implant (SLA or SLActive) was used. |
| Incomplete outcome data (attrition bias) All outcomes | Low risk           | All outcome data presented. There were 2 failures before loading. There was 1 withdrawal at 1 year due to cancer recurrence and the mandible with 5 implants (2 SLA and 3 SLActive) had to be resected |
| Selective reporting (reporting bias)       | Low risk           | No selective reporting identified. |
| Other bias                                 | Low risk           | No other biases identified. |
Heydenrijk 2002

<table>
<thead>
<tr>
<th>Methods</th>
<th>5-year follow-up randomised, parallel group study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Edentulous adults for at least 2 years with severely resorbed mandibles (class V-VI according to the classification of Cawood 1988). Treated in the University Hospital of Groningen, the Netherlands 40 enrolled (20 in each group) and results given for 37. Exclusion criteria: people subjected to radiotherapy in the head and neck region or pre-prosthetic surgery or previous oral implantology</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: IMZ® (Friedrichsfeld AG, Mannheim, Germany) non-submerged titanium plasma-sprayed cylinders Group 2: ITI® (Institut Straumann AG, Waldenburg, Switzerland) non-submerged solid titanium plasma-sprayed screws supporting overdentures on 2 implants connected with a bar</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Periotest, marginal bone level changes on standardised intraoral radiographs, plaque accumulation, bleeding index, calculus, mucosa score, probing pocket depth, microbiological sampling</td>
</tr>
<tr>
<td>Notes</td>
<td>Outcome assessors could not be blinded. 3 withdrawals: 2 from the ITI group for death (year 3) and illness (year 4) and 1 from the IMZ group for moving (year 4)</td>
</tr>
</tbody>
</table>

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “The randomization process was as follow: a series of 60 integers were randomized and subsequently assigned to the consecutive patients. The first 20 randomized integers were assigned to IMZ 1-stage, the second 20 integers to IMZ 2-stage, and the remaining integers to ITI. A note with the assigned treatment modality was put in an envelope for each patient. In this way, the consecutive patients received a randomly assigned treatment modality.” No answer to our request of clarification.</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the article. No answer to our request of clarification.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>Unclear risk</td>
<td>Study reported: “Measurements were done by the same observer throughout the evaluation period after calibration.” No answer to our request of clarification.</td>
</tr>
</tbody>
</table>
### Heydenrijk 2002 (Continued)

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>3 out of 40 withdrawals: 2 from the ITI group for death (year 3) and illness (year 4) and 1 from the IMZ group for moving (year 4). All outcome data presented apart from 2 radiographs missing for 2 participants, 1 from each group</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Unclear risk</td>
<td>Insufficient information to evaluate the comparability of groups at entry</td>
</tr>
</tbody>
</table>

### Kielbassa 2009

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>3-year follow-up randomised, multicentre, parallel group study</td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>Adults with (\geq 1) missing teeth in a healed site (for at least 6 months after extraction) of the maxilla or mandible, with a residual bone height adequate to harbour implants with a diameter of at least 3.5 mm and length of at least 10 mm long. Treated in 12 different University Hospitals in Berlin, Seville, Jerusalem, Vienna, Rome, Witten, Freiburg, Graz, Milan, Bern, Liege and Madrid. 177 enrolled (NobelActive Internal 64 included, NobelActive External 53, NobelReplace 60 included) results given for 127 participants at 3 years. Exclusion criteria: health problems that would preclude surgical procedures, drug or alcohol abuse, any pathological condition, severe bruxism, psychiatric disease, inability of the person to provide informed consent, the need for bone augmentation to obtain an ideal position of the implant(s), residence outside the city of the respective study centre or inability for follow-up</td>
<td></td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: NobelActive® TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB, Göteborg, Sweden). Group 2: NobelActive® TiUnite oxidised titanium grade 4 tapered screws with external hexagon. Group 3: NobelReplace® Tapered Groovy TiUnite oxidised titanium grade 4 tapered screws with internal connection, placed in healed sites with immediate provisional single crown restorations</td>
<td></td>
</tr>
<tr>
<td>Outcomes</td>
<td>Crestal bone levels around implants, implant stability, soft tissue aesthetics, number of adverse events at participant level, papilla score, plaque accumulation</td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td>At 3-years, 45 participants were lost to follow-up: 18 in the tapered implant with variable thread group, 9 in the transmucosal tapered implant with variable-thread design group, and 18 in the standard tapered implant group</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Random sequence generation (selection bias)</th>
<th>Low risk</th>
<th>Study clarified: &quot;Prior to surgery, patients were randomised into 1 of the 3 treatment groups using sealed, numbered, opaque envelopes prepared in advance by the sponsor. The envelopes were prepared from a random-number table using a blocking method of 12 assignments per block.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>High risk</td>
<td>Study clarified: &quot;The details of the randomisation procedure were unknown to all of the investigators. Thus, a complete separation of the individuals involved in the generation and implementation of the assignments was guaranteed.&quot; Authors replied: &quot;Different implants were allocated to patients after inclusion, and right (usually several days) before surgery. Due to the fact that the different implant types needed different instruments and components (i.e. drills, drivers etc), it was not practical to break the allocation seal after flap elevation. Hence the seal was broken as soon as possible (most times after the patient was included and had signed informed consent forms), and before the beginning of the surgical procedure.&quot;</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>High risk</td>
<td>Study clarified: &quot;Due to the nature of the treatment, neither the study personnel nor the patients could be blinded to treatment assignment.&quot; Authors replied: &quot;... apart from the radiographic assessment, the other parameters were evaluated by the surgeon at each study centre. With the follow-ups, another dentist took care occasionally (in some cases the surgeon was not available).&quot; Comment: the outcome assessors could have been blinded to some of the outcome measures, otherwise independent assessors could have been used</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>High risk</td>
<td>At 3-years, 45 participants out of 177 were lost to follow-up. All outcome data presented</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
</tbody>
</table>
### Lang 2007

**Methods**

1-year follow-up randomised, parallel group study.

**Participants**

Adults > 21 years needing an immediate post-extractive implant in the aesthetic zone (premolar to premolar) between 2 adjacent teeth

Treated at 9 different centres possibly London, Rimini, Boston, Bern, Connecticut, Copenhagen, Geneva, Zurich and Athens

208 enrolled (104 in each group) and results given for 208.

Exclusion criteria: generic contraindication to oral surgery, smoking > 10 cigarettes/day, periodontal bone loss > 20% at the adjacent teeth, full-mouth plaque and bleeding scores > 25% at baseline, teeth to be replaced affected by periodontal disease, presence of symptomatic periapical radiolucencies, acute abcesses or chronic sinus tracts at the implant site, lack of primary implant stability, < 7 mm of mesio-distal space between the adjacent teeth, < 2 mm of keratinised mucosa

**Interventions**

Group 1: ITI® (Institut Straumann AG, Waldenburg, Switzerland) submerged sandblasted large-grit acid-etched (SLA) solid titanium screws: cylindrical

Group 2: ITI® (Institut Straumann AG, Waldenburg, Switzerland) submerged sandblasted large-grit acid-etched (SLA) solid titanium screws: tapered shape

Sites were augmented with granules of deproteinised bovine bone mineral (BioOss Spongiosa) and resorbable barriers (BioGide) if there was a residual gap defect of at least 0.5 mm between the bone and the implant, exposed SLA surface in a supracrestal location, and a buccal bony plate < 1 mm

**Outcomes**

Implant stability (resonance frequency analysis), complications, marginal bone level changes on standardised intraoral radiographs, participant evaluation of the surgical procedure, operator and assistant evaluation of the surgical procedure

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: “Patients were entered into the study by a Central Registrar. After having been entered into the study, all subjects were randomly assigned to one of the two treatment regimens according to pre-defined randomisation tables and using a balanced random-permuted block approach stratifying for smoking status.”</td>
</tr>
</tbody>
</table>
### Lang 2007 (Continued)

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: “Assignment was concealed from the investigator until the time during the surgical procedure that required application of the cylindrical or the tapered implant by an opaque envelope.”</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Low risk</td>
<td>There was no information about blinding in the article. Authors replied: “Every centre had an assessor separate from the surgeon that performed the procedures. From the transmucosal part of the implant it was not possible to tell which implant had been used except for the radiographs. These, however, were not accessible to the assessors.”</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals.</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>High risk</td>
<td>Not all evaluated outcomes were presented.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other biases identified.</td>
</tr>
</tbody>
</table>

### Lee 2007

<table>
<thead>
<tr>
<th>Methods</th>
<th>3-year follow-up randomised, split-mouth study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Partially edentulous adults showing good oral health. Treated in the College of Dentistry, Yonsei University, Seoul, Korea 17 enrolled and results given for 17. Exclusion criteria: no specific criteria mentioned.</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: Astra® TiO₂-blast titanium grade 3 cylindrical screws with internal connection without the Microthread™ (Astra Tech AB, Mölndal, Sweden) Group 2: Astra® TiO₂-blast titanium grade 3 tapered screws with internal connection with the Microthread™, placed adjacent to each other restored as a 2-unit fixed prosthesis</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Marginal bone level changes on standardised intraoral radiograph, pain from the implant regions, implant stability, gingival inflammation, superstructure complications</td>
</tr>
</tbody>
</table>

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
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<tbody>
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<td></td>
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</tbody>
</table>
Lee 2007 (Continued)

<table>
<thead>
<tr>
<th>Random sequence generation (selection bias)</th>
<th>Low risk</th>
<th>Study reported “At the same edentulous area of each patient, one fixture of each implant type was installed in a randomised order.” Authors replied: “randomisation was done by throwing coins.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no information about allocation concealment in the article. The authors replied that allocation concealment was done during surgery.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>High risk</td>
<td>There was no information about blinding in the article. Comment: we considered that the study was not blinded.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals.</td>
</tr>
<tr>
<td>Selective reporting (reporting bias) Low risk</td>
<td>No selective reporting identified.</td>
<td></td>
</tr>
<tr>
<td>Other bias Low risk</td>
<td>No other bias identified.</td>
<td></td>
</tr>
</tbody>
</table>

Moberg 2001

<table>
<thead>
<tr>
<th>Methods</th>
<th>3-year follow-up randomised, parallel group study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults with edentulous mandibles treated in the University Dental Clinic of the Karolinska Institute, Huddinge, Sweden. 40 enrolled (20 in each group) and results given for 36. Exclusion criteria: general or local contraindications (such as systemic medical conditions, drug abuse or local jaw pathology), or both</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark II type submerged turned titanium screws. Group 2: ITI® (Institut Straumann AG, Waldenburg, Switzerland) non-submerged hollow titanium plasma-sprayed screws supporting fixed prostheses</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Periotest and tapping the implant with superstructures removed at 3 years, marginal bone level changes on intraoral and panoramic radiographs, plaque accumulation, marginal bleeding, probing pocket depths, tightness of screws, sensory changes, treatment time, participant satisfaction, mechanical and biological complications, peri-implant infections with bone loss. 1- and 3-year data used.</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
</tbody>
</table>
### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the article. No answer to our request of clarification.</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>No information provided in the article. No answer to our request of clarification.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>Not possible, but no information provided on who made the assessments (an independent outcome assessor could have been used) No answer to our request of clarification.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>4 out of 40 withdrawals: 2 in the Brånemark group (1 died and 1 did not attend the radiographic examination) and 2 died in the ITI group. All outcome data presented</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Unclear risk</td>
<td>At the 3-year examination, 2 ITI implants were treated for peri-implantitis and their fate was not reported</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>

### Payne 2003

**Methods**

10-year follow-up randomised, parallel group study.

**Participants**

Adults aged 55-80 years with edentulous mandibles having 8-15 mm of residual anterior bone height

Treated in the School of Dentistry, University of Otago, Dunedin, New Zealand

24 enrolled (12 in each group) and results given for 18.

Exclusion criteria: people with type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) detected at implant insertion (none), previously bone-grafted or irradiated jaws, history of bruxism, any evidence of current or previous smoking and any systemic diseases likely to compromise implant surgery

**Interventions**

Group 1: ITI® (Institut Straumann AG, Waldenburg, Switzerland) non-submerged sand-blasted large-grit acid-etched (SLA) solid titanium screws

Group 2: Southern® (Southern Implants Ltd, Irene, South Africa) non-submerged sand-blasted acid-etched titanium screws supporting overdentures on 2 implants early loaded at 2 weeks
Payne 2003  (Continued)

Outcomes

- Resonance frequency analysis, marginal bone level changes on standardised intraoral radiographs, prosthesis survival, plaque accumulation, modified gingival index, probing pocket depth, width of the keratinised mucosa, recession, prosthetic maintenance events 1-, 3-, 5- and 10-year data used.

Notes

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study reported: “A table of random numbers was used with maximum concealment to allocate...”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “A table of random numbers was used with maximum concealment to allocate...” Allocation concealment unclear from the study.</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>Outcome assessors could not be blinded; however, independent outcome assessors could have been used</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>High risk</td>
<td>All outcome data presented. 6 withdrawals out of 24 participants over 10 years: 3 in the ITI group (2 died and 1 lack of interest) and 3 in the Southern group (2 died and 1 dropped out)</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>

Payne 2004

Methods

- 1-year follow-up randomised, parallel group study.

Participants

- Adults aged 55-80 years with edentulous maxillae opposing overdentures supported by 2 implants
- Treated in the School of Dentistry, University of Otago, Dunedin, New Zealand
- 40 enrolled (20 in each group) and results given for 38

Exclusion criteria: maxillae with a shape type E (extremely resorbed) according to the Lekholm and Zarb classification (Lekholm 1985) on radiographs, previously bone-grafted maxillae, history of bruxism, any evidence of current or previous smoking and any systemic disease likely to compromise implant surgery
Payne 2004  (Continued)

| Interventions | Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) TiUnite non-submerged oxidised titanium screws of 3.3 mm diameter  
Group 2: Southern® (Southern Implants Ltd, Irene, South Africa) non-submerged sandblasted acid-etched titanium screws 3.25 mm diameter supporting maxillary overdentures on 3 unsplinted implants early loaded at 12 weeks  
Maxillae were treated with either a ridge expansion osteotomy or a combined ridge split and osteotomy procedure, depending on the ridge bucco-palatal width and the degree of ridge resorption. Autogenous bone grafts were used to fill intraosseous grooves of the ridge split-cases |

| Outcomes | Stability test, marginal bone level changes on standardised intraoral radiographs, resonance frequency values  
1-year data used. |

| Notes |

| Risk of bias |

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study reported: &quot;Using a table of random numbers the participants were randomly allocated (with maximum concealment).&quot;</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>Study reported: &quot;Using a table of random numbers the participants were randomly allocated (with maximum concealment).&quot;</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>Unclear risk</td>
<td>Outcome assessors could not be blinded; however, independent outcome assessors could have been used</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
<td>All outcome data presented. 2 withdrawals out of 40 participants: 1 in the Brånemark group (1 of the study implants could not be placed) and 1 in the Southern group (death)</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>
### Methods
1-year follow-up randomised, split-mouth study.

### Participants
Adults with partially edentulous mandibles.
Treated in a private dental practice in Rome, Italy.
34 enrolled and results given for 34.
Exclusion criteria: severe bleeding disorders, uncontrolled diabetes or cancer, psychological diseases, untreated periodontitis and people taking intravenous bisphosphonates.

### Interventions
- **Group 1:** NobelActive® TiUnite oxidised titanium grade 4 tapered screws with internal connection (Nobel Biocare AB)
- **Group 2:** Nobel Speedy Groovy TiUnite oxidised titanium grade 4 tapered screws with external connection (Nobel Biocare AB) placed in healed sites loaded after 4 months of healing with single crowns.

### Outcomes
Implant stability (resonance frequency analysis), marginal bone level changes on standardised intraoral radiographs, surgical and prosthetic complications, bleeding on probing and plaque scores.

### Notes

#### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: &quot;A pregenerated random sequence was created... Opaque envelopes were sealed according to pregenerated list.&quot;</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Low risk</td>
<td>Study clarified: &quot;An independent judge prepared all envelopes. Each edentulous site of each patient was randomly assigned to one of the two implant groups. Immediately after flap elevation, an assistant indicated which implant had to be placed first following the indications contained in the sequentially numbered envelope.&quot;</td>
</tr>
</tbody>
</table>
| Blinding (performance bias and detection bias) | Unclear risk       | Study clarified: "An independent assessor made intraoral radiographs by means of a custom radiographic holder and parallel technique... An independent radiologist, not previously involved in this study, performed all the bone height measurements. ", "One blinded outcome assessor who was otherwise not involved in the study performed all resonance frequency measurements." Comment: the assessors of the reso-
### Prosper 2009

#### Methods
2-year follow-up randomised, split-mouth study.

#### Participants
Adults aged 25-70 years with 6 posterior missing teeth, at least 1 in each posterior quadrant
Treated in 12 dental centres in 5 major demographic areas of Italy
68 enrolled and results given for 66.
Exclusion criteria: previous dental implant surgery, temporomandibular disorders, any evidence of current or previous smoking and any systemic disease likely to compromise implant surgery

#### Interventions
- **Group 1:** WINSIX® cylindrical screws (WINSIX Ltd, London, UK)
- **Group 2:** WINSIX® tapered screws inserted into healed sites and conventionally loaded supporting single crowns for 2 years
Each participant received 3 tapered implants and 3 cylindrical implants. Of these implants, 1 was placed submerged, 1 was non-submerged and 1 was platform switched

#### Outcomes
Stability test using the implant stability quotient, marginal bone level changes on standardised intraoral radiographs, sulcus bleeding index, plaque index, pain levels

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Low risk</td>
<td>Study reported: &quot;Randomization was done with sealed opaque envelopes containing designations based on within patient allocation lists randomly generated at the permuted block size of 6 and stratified according to centre.&quot;</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>There was no clarification from the study as to whether the surgeons knew which implant they would be placing before prepa-</td>
</tr>
</tbody>
</table>
Prosper 2009 (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Blinding (performance bias and detection bias)</th>
<th>Incomplete outcome data (attrition bias)</th>
<th>Selective reporting (reporting bias)</th>
<th>Other bias</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High risk</td>
<td>Low risk</td>
<td>High risk</td>
<td>Low risk</td>
</tr>
<tr>
<td></td>
<td>Outcome assessors could not be blinded.</td>
<td>All outcome data presented, 2 withdrawals out of 68 participants over first 12 months: 4 cylindrical implants failed vs. 2 tapered implants. There were 2 withdrawals in the first 12 months</td>
<td>Data not given for the participants in which implants failed</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>

Schincaglia 2007

Methods

3-year follow-up randomised, split-mouth study.

Participants

Adults with bilateral distal partial edentulous mandibles allowing the placement of at least 2 x 8.5-mm long implants
Treated in the School of Dentistry, University of Bologna, Italy
10 participants enrolled and results given for 10.
Exclusion criteria: need of augmentation procedures, extraction sites healing < 4 months, different type of opposing bilateral occlusion, implants inserted with a torque < 20 Ncm or with an implant stability quotient < 60

Interventions

Group 1: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark IV TiUnite oxidised
Group 2: Brånemark® (Nobel Biocare AB, Göteborg, Sweden) Mark IV turned, immediately loaded titanium screws supporting screw-retained partial fixed prostheses

Outcomes

Resonance frequency analysis, marginal bone level changes on intraoral radiographs, pocket depths, sulcus bleeding index, plaque index, prostheses survival
3-year data used.

Notes
### Schincaglia 2007

(Continued)

<table>
<thead>
<tr>
<th>Risk of bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “Test and control sides were randomly assigned according to a pre-determined randomisation table.” Authors replied: “A list with 10 positions was created before patient's recruitment. For each position the test side (where the test implants should have been inserted) was chosen by flip coin. Then, the eligible patients were consecutively assigned to a position of the list as they entered the study (first patient to position 1 ...).”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>High risk</td>
<td>There was no clarification from the study. Authors replied: “Therefore the test and the control sides were known at the time of patient enrolment and the surgeon was not blinded.”</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>Study reported: “A blinded examiner measured the bone on each radiograph.” No information provided for the other outcomes.</td>
</tr>
<tr>
<td>Blinding (performance bias) All outcomes</td>
<td>Unclear risk</td>
<td>Study reported: “A blinded examiner measured the bone on each radiograph.” No information provided for the other outcomes.</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals. The authors provided the mean radiographic bone loss change at a participant level on request</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>

### Song 2009

<table>
<thead>
<tr>
<th>Methods</th>
<th>1-year follow-up randomised, split-mouth study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults aged 37-78 years with partially edentulous sites. Most participants were in good health, and the 2 participants who had diabetes and hypertension were well controlled with medication. Treated in the College of Dentistry, Yonsei University, Seoul, Korea 20 enrolled and results given for 20. Exclusion criteria: no specific criteria.</td>
</tr>
</tbody>
</table>
**Interventions**

<table>
<thead>
<tr>
<th>Group 1: Implantium® sand-blasted, large grit, acid-etched (SLA) titanium cylindrical screws with microthreads 0.5 mm below the top of the implant and internal connection (Dentium, Seoul, Korea)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 2: Implantium® SLA titanium cylindrical screws with microthreads to top of the implant and internal connection (Dentium)</td>
</tr>
</tbody>
</table>

Implants were placed adjacent to each other restored as a 2-unit fixed prosthesis apart from 2 participants where the implants were splinted to fabricate 3- and 4-unit prostheses. Mandibular implants were loaded after 3 months and maxillary implants after 6 months.

**Outcomes**

Prosthesis and implant failure, complications, marginal bone level changes on standardised intraoral radiograph, pain, discomfort, modified plaque index and modified sulcus bleeding index

1-year data used.

**Notes**

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>The study did not state how randomisation was done. Authors replied: “Randomisation was done by throwing coins.”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>The study did not state if there was allocation concealment. Authors replied: “it was concealed to surgeons.”</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>High risk</td>
<td>It was not possible to blind the outcome assessors to the radiographic readings but independent assessors could have been used as well as blinded assessor could have been used to test implant mobility</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias) All outcomes</td>
<td>Low risk</td>
<td>All outcome data presented, no withdrawals.</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>
Tawse-Smith 2001

<table>
<thead>
<tr>
<th>Methods</th>
<th>10-year follow-up randomised, parallel group study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Edentulous mandibles having 13-15 mm of residual anterior bone height Treated in the School of Dentistry, University of Otago, Dunedin, New Zealand 24 enrolled (12 in each group) and results given for 20. Exclusion criteria: people with type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) detected at implant insertion (none), previously bone-grafted or irradiated jaws, history of bruxism, any evidence of current or previous smoking and any systemic disease likely to compromise implant surgery</td>
</tr>
<tr>
<td>Interventions</td>
<td>Group 1: Steri-Oss® (Steri-Oss, Yorba Linda, California, USA) non-submerged acid-etched titanium screws HL series, 3.8 mm in diameter Group 2: Southern® (Southern Implants Ltd, Irene, South Africa) non-submerged sand-blasted acid-etched titanium screws supporting mandibular overdentures on 2 implants conventionally loaded at 12 weeks</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Prosthesis and implant failures, complications, marginal bone level changes on standardised intraoral radiographs, plaque accumulation, modified sulcus bleeding index, probing pocket depth, width of the keratinised mucosa 1-, 3-, 5- and 10-year data used.</td>
</tr>
</tbody>
</table>

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>Not reported in the study. Authors replied: “Patients were first allocated on a one-by-one basis to each of our implant systems (total was actually 4 systems: Sterioss, Southern, ITI and Bränemark). Thereafter using a table of random numbers we went down each list and allocated the patient to a loading group (either 12 weeks, 6 weeks and for forthcoming publications 2 weeks),”</td>
</tr>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>Unclear from the study and authors’ reply did not clarify the matter</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias) All outcomes</td>
<td>Unclear risk</td>
<td>Not reported in the study. Authors replied: “Outcome assessors were definitively blinded with respect to the loading schedule, however the loading schedule was not under investigation and we judged that it was not possible to blind for the outcome measures of interest in the present review.”</td>
</tr>
</tbody>
</table>
Tawse-Smith 2001  (Continued)

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comment</td>
<td>it remains unclear whether an independent outcome assessor was used</td>
<td></td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>Low risk</td>
<td>All outcome data presented. 4 drop-outs occurred over a 10-year period: 3 in the Steri-Oss group (2 drop-outs and 1 death) and 1 in the Southern group (death)</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>Low risk</td>
<td>No other bias identified.</td>
</tr>
</tbody>
</table>

Tawse-Smith 2002

Methods  
10-year follow-up randomised, parallel group study.

Participants  
Edentulous mandibles having 13-15 mm of residual anterior bone height  
Treated in the School of Dentistry, University of Otago, Dunedin, New Zealand  
24 enrolled (12 in each group) and results given for 19.  
Exclusion criteria: people with type IV bone quality (very soft bone) according to the Lekholm and Zarb classification (Lekholm 1985) detected at implant insertion (none), previously bone-grafted or irradiated jaws, history of bruxism, any evidence of current or previous smoking, any systemic disease likely to compromise implant surgery

Interventions  
Group 1: Steri-Oss® (Steri-Oss, Yorba Linda, California, USA) non-submerged acid-etched titanium screws HL series, 3.8 mm in diameter  
Group 2: Southern® (Southern Implants Ltd, Irene, South Africa) non-submerged sandblasted acid-etched titanium screws supporting mandibular overdentures on 2 implants early loaded at 6 weeks

Outcomes  
Periotest, marginal bone level changes on standardised intraoral radiographs, prostheses survival, plaque accumulation, modified sulcus bleeding index, probing pocket depth, width of the keratinised mucosa  
1-, 3-, 5- and 10-year data used.

Notes  
Most of the failed implants were placed by a surgeon who placed only Steri-Oss implants

Risk of bias

Bias  | Authors’ judgement | Support for judgement |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Random sequence generation (selection bias)</td>
<td>Unclear risk</td>
<td>Not reported in the study. Authors replied: “Patients were first allocated on a one-by-one basis to each of our implant systems (total was actually 4 systems: Steri-Oss, Southern, ITI and Brånemark). Thereafter using a table of random numbers we went down each list</td>
</tr>
</tbody>
</table>
**Tawse-Smith 2002** *(Continued)*

<table>
<thead>
<tr>
<th>Bias Type</th>
<th>Risk Level</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment (selection bias)</td>
<td>Unclear risk</td>
<td>Unclear from the study and authors' reply did not clarify the matter</td>
</tr>
<tr>
<td>Blinding (performance bias and detection bias)</td>
<td>Unclear risk</td>
<td>Not reported in the study. Authors replied: “outcome assessors were definitively blinded with respect to the loading schedule, however the loading schedule was not under investigation and we judged that it was not possible to blind for the outcome measures of interest in the present review.” Comment: it remains unclear whether an independent outcome assessor was used</td>
</tr>
<tr>
<td>Incomplete outcome data (attrition bias)</td>
<td>High risk</td>
<td>All outcome data presented, 2 drop-outs occurred over a 10-year period in the Steri-Oss group and 3 participants died in the Southern group, out of 12 participants in each group</td>
</tr>
<tr>
<td>Selective reporting (reporting bias)</td>
<td>Low risk</td>
<td>No selective reporting identified.</td>
</tr>
<tr>
<td>Other bias</td>
<td>High risk</td>
<td>Most of the failed Steri-Oss implants were placed by a surgeon who placed only Steri-Oss implants and who was judged, afterwards, to have insufficient clinical experience, therefore effect of the different implant systems is confounded by the different degree of surgical experience of different operators</td>
</tr>
</tbody>
</table>

**Wennström 2004**

| Methods                                        | 5-year follow-up randomised split-mouth study. |
| Participants                                   | Partially edentulous adults with a previous history of periodontal disease Treated in the University of Gothenburg, Sweden. 51 enrolled and results given for 47. Exclusion criteria: people with inadequate self performed plaque control, insufficient bone volume at the recipient sites (i.e. need for ridge augmentation or sinus lift procedures), uncontrolled diabetes, haemophilia, metabolic bone disorder, history of renal failure, radiation treatment to the head or neck region, current chemotherapy, pregnancy |
| Interventions | Group 1: Astra® (Astra Tech AB, Mölndal, Sweden) submerged titanium cylindrical screws with TiO2-blasted surfaces.  
| Group 2: Astra® (Astra Tech AB, Mölndal, Sweden) submerged titanium cylindrical screws with turned surfaces supporting screw-retained partial fixed prostheses |
| Outcomes | Prosthesis success, implant survival, peri-implant marginal bone level changes, prosthetic complications, plaque score, bleeding sites, probing pocket depth, width of the keratinised mucosa |
| Notes | Authors did not disclose how many implants with a turned or a TiO2-blasted surface were placed and reported the data of the various outcomes combined for both implant types, rendering the comparison of the 2 surfaces meaningless |

**Risk of bias**

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
</table>
| Random sequence generation (selection bias) | High risk | Study reported: “Each patient received a minimum of two implants, and by randomization every second implant that was installed had been designed with a machined surface and the remaining with a roughened Tioblast surface.”  
No reply to letter.  
Comment: this method of allocation determines an imbalanced number of implants of the 2 different types |
| Allocation concealment (selection bias) | Low risk | Study reported: “The randomization code for the single patient was made available for the operator first after he had completed preparation of the recipient sites.” |
| Blinding (performance bias and detection bias)  
All outcomes | Unclear risk | Unclear from the study.  
No reply to letter. |
| Incomplete outcome data (attrition bias)  
All outcomes | Unclear risk | 4 withdrawals after 2, 3 and 4 years, 3 due to participant death and 1 because the participant did not come back. Unclear whether prostheses were removed to assess implant mobility and, for this reason, the study could be used only to answer the first part of the secondary objective  
No reply to letter. |
| Selective reporting (reporting bias) | High risk | Authors did not disclose how many implants with a turned or a TiO2-blasted sur- |
Wennström 2004  

face were placed and reported the data of the various outcomes combined for both implant types, rendering the comparison of the 2 surfaces meaningless. No reply to our letter for requesting more details

| Other bias | Low risk | No other biases identified. |

**Characteristics of excluded studies  [ordered by study ID]**

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abtahi 2012</td>
<td>Follow-up &lt; 1 year post-loading.</td>
</tr>
<tr>
<td>Boerrigter 1997</td>
<td>The number of participants at entry in each group changed during the 10-year follow-up. Implant stability was not assessed. The authors did not reply to our letter</td>
</tr>
<tr>
<td>Camullo 2012</td>
<td>The prostheses were permanently cemented on the implants. Authors replied: “the implant restorations were not removed to assess mobility after 1 year.” Individual implant stability could not be assessed.</td>
</tr>
<tr>
<td>Cehreli 2010</td>
<td>The author informed us that this was a retrospective study.</td>
</tr>
<tr>
<td>da Cunha 2004</td>
<td>Follow-up &lt; 1 year post-loading.</td>
</tr>
<tr>
<td>Du Preez 2007</td>
<td>Quasi-randomised trial.</td>
</tr>
<tr>
<td>Esposito 2013b</td>
<td>Follow-up &lt; 1 year post-loading, but the trial is ongoing.</td>
</tr>
<tr>
<td>Friberg 1992</td>
<td>Study classified as not a randomised controlled trial after author's reply</td>
</tr>
<tr>
<td>Friberg 2003</td>
<td>Quasi-randomised trial.</td>
</tr>
<tr>
<td>Geertman 1996</td>
<td>Data of 2 different randomised controlled trials were combined. Asked for separate data. No reply to letter</td>
</tr>
<tr>
<td>Geurs 2002</td>
<td>Unclear which implant type(s) failed and number of drop-outs. Author's reply did not clarify the issue</td>
</tr>
<tr>
<td>Gher 1994</td>
<td>Problems with design and analysis. The unit of randomisation was both the participant and the implant and it was not possible to use the data without further information from authors. The authors did not reply to our letter</td>
</tr>
<tr>
<td>Goené 2007</td>
<td>Experimental mini-titanium implants placed in humans and removed for histology 4-8 weeks after unloaded healing</td>
</tr>
<tr>
<td>Author</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Gultekin 2013</td>
<td>Some prostheses were permanently cemented on the implants. Authors replied: “It was not possible to check implants separately after loading as to whether they were mobile or not because all restorations were cemented.” Individual implant stability could not be assessed.</td>
</tr>
<tr>
<td>Joly 2003</td>
<td>Follow-up &lt; 1 year post-loading.</td>
</tr>
<tr>
<td>Jones 1997</td>
<td>Study judged not to be a randomised controlled trial. No reply to letter</td>
</tr>
<tr>
<td>Kadkhodazadeh 2013</td>
<td>Study judged not to be a randomised controlled trial due to unbalanced placements of different implant types. No reply to letter</td>
</tr>
<tr>
<td>Kang 2012</td>
<td>It was uncertain whether the adjacent implants were splinted or not, and whether the restorations were removed to assess stability. No reply to our letter</td>
</tr>
<tr>
<td>Karabuda 2002</td>
<td>Study classified as not a randomised controlled trial after author's reply</td>
</tr>
<tr>
<td>Karlsson 1998</td>
<td>Not all participants were participating in a split-mouth study. Author's reply did not clarify the issue</td>
</tr>
<tr>
<td>Kemppainen 1997</td>
<td>1 group of participants received 1 implant type whereas the other group received implants of the same brand but with different shapes (ITI hollow cylinders or screws)</td>
</tr>
<tr>
<td>Khang 2001</td>
<td>Implant stability only assessed at delivery of final prosthesis on fixed prostheses and overdentures and not at later follow-up with removed prosthesis. Type of ‘split-mouth’ study with unequal number of implants randomly allocated to each participant. Author had no time to re-analyse data</td>
</tr>
<tr>
<td>Kim 2010</td>
<td>Trial described as a randomised controlled trial; however, authors reported the following: “The mesiodistal location of each implants were randomly determined. However, because of the difference in coronal diameter of fixtures, mostly S were implanted mesial to C.” We interpret this as the trial being not truly randomised.</td>
</tr>
<tr>
<td>Liaje 2012</td>
<td>Implant stability was not assessed. The authors reported: “The prosthesis were cemented after the fabrication and the implant stability was not assessed at 1 year.”</td>
</tr>
<tr>
<td>Liddelow 2010</td>
<td>'Risky' trial comparing 2 different single implants immediately loaded with a mandibular overdenture. The study was discontinued due to excessive implant failures</td>
</tr>
<tr>
<td>Mackie 2011</td>
<td>Compilation of various randomised controlled trials evaluating different implant systems (Steri-Oss, Southern, Straumann, Bränemark) and loading protocols of 2, 6 and 12 weeks. Some of these trials are already included in the present review</td>
</tr>
<tr>
<td>Mau 2002</td>
<td>Unusually high drop-out rate often for questionable reasons (only data of 189 of the 313 participants admitted in the trial were presented). Early failures counted as drop-outs. Unclear success criteria. Unclear follow-up periods. We were unable to extract any meaningful data. No reply to letter</td>
</tr>
<tr>
<td>Reference</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mau 2003</td>
<td>Problem as number of implants was confounded with implant type: participants having an overdenture supported by 2 IMZ cylinders were compared with participants with an overdenture supported by 4 ITI TPS screws</td>
</tr>
<tr>
<td>Oates 2007</td>
<td>Follow-up &lt; 1 year post-loading.</td>
</tr>
<tr>
<td>Orsini 2007</td>
<td>Trial evaluating experimental implants placed in humans and retrieved 2 months after placement for histological evaluation</td>
</tr>
<tr>
<td>Park 2010</td>
<td>Follow-up &lt; 1 year post-loading.</td>
</tr>
<tr>
<td>Peñarrocha-Diago 2012</td>
<td>It was unclear from the study whether the prosthesis were removed to assess implant stability Authors responded: “due to the absence of clinical symptoms or radiological signs that indicate problems in those splinted implants, we saw unjustified the removal of the fixed prostheses of those splinted implants by bar/bridges. So at 12 months of loading, mobility was not assessed in those splinted implants.” We did not consider this was acceptable since it has been demonstrated that implants can be mobile even in absence of radiographic signs</td>
</tr>
<tr>
<td>Piao 2009</td>
<td>Implant stability not recorded, radiographic baseline used was set at loading and not at implant placement. No reply to letter</td>
</tr>
<tr>
<td>Reingewirtz 2000</td>
<td>Study classified as not a randomised controlled trial since only one Calcitek implant was compared with 23 Microdent. Not written to authors</td>
</tr>
<tr>
<td>Roccuzzo 2003</td>
<td>Not a randomised controlled trial but quasi-randomised trial with alternate assignment</td>
</tr>
<tr>
<td>Roccuzzo 2001</td>
<td>Problem as time of implant loading was confounded with implant type: ITI SLA implants healed for 6 weeks, whereas ITI TPS implants healed for 12 weeks. Mobile implants not considered failures</td>
</tr>
<tr>
<td>Sanz 2010</td>
<td>Follow-up &lt; 1 year post-loading. Unclear numbers of participants within each group</td>
</tr>
<tr>
<td>Schätzle 2009</td>
<td>Trial evaluating different palatal implants for orthodontic anchorage and not dental implant for supporting dental prostheses</td>
</tr>
<tr>
<td>Shibli 2010</td>
<td>Trial evaluating experimental implants placed in humans and retrieved 2 months after placement for histological evaluation</td>
</tr>
<tr>
<td>Shin 2006</td>
<td>Number of enrolled participants unclear. No reply to letter.</td>
</tr>
<tr>
<td>Stavropoulos 2007</td>
<td>Implant stability could not be assessed because prostheses were permanently cemented</td>
</tr>
<tr>
<td>Tallarico 2011</td>
<td>There was a confounding factor of a 1-stage vs. 2-stage approach as the primary objective of the trial</td>
</tr>
<tr>
<td>Tan 2010</td>
<td>The stability of individual implants was not assessed with the removed prostheses</td>
</tr>
<tr>
<td>Study (Year)</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Testori 2003</td>
<td>Problem as implant types: Osseotite and Osseotite NT were confounded with early and immediate loading</td>
</tr>
<tr>
<td>Thoma 2014</td>
<td>Some prostheses were permanently cemented on the implants. Authors replied: “Some implants were splinted (as being part of a fixed partial prostheses), single implants next to each other were not splinted. Splinted implant prostheses were not removed.” Individual implant stability could not be assessed.</td>
</tr>
<tr>
<td>Tomatis 2002</td>
<td>Study classified as not a randomised controlled trial after author’s reply</td>
</tr>
<tr>
<td>Truhlar 1997</td>
<td>Due to the extreme complexity of the study design, we were unable to extract any meaningful data. No reply to letter</td>
</tr>
<tr>
<td>Tymstra 2011</td>
<td>Implants having identical surface and material with different shapes that were positioned in a different way</td>
</tr>
<tr>
<td>Van Assche 2012</td>
<td>It was unclear from the study whether the prosthesis were removed to assess implant stability Authors responded: “Only if radiographic signs indicated a possibility of implant mobility.” We did not consider this was acceptable since it has been demonstrated that implants can be mobile even in absence of radiographic signs. There was also a difference in number of participants and the failures of implants between different reports</td>
</tr>
<tr>
<td>Van Steenberghe 2000</td>
<td>Split-mouth design. Outcome data of a certain number of implants were not reported</td>
</tr>
<tr>
<td>Zetterqvist 2010</td>
<td>Participants had sites randomly assigned to have implants with different surfaces. This generated a trial that has not a parallel group or a split-mouth design and we are unable to use this type of data. Data on implant failures were not presented either</td>
</tr>
<tr>
<td>Åstrand 2003</td>
<td>Parallel group study in which participants in the test group received Brånemark Mark IV implants in bone quality type 3 and 4 and Brånemark Mark II or standard implants in bone quality type 1 and 2. Participants in the control group received Brånemark standard or Mark II implants in all bone quality types. In order to use the data, we needed only data of implants placed in bone quality type 3 and 4. Written to the author who was unable to provide data in the appropriate form</td>
</tr>
</tbody>
</table>
## Data and Analyses

### Comparison 1. Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Implant failure: 1 year</td>
<td>2</td>
<td>99</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>1.64 [0.22, 12.01]</td>
</tr>
<tr>
<td>2 Implant failure: 3 years</td>
<td>2</td>
<td>96</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>2.38 [0.37, 15.38]</td>
</tr>
<tr>
<td>3 Implant failure: 5 years</td>
<td>1</td>
<td>54</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>3.0 [0.13, 70.53]</td>
</tr>
<tr>
<td>4 Implant failure: 10 years</td>
<td>1</td>
<td>54</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>3.0 [0.13, 70.53]</td>
</tr>
</tbody>
</table>

### Comparison 2. Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Implant failure: 1 year</td>
<td>2</td>
<td>48</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>0.14 [0.02, 1.08]</td>
</tr>
<tr>
<td>2 Implant failure: 3 years</td>
<td>2</td>
<td>47</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>0.14 [0.02, 1.06]</td>
</tr>
<tr>
<td>3 Implant failure: 5 years</td>
<td>2</td>
<td>46</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>0.14 [0.02, 1.08]</td>
</tr>
<tr>
<td>4 Implant failure: 10 years</td>
<td>2</td>
<td>39</td>
<td>Risk Ratio (M-H, Fixed, 95% CI)</td>
<td>0.14 [0.02, 1.10]</td>
</tr>
</tbody>
</table>

### Comparison 3. Turned versus roughened implants

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Early implant failure</td>
<td>7</td>
<td>404</td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>2.79 [0.87, 8.90]</td>
</tr>
<tr>
<td>2 Peri-implantitis</td>
<td>4</td>
<td></td>
<td>Risk Ratio (Random, 95% CI)</td>
<td>0.80 [0.67, 0.96]</td>
</tr>
</tbody>
</table>
### Analysis 1.1. Comparison 1 Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws, Outcome 1 Implant failure: 1 year.

#### Review
Interventions for replacing missing teeth: different types of dental implants

#### Comparison
1. Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws

#### Outcome
1. Implant failure: 1 year

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Brånemark</th>
<th>ITI</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
</tr>
<tr>
<td>Batenburg 1998</td>
<td>1/30</td>
<td>0/29</td>
<td>2.90 [0.12, 68.50]</td>
<td>33.7 %</td>
<td></td>
</tr>
<tr>
<td>Moberg 2001</td>
<td>1/20</td>
<td>1/20</td>
<td>1.00 [0.07, 14.90]</td>
<td>66.3 %</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>50</strong></td>
<td><strong>49</strong></td>
<td><strong>1.64</strong> [<strong>0.22, 12.01</strong>]</td>
<td><strong>100.0 %</strong></td>
<td><strong>1.64</strong> [“0.22, 12.01”]</td>
</tr>
</tbody>
</table>

- **Total events:** 2 (Brånemark), 1 (ITI)
- **Heterogeneity:** Chi² = 0.25, df = 1 (P = 0.61); I² = 0.0%
- **Test for overall effect:** Z = 0.49 (P = 0.63)
- **Test for subgroup differences:** Not applicable

#### Analysis 1.2. Comparison 1 Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws, Outcome 2 Implant failure: 3 years.

#### Review
Interventions for replacing missing teeth: different types of dental implants

#### Comparison
1. Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws

#### Outcome
2. Implant failure: 3 years

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Brånemark</th>
<th>ITI</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
</tr>
<tr>
<td>Batenburg 1998</td>
<td>1/30</td>
<td>0/29</td>
<td>2.90 [0.12, 68.50]</td>
<td>34.3 %</td>
<td></td>
</tr>
<tr>
<td>Moberg 2001</td>
<td>2/18</td>
<td>1/19</td>
<td>2.11 [0.21, 21.32]</td>
<td>65.7 %</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>48</strong></td>
<td><strong>48</strong></td>
<td><strong>2.38</strong> [<strong>0.37, 15.38</strong>]</td>
<td><strong>100.0 %</strong></td>
<td><strong>2.38</strong> [“0.37, 15.38”]</td>
</tr>
</tbody>
</table>

- **Total events:** 3 (Brånemark), 1 (ITI)
- **Heterogeneity:** Chi² = 0.03, df = 1 (P = 0.87); I² = 0.0%
- **Test for overall effect:** Z = 0.91 (P = 0.36)
- **Test for subgroup differences:** Not applicable

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Interventions for replacing missing teeth: different types of dental implants (Review) 104

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### Analysis 1.3. Comparison 1 Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws, Outcome 3 Implant failure: 5 years.

#### Review: Interventions for replacing missing teeth: different types of dental implants

#### Comparison: 1 Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws

#### Outcome: 3 Implant failure: 5 years

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Branemark</th>
<th>ITI</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H/Fixed 95% CI</td>
<td></td>
<td>M-H/Fixed 95% CI</td>
</tr>
<tr>
<td>Batenburg 1998</td>
<td>1/27</td>
<td>0/27</td>
<td>100.0 %</td>
<td>3.00 [ 0.13, 70.53 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>27</td>
<td>27</td>
<td>100.0 %</td>
<td>3.00 [ 0.13, 70.53 ]</td>
<td></td>
</tr>
<tr>
<td>Total events: 1 (Branemark), 0 (ITI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.68 (P = 0.50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for subgroup differences: Not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Interventions for replacing missing teeth: different types of dental implants (Review)  
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### Analysis 1.4. Comparison 1 Different implant systems: Brånemark turned versus ITI TPS hollow titanium screws, Outcome 4 Implant failure: 10 years.

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Brånemark</th>
<th>ITI</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batenburg 1998</td>
<td>1/27</td>
<td>0/27</td>
<td></td>
<td>100.0%</td>
<td>3.00 [0.13, 70.53]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>27</strong></td>
<td><strong>27</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>3.00 [0.13, 70.53]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 1 (Brånemark), 0 (ITI)
Heterogeneity: not applicable
Test for overall effect: Z = 0.68 (P = 0.50)
Test for subgroup differences: Not applicable

### Analysis 2.1. Comparison 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss, Outcome 1 Implant failure: 1 year.

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Southern</th>
<th>Steri-Oss</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tawse-Smith 2001</td>
<td>0/12</td>
<td>1/12</td>
<td></td>
<td>21.4%</td>
<td>0.33 [0.01, 7.45]</td>
</tr>
<tr>
<td>Tawse-Smith 2002</td>
<td>0/12</td>
<td>5/12</td>
<td></td>
<td>78.6%</td>
<td>0.09 [0.01, 1.48]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>24</strong></td>
<td><strong>24</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>0.14 [0.02, 1.08]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 0 (Southern), 6 (Steri-Oss)
Heterogeneity: $\chi^2 = 0.39$, df = 1 ($P = 0.53$); $I^2 = 0.0$
Test for overall effect: Z = 1.88 ($P = 0.059$)
Test for subgroup differences: Not applicable
### Analysis 2.2. Comparison 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss, Outcome 2 Implant failure: 3 years.

Review: Interventions for replacing missing teeth: different types of dental implants

Comparison: 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss

Outcome: 2 Implant failure: 3 years

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Southern</th>
<th>Steri-Oss</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H,Fixed,95% CI</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
</tr>
<tr>
<td>Tawse-Smith 2001</td>
<td>0/12</td>
<td>1/11</td>
<td>22.1 %</td>
<td>0.31 [ 0.01, 6.85 ]</td>
<td></td>
</tr>
<tr>
<td>Tawse-Smith 2002</td>
<td>0/12</td>
<td>5/12</td>
<td>77.9 %</td>
<td>0.09 [ 0.01, 1.48 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>24</td>
<td>23</td>
<td>100.0 %</td>
<td>0.14 [ 0.02, 1.06 ]</td>
<td></td>
</tr>
</tbody>
</table>

Total events: 0 (Southern), 6 (Steri-Oss)

Heterogeneity: Chi² = 0.34, df = 1 (P = 0.56); I² = 0.0%

Test for overall effect: Z = 1.90 (P = 0.057)

Test for subgroup differences: Not applicable

### Analysis 2.3. Comparison 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss, Outcome 3 Implant failure: 5 years.

Review: Interventions for replacing missing teeth: different types of dental implants

Comparison: 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss

Outcome: 3 Implant failure: 5 years

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Southern</th>
<th>Steri-Oss</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H,Fixed,95% CI</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
</tr>
<tr>
<td>Tawse-Smith 2001</td>
<td>0/11</td>
<td>1/11</td>
<td>21.4 %</td>
<td>0.33 [ 0.02, 7.39 ]</td>
<td></td>
</tr>
<tr>
<td>Tawse-Smith 2002</td>
<td>0/12</td>
<td>5/12</td>
<td>78.6 %</td>
<td>0.09 [ 0.01, 1.48 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>23</td>
<td>23</td>
<td>100.0 %</td>
<td>0.14 [ 0.02, 1.08 ]</td>
<td></td>
</tr>
</tbody>
</table>

Total events: 0 (Southern), 6 (Steri-Oss)

Heterogeneity: Chi² = 0.39, df = 1 (P = 0.53); I² = 0.0%

Test for overall effect: Z = 1.89 (P = 0.059)

Test for subgroup differences: Not applicable
### Analysis 2.4. Comparison 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss, Outcome 4 Implant failure: 10 years.

Review: Interventions for replacing missing teeth: different types of dental implants

Comparison: 2 Different implant systems: Southern blasted/etched titanium screws versus Steri-Oss

Outcome: Implant failure: 10 years

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Southern</th>
<th>Steri-Oss</th>
<th>Risk Ratio M-H,Fixed</th>
<th>Weight</th>
<th>Risk Ratio M-H,Fixed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>95% CI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tavise-Smith 2001</td>
<td>0/11</td>
<td>1/9</td>
<td>23.8 %</td>
<td>0.28</td>
<td>[0.01, 6.10]</td>
</tr>
<tr>
<td>Tavise-Smith 2002</td>
<td>0/9</td>
<td>5/10</td>
<td>76.2 %</td>
<td>0.10</td>
<td>[0.01, 1.59]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>20</td>
<td>19</td>
<td>100.0 %</td>
<td>0.14</td>
<td>[0.02, 1.10]</td>
</tr>
</tbody>
</table>

Total events: 0 (Southern), 6 (Steri-Oss)

Heterogeneity: Chi² = 0.24, df = 1 (P = 0.62); I² = 0.0%

Test for overall effect: Z = 1.87 (P = 0.061)

Test for subgroup differences: Not applicable

Interventions for replacing missing teeth: different types of dental implants (Review)

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Analysis 3.1. Comparison 3 Turned versus roughened implants, Outcome 1 Early implant failure.

Review: Interventions for replacing missing teeth: different types of dental implants

Comparison: Turned versus roughened implants

Outcome: 1 Early implant failure

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Turned</th>
<th>Roughened</th>
<th>Risk Ratio M-H Random 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H Random 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batenburg 1998</td>
<td>1/30</td>
<td>1/60</td>
<td></td>
<td>18.0 %</td>
<td>2.00 [0.13, 30.88]</td>
</tr>
<tr>
<td>Astrand 1999</td>
<td>3/33</td>
<td>1/33</td>
<td></td>
<td>27.5 %</td>
<td>3.00 [0.33, 27.38]</td>
</tr>
<tr>
<td>Moberg 2001</td>
<td>1/20</td>
<td>0/20</td>
<td></td>
<td>13.6 %</td>
<td>3.00 [0.13, 69.52]</td>
</tr>
<tr>
<td>Astrand 2002</td>
<td>1/28</td>
<td>0/28</td>
<td></td>
<td>13.5 %</td>
<td>3.00 [0.13, 70.64]</td>
</tr>
<tr>
<td>Wennström 2004</td>
<td>1/51</td>
<td>0/51</td>
<td></td>
<td>13.3 %</td>
<td>3.00 [0.13, 71.96]</td>
</tr>
<tr>
<td>Fröberg 2006</td>
<td>0/15</td>
<td>0/15</td>
<td>Not estimable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schincaglia 2007</td>
<td>1/10</td>
<td>0/10</td>
<td></td>
<td>14.1 %</td>
<td>3.00 [0.14, 65.90]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>187</strong></td>
<td><strong>217</strong></td>
<td></td>
<td><strong>100.0 %</strong></td>
<td><strong>2.79 [0.87, 8.90]</strong></td>
</tr>
</tbody>
</table>

Total events: 8 (Turned), 2 (Roughened)

Heterogeneity: Tau² = 0.0, Chi² = 0.07, df = 5 (P = 1.00); I² = 0.0%

Test for overall effect: Z = 1.73 (P = 0.083)

Test for subgroup differences: Not applicable
### Analysis 3.2. Comparison 3 Turned versus roughened implants, Outcome 2 Peri-implantitis.

**Review:** Interventions for replacing missing teeth: different types of dental implants  
**Comparison:** Turned versus roughened implants  
**Outcome:** Peri-implantitis

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>log [Risk Ratio] (SE)</th>
<th>IV/Random,95% CI</th>
<th>Weight</th>
<th>Risk Ratio (SE) IV/Random,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrand 1999</td>
<td>-1.61 (1.53)</td>
<td></td>
<td>0.3 %</td>
<td>0.20 [ 0.01, 4.01 ]</td>
</tr>
<tr>
<td>Moberg 2001</td>
<td>-1.14 (1.11)</td>
<td></td>
<td>0.6 %</td>
<td>0.32 [ 0.04, 2.82 ]</td>
</tr>
<tr>
<td>Astrand 2002</td>
<td>-0.21 (0.09)</td>
<td></td>
<td>98.6 %</td>
<td>0.81 [ 0.68, 0.97 ]</td>
</tr>
<tr>
<td>Schincaglia 2007</td>
<td>0 (1.34)</td>
<td></td>
<td>0.4 %</td>
<td>1.00 [ 0.07, 13.82 ]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td></td>
<td></td>
<td>100.0 %</td>
<td><strong>0.80 [ 0.67, 0.96 ]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2 = 0.0$; $\chi^2 = 1.55$, $df = 3$ ($P = 0.67$); $I^2 = 0.0$

Test for overall effect: $Z = 2.46$ ($P = 0.014$)  
Test for subgroup differences: Not applicable

---

### ADDITIONAL TABLES

#### Table 1. Results from trials comparing different implant surfaces (five trials)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brånemark Mark III implants: turned versus oxidised surface (TiUnite) (Fröberg 2006) Split-mouth</td>
<td>Implant failure (1 year)</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Brånemark Mark IV implants: turned versus oxidised surface (TiUnite) (Schincaglia 2007) Split-mouth</td>
<td>Failure</td>
<td>Turned 0/10 Oxidised 1/10</td>
<td>RR 0.33 (0.82 to 7.32)</td>
<td>P value = 0.49</td>
</tr>
<tr>
<td></td>
<td>Bone level (1 year)</td>
<td>Turned 1.06 ± 0.618 mm Oxidised 0.92 ± 0.649 mm</td>
<td>MD 0.11 (-0.38 to 0.60)</td>
<td>P value = 0.66</td>
</tr>
<tr>
<td></td>
<td>Bone level (3 years)</td>
<td>-</td>
<td>MD -0.15 (-0.56 to 0.26)</td>
<td>P value = 0.48</td>
</tr>
</tbody>
</table>
Table 1. Results from trials comparing different implant surfaces (five trials)  (Continued)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITI regular neck: SLA standard versus SLActive surface <em>(Heberer 2011)</em> Split-mouth</td>
<td>Implant failure (1 year)</td>
<td>SLA standard 2/20 SLActive 0/20</td>
<td>RR 5.00 (0.26 to 98.00) P value = 0.29</td>
<td></td>
</tr>
<tr>
<td>MegaGen EZ Plus implants with blasted surface: standard versus calcium-incorporated (Xpeed) surface <em>(Esposito 2012)</em> Parallel group</td>
<td>Implant failure (1 year)</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Bone level (1 year)</td>
<td>Xpeed Mean -0.58, SD 0.31, 30 participants Standard Mean -0.62, SD 0.36, 30 participants</td>
<td>MD 0.04 (-0.13 to 0.21) P value = 0.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPI Element implants with sand-blasted acid-etched surface: standard versus SurfLink-modified surface <em>(Esposito 2013a)</em> Split-mouth</td>
<td>Implant failure (1 year)</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Bone level (1 year)</td>
<td>SurfLink Mean -1.09, SD 0.76, 21 participants Element Mean -1.36, SD 0.86, 21 participants</td>
<td>MD 0.27 (-0.01 to 0.55) P value = 0.0.057</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI: confidence interval; MD: mean difference; SD: standard deviation; RR: risk ratio.

Table 2. Results from trials comparing implants with different shapes, but having similar surface preparation and material (seven trials)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astra cylindrical versus Astra conical implants <em>(Lee 2007)</em> Split-mouth</td>
<td>Implant failure</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Brånemark Mark II type versus Brånemark conical transmucosal implants <em>(Gatti 2002)</em> Parallel group</td>
<td>Implant failure</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Implantium microthreads at the top versus Implantium microthreads 0.5 mm below the top <em>(Song 2009)</em> Split-mouth</td>
<td>Implant failure</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2. Results from trials comparing implants with different shapes, but having similar surface preparation and material (seven trials) (Continued)

<table>
<thead>
<tr>
<th>Implant failure (1 year)</th>
<th>Internal 4/63</th>
<th>External 3/50</th>
<th>RR 1.06 (0.25 to 4.51)</th>
<th>P value = 0.94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant failure (3 years)</td>
<td>Internal 3/41</td>
<td>External 5/45</td>
<td>RR 0.66 (0.17 to 2.58)</td>
<td>P value = 0.55</td>
</tr>
<tr>
<td>Bone level (1 year)</td>
<td>Internal Mean 0.89, SD 1.36, 53 participants</td>
<td>External Mean 0.59, SD 0.98, 44 participants</td>
<td>MD 0.30 (-0.17 to 0.77)</td>
<td>P value = 0.21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implant failure (1 year)</th>
<th>External 3/50</th>
<th>NobelReplace 5/56</th>
<th>RR 0.67 (0.17 to 2.67)</th>
<th>P value = 0.57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant failure (3 years)</td>
<td>External 3/41</td>
<td>NobelReplace 3/41</td>
<td>RR 1.00 (0.21 to 4.67)</td>
<td>P value = 1.00</td>
</tr>
<tr>
<td>Bone level (1 year)</td>
<td>External Mean 0.59, SD 0.98, 44 participants</td>
<td>NobelReplace Mean 0.59, SD 0.98, 44 participants</td>
<td>MD 0.00 (-0.41 to 0.41)</td>
<td>P value = 1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implant failure (1 year)</th>
<th>Internal 3/50</th>
<th>NobelReplace 5/56</th>
<th>RR 0.90 (0.25 to 3.15)</th>
<th>P value = 0.86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant failure (3 years)</td>
<td>Internal 3/41</td>
<td>NobelReplace 3/41</td>
<td>RR 1.00 (0.21 to 4.67)</td>
<td>P value = 1.00</td>
</tr>
<tr>
<td>Bone level (1 year)</td>
<td>Internal Mean 0.89, SD 1.36, 53 participants</td>
<td>NobelReplace Mean 0.59, SD 0.98, 44 participants</td>
<td>MD 0.30 (-0.17 to 0.77)</td>
<td>P value = 0.21</td>
</tr>
</tbody>
</table>

| Bone level (1 year)      | NobelActive Mean 0.51, SD 0.34, 34 participants | Nobel Speedy Groovy | MD -0.59 (-0.74 to -0.44) | P value < 0.001 |
### Table 2. Results from trials comparing implants with different shapes, but having similar surface preparation and material (seven trials) (Continued)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WINSIX cylindrical versus WINSIX tapered implants (Prosper 2009)</td>
<td>Implant failure (1 year)</td>
<td>Cylindrical 4/66 Tapered 2/66</td>
<td>RR 2.00 (0.38 to 10.58) P value = 0.41</td>
<td></td>
</tr>
</tbody>
</table>

CI: confidence interval; MD: mean difference; RR: risk ratio; SD: standard deviation.

### Table 3. Results from trials comparing implants with different materials, but having similar surface preparation and shape (one trial)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITA SLActive implants: titanium grade 4 versus titanium-13zirconium (Roxolid) (Al-Nawas 2012)</td>
<td>Implant failure (1 year)</td>
<td>SLActive 2/89 Roxolid 1/89</td>
<td>RR 2.00 (0.18 to 21.66) P value = 0.57</td>
<td></td>
</tr>
</tbody>
</table>

CI: confidence interval; RR: risk ratio.

### Table 4. Results from trials comparing implants with different surface preparation, shape, material or a combination (13 trials)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankylos Plus Dentsply versus Seven Sweden &amp; Martina implants (Crespi 2009)</td>
<td>Implant failure</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Astra TiO2-blast cylindrical versus turned Bränemark Mark II implants (Astrand 1999)</td>
<td>Implant failure (1 year)</td>
<td>Astra 1/33 Bränemark 4/33</td>
<td>RR 0.25 (0.03 to 2.12) P value = 0.20</td>
<td></td>
</tr>
</tbody>
</table>

Interventions for replacing missing teeth: different types of dental implants (Review) Copyright © 2014 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Table 4. Results from trials comparing implants with different surface preparation, shape, material or a combination (13 trials) (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Implant failure (3 years)</th>
<th>RR 0.40 (0.08 to 1.92)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Astra 2/33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brånemark 5/33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value = 0.25</td>
<td></td>
</tr>
<tr>
<td>Implant failure (5 years)</td>
<td>Astra 2/31</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Brånemark 5/33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value = 0.28</td>
<td></td>
</tr>
<tr>
<td>Bone level (1 year)</td>
<td>Astra</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Mean -0.26, SD 0.60, 32 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brånemark</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Mean -0.17, SD 0.37, 33 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value = 0.28</td>
<td></td>
</tr>
<tr>
<td>Bone level (3 years)</td>
<td>Astra</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Mean -0.23, SD 0.88, 32 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brånemark</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Mean -0.17, SD 0.44, 33 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value = 0.28</td>
<td></td>
</tr>
<tr>
<td>Bone level (5 years)</td>
<td>Astra</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Mean -0.23, SD 0.88, 31 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brånemark</td>
<td>RR 0.43 (0.09 to 2.04)</td>
</tr>
<tr>
<td></td>
<td>Mean -0.17, SD 0.44, 33 participants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value = 0.28</td>
<td></td>
</tr>
<tr>
<td>Astra TiO2-blast versus ITI SLA titanium implants (Akoglu 2011) Parallel group</td>
<td>Implant failure</td>
<td>No failures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RR 1.00 (0.07 to 15.26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P value = 1.00</td>
</tr>
<tr>
<td>Astra TiO2-blast versus Swiss-Plus (Zimmer) cylindrical implants (Akoglu 2011) Parallel group</td>
<td>Implant failure</td>
<td>No failures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RR 1.00 (0.07 to 15.26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P value = 1.00</td>
</tr>
<tr>
<td>Brånemark versus IMZ implants (Batenburg 1998) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>Brånemark 1/30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RR 1.00 (0.07 to 15.26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P value = 1.00</td>
</tr>
<tr>
<td></td>
<td>Implant failure (3 years)</td>
<td>Brånemark 1/30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RR 1.00 (0.07 to 15.26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P value = 1.00</td>
</tr>
<tr>
<td></td>
<td>Implant failure (5 years)</td>
<td>Brånemark 1/27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RR 1.11 (0.07 to 16.91)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P value = 0.94</td>
</tr>
<tr>
<td>Implant failure (10 years)</td>
<td>Brånemark 1/27 IMZ 4/29</td>
<td>RR 0.27 (0.03 to 2.25)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Brånemark MKII versus ITI TPS hollow screw implants- (Batenburg 1998; Moberg 2001) Parallel group</td>
<td>Implant failure (1 and 3 years)</td>
<td>-</td>
</tr>
<tr>
<td>Brånemark MKII versus ITI TPS hollow screw implants- (Batenburg 1998) Parallel group</td>
<td>Implant failure (5 years)</td>
<td>Brånemark 1/27 ITI 0/27</td>
</tr>
<tr>
<td>Brånemark MKII versus ITI TPS hollow screw implants- (Batenburg 1998) Parallel group</td>
<td>Implant failure (10 years)</td>
<td>Brånemark 1/27 ITI 0/27</td>
</tr>
<tr>
<td>Brånemark MKII versus ITI TPS solid screw implants (Astrand 2002) Split-mouth</td>
<td>Implant failure (3 years)</td>
<td>Brånemark 1/28 ITI 2/28 (assume parallel for analysis)</td>
</tr>
<tr>
<td>Brånemark MKIV TiUnite versus Southern regular implants (Payne 2004) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>Brånemark 4/19 Southern 7/19</td>
</tr>
<tr>
<td>IMZ titanium TPS versus ITI TPS hollow implants (Batenburg 1998) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>IMZ 1/30 ITI 0/29</td>
</tr>
<tr>
<td></td>
<td>Implant failure (3 years)</td>
<td>IMZ 1/30 ITI 0/29</td>
</tr>
<tr>
<td></td>
<td>Implant failure (5 years)</td>
<td>IMZ 1/30 ITI 0/27</td>
</tr>
<tr>
<td></td>
<td>Implant failure (10 years)</td>
<td>IMZ 4/29 ITI 0/27</td>
</tr>
</tbody>
</table>
Table 4. Results from trials comparing implants with different surface preparation, shape, material or a combination (13 trials) (Continued)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Outcome</th>
<th>IMZ 1/20</th>
<th>ITI 0/20</th>
<th>RR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMZ titanium TPS versus ITI TPS solid implants (Heydenrijk 2002) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>IMZ 1/20</td>
<td>ITI 0/20</td>
<td>3.00 (0.13 to 69.52)</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Implant failure (3 years)</td>
<td>IMZ 1/20</td>
<td>ITI 0/19</td>
<td>3.00 (0.13 to 69.52)</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Implant failure (5 years)</td>
<td>IMZ 1/19</td>
<td>ITI 0/18</td>
<td>2.85 (0.12 to 65.74)</td>
<td>0.51</td>
</tr>
<tr>
<td>ITI SLA versus Southern implants (Payne 2003) Parallel group</td>
<td>Implant failure (10 years)</td>
<td>No failures</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bone change (1 year)</td>
<td>ITI TPS Mean 0.26, SD 0.23, 12 participants Southern Mean 0.28, SD 0.15, 12 participants</td>
<td>MD -0.02 (-0.18 to 0.14)</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bone change (3 years)</td>
<td>ITI TPS Mean 0.26, SD 0.23, 10 participants Southern Mean 0.24, SD 0.18, 11 participants</td>
<td>MD 0.02 (-0.20 to 0.24)</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bone change (5 years)</td>
<td>ITI TPS Mean 0.47, SD 0.46, 10 participants Southern Mean 0.30, SD 0.36, 10 participants</td>
<td>MD 0.17 (-0.19 to 0.53)</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bone change (10 years)</td>
<td>ITI TPS Mean 0.33, SD 0.55, 9 participants Southern Mean 0.41, SD 0.58, 9 participants</td>
<td>MD -0.08 (-0.60 to 0.44)</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>ITI SLA titanium implants versus SwissPlus (Zimmer) cylindrical implants (Akoglu 2011) Parallel group</td>
<td>Implant failure (5 years)</td>
<td>No failures</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
Table 4. Results from trials comparing implants with different surface preparation, shape, material or a combination (13 trials) (Continued)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NobelReplace Select Tapered versus NobelReplace Groovy implants (den Hartog 2011) Parallel group</td>
<td>Implant failure (1 year)</td>
<td></td>
<td>RR 3.00 (0.13 to 70.92)</td>
<td>P value = 0.50</td>
</tr>
<tr>
<td></td>
<td>Bone level (1 year)</td>
<td>Astra Mean 1.19, SD 0.82, 31 participants Bränemark Mean 0.9, SD 0.57, 31 participants</td>
<td>MD 0.29 (-0.06 to 0.64)</td>
<td>P value = 0.11</td>
</tr>
<tr>
<td>Southern regular versus Steri-Oss implants (Tawse-Smith 2001; Tawse-Smith 2002) Parallel group</td>
<td>Implant failure (1, 3, 5 and 10 years)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Southern regular versus turned Neoss implants (Alsabeeha 2011) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>Southern Regular 1/11 Neoss 0/12</td>
<td>RR 3.25 (0.15 to 72.36)</td>
<td>P value = 0.46</td>
</tr>
<tr>
<td>Southern wide versus turned Neoss implants (Alsabeeha 2011) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>No failures</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Southern regular versus Southern wide (Alsabeeha 2011) Parallel group</td>
<td>Implant failure (1 year)</td>
<td>Southern regular 1/11 Southern wide 0/12</td>
<td>RR 3.25 (0.15 to 72.36)</td>
<td>P value = 0.46</td>
</tr>
</tbody>
</table>

CI: confidence interval; MD: mean difference; SD: standard deviation; RR: risk ratio.

Table 5. Results from trials comparing turned and roughened surfaces

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Data</th>
<th>Effect estimate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turned versus roughened surfaces (Batenburg 1998; Astrand 1999; Astrand 2002; Moberg</td>
<td>Implants affected by peri-implantitis (3 years) (Astrand 1999; Astrand 2002; Moberg 2001; Schincaglia</td>
<td>4 trials</td>
<td>Pooled RR 0.80 (0.67 to 0.96) P value = 0.01</td>
</tr>
</tbody>
</table>
Table 5. Results from trials comparing turned and roughened surfaces  (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Implants affected by peri-implantitis (5 years)</th>
<th>RR</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Astrand 1999)</td>
<td>3 parallel group and 2 split-mouth</td>
<td>Turned 0/33 Roughened 1/31</td>
<td>0.31 (0.01 to 7.42)</td>
<td>0.47</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Implants lost for peri-implantitis (10 years)</th>
<th>RR</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Batenburg 1998)</td>
<td></td>
<td>Turned 0/27 Roughened 3/29</td>
<td>0.15 (0.01 to 2.83)</td>
<td>0.21</td>
</tr>
</tbody>
</table>

CI: confidence interval; RR: risk ratio.

**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 (Higgins 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.
Appendix 2. 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 EMBASE subject search was run with the Cochrane Oral Health Group search strategy for identifying randomised controlled trials in EMBASE:

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

Appendix 3. The 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 4. The 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)

WHAT'S NEW

Last assessed as up-to-date: 17 January 2014.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>21 August 2014</td>
<td>Amended</td>
<td>Minor edits</td>
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HISTORY


Review first published: Issue 4, 2002
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<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>18 June 2014</td>
<td>New citation required but conclusions have not changed</td>
<td>Review update including 11 new studies; 27 included studies in total. Methods have been updated and risk of bias done on all included studies. Change of authors</td>
</tr>
<tr>
<td>4 March 2014</td>
<td>New search has been performed</td>
<td>Searches updated to January 2014.</td>
</tr>
<tr>
<td>4 June 2008</td>
<td>Amended</td>
<td>Converted to new review format.</td>
</tr>
<tr>
<td>10 August 2007</td>
<td>New citation required and conclusions have changed</td>
<td>Substantive amendment. This update of the review includes four new additional included and three new excluded randomised controlled trials. The follow up of one previously included study has been prolonged to 5 years. The quality assessment section has been simplified. Minor changes to the conclusions</td>
</tr>
</tbody>
</table>

**CONTRIBUTIONS OF AUTHORS**

Conceiving, designing and coordinating the review (Marco Esposito (ME)).

Developing search strategy and undertaking searches (ME).

Screening search results and retrieved papers against inclusion criteria (ME, Yasmin Ardebili (YA)).

Appraising quality (ME, YA, Helen Worthington (HW)).

Extracting data from papers (ME, HW, YA).

Writing to authors for additional information (ME, HW, YA).

Data management for the review and entering data into Review Manager (HW, ME, YA).

Analysis and interpretation of data (ME, HW).

Writing the review (ME, YA).

Providing general advice on the review (HW).

**DECLARATIONS OF INTEREST**

Marco Esposito is working as independent methodological consultant for various implant-related projects for some of the companies whose implants were used both in included and excluded trials. In particular, he was one of the authors of two of the included and one of the excluded trials; however, he was not involved in their quality assessment.

Yasmin Ardebili: no interests to declare.

Helen V Worthington: no interests to declare.
SOURCES OF SUPPORT

Internal sources

- School of Dentistry, The University of Manchester, UK.
- MAHSC, UK.

The Cochrane Oral Health Group is supported by the Manchester Academic Health Sciences Centre (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 Association of Oral Surgeons, UK; British Orthodontic Society, UK; British Society of Paediatric Dentistry, UK; British Society of Periodontology, UK; Canadian Dental Hygienists Association, Canada; Mayo Clinic, USA; 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)

*Dental Implantation, Endosseous; *Dental Implants; Dental Prosthesis Design; Dental Restoration Failure [statistics & numerical data]; Jaw, Edentulous [*rehabilitation]; Jaw, Edentulous, Partially [rehabilitation]; Randomized Controlled Trials as Topic

MeSH check words

Humans