Clinical outcomes of vertical bone augmentation to enable dental implant placement: a systematic review
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CRD summary
This review found that guided bone regeneration was useful for vertical bone augmentation, but the intervention was highly technique-sensitive and its generalisability was limited. There was insufficient evidence regarding the efficacy and safety of other augmentation techniques. Given the methodological weaknesses of the review and the uncertain quality of the included studies, the reliability of the results is unclear.

Authors' objectives
To assess the efficacy and safety of various vertical bone augmentation techniques.

Searching
MEDLINE and EMBASE were searched for relevant articles, published in English, from 1966 to November 2007; the search terms were reported. The Cochrane Central Register of Controlled Trials (CENTRAL) and the Cochrane Public Health Group's Specialised Register were also searched, but the search terms were not reported. Additional studies were sought by manually checking the reference lists of retrieved articles, review articles, and several relevant journals (January 1990 to November 2007). If further information was required, the authors were contacted for details.

Study selection
Randomised controlled trials (RCTs) and non-randomised clinical trials, cohort studies, case-control studies, and case reports of vertical bone augmentation were eligible for inclusion if at least five patients completed the study and there was a minimum of one year of follow-up. Studies reporting horizontal bone augmentation, extraction socket preservation or sinus lift procedures were excluded.

The included studies assessed the following augmentation techniques: distraction osteogenesis, guided bone regeneration (GBR) principles, onlay bone grafts, and other techniques. Most of the included studies were case series. The outcomes assessed were vertical bone gain or loss, complication rate, implant survival, and (for the GBR group only) histologically assessed new bone formation and bone to implant contact. For GBR studies only, the one-year follow-up criterion was replaced by the time to abutment connection. Animal studies were also reviewed (these results are beyond the scope of this abstract).

The initial decision on study selection was made by one author and potentially relevant articles were assessed by two reviewers.

Assessment of study quality
The authors did not state that they assessed validity.

Data extraction
Data on the following outcomes were reported: height gain (mm); implant success (%), implant survival (%), implant failure (%), complications (%), and marginal bone loss.

The authors did not state how the data were extracted for the review, nor how many reviewers performed the data extraction.

Methods of synthesis
The studies were grouped according to the augmentation technique, and synthesised narratively.

Results of the review
A total of 26 studies were included.

**Distraction osteogenesis** (210 participants, 13 studies, including one RCT): All studies showed an increase in vertical bone gain of between 5 and 15mm. Complication rates ranged from 10% to 75.7% and the most common complication was a progressive lingual or palatal inclination. Implant survival rates ranged from 90% to 100%.

**GBR principles** (159 participants, seven studies, including two RCTs): All studies showed an increase in vertical bone gain of between 2 and 8mm. Bone loss ranged from 1.27 to 2.0mm and implant survival rates were 92.1% to 100%, over one to seven years. Complication rates ranged from 0 to 25% in most studies; one study reported a rate of 45%.

**Onlay bone grafts** (122 participants, five studies, no RCTs): These studies varied in their results in terms of mean vertical bone increase and bone stability. Minor complications were reported. Graft survival rates ranged from 76% to 100%.

**Other techniques** (38 participants, three studies, no RCTs): One study reported a vertical bone gain (5.2mm); one reported bone stability (bone loss of 1.0mm in year one and 0.1mm in year two); one reported complications (two out of 10 participants); and one reported the success rate (100%).

**Authors' conclusions**
The clinical and histological data supported the use of GBR, but few investigators were using these techniques and data on only a few patients had been reported. The intervention was highly technique-sensitive and the generalisability of this approach was limited. There was insufficient evidence regarding the use of other approaches.

**CRD commentary**
This review addressed a clear question. The search appeared to include some relevant sources, but may not have been comprehensive. No effort appears to have been made to search for unpublished literature and only English-language articles were eligible, which means the search may have been affected by language or publication bias. Where stated, the inclusion criteria were broad; no participant or outcome criteria were defined. As the initial study selection was performed by one reviewer, it is possible that errors and bias may have occurred in the review process. No attempt appears to have been made to assess the validity of the studies and no information was given regarding the extraction of data from the studies, which makes the reliability of the authors' conclusions uncertain. A narrative synthesis was appropriate.

The authors' conclusions were suitably conservative. Given the poor methodology and reporting, the reliability of the results is uncertain.

**Implications of the review for practice and research**
The authors did not state any implications for practice or further research.

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