

Effectiveness of orthodontic miniscrew implants in anchorage reinforcement during en-masse retraction: A systematic review and meta-analysis

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Introduction: The aim of this systematic review was to compare the effectiveness of orthodontic miniscrew implants—temporary intraoral skeletal anchorage devices (TISADs)—in anchorage reinforcement during en-masse retraction in relation to conventional methods of anchorage. **Methods:** A search of PubMed, Embase, Cochrane Central Register of Controlled Trials, and Web of Science was performed. The keywords were orthodontic, mini-implants, miniscrews, miniplates, and temporary anchorage device. Relevant articles were assessed for quality according to Cochrane guidelines and the data extracted for statistical analysis. A meta-analysis of raw mean differences concerning anchorage loss, tipping of molars, retraction of incisors, tipping of incisors, and treatment duration was carried out. **Results:** Initially, we retrieved 10,038 articles. The selection process finally resulted in 14 articles including 616 patients (451 female, 165 male) for detailed analysis. Quality of the included studies was assessed as moderate. Meta-analysis showed that use of TISADs facilitates better anchorage reinforcement compared with conventional methods. On average, TISADs enabled 1.86 mm more anchorage preservation than did conventional methods ($P < 0.001$). **Conclusions:** The results of the meta-analysis showed that TISADs are more effective than conventional methods of anchorage reinforcement. The average difference of 2 mm seems not only statistically but also clinically significant. However, the results should be interpreted with caution because of the moderate quality of the included studies. More high-quality studies on this issue are necessary to enable drawing more reliable conclusions. (*Am J Orthod Dentofacial Orthop* 2017;151:440-55)

The resistance to undesirable maxillary mesial molar movement while closing maxillary arch spaces after extraction of the first or second premolars is a key element of anchorage control and is obviously crucial for optimal treatment results.^{1,2} Successful treatment of an adult with a full Class II malocclusion and maxillary dentoalveolar protrusion necessitating closure of the extraction spaces entirely from the front (by retraction of anterior teeth only) requires maximum anchorage achievable with various methods.³

Extraoral appliances, although efficient in anchorage control,⁴ highly depend on the patient's compliance⁵ and are therefore considered a fallible form of anchorage control with variable levels of outcome. Moreover, they have been associated with isolated cases of facial injury.^{6,7} On the other hand, the effectiveness of intraoral appliances—eg, a Nance holding arch or transpalatal bar—has been questioned with prospective research alluding to limited benefits during active appliance therapy.⁸

Orthodontic implants or temporary intraoral skeletal anchorage devices (TISADs) are a compliance-free alternative to more traditional forms of anchorage. They are not attached directly to the teeth, unlike other methods of anchorage reinforcement. TISADs are regarded as simple to place and have reported survival rates ranging from 80% to 94%^{9,10} and have therefore been advocated as the potential method of choice when anchorage reinforcement is necessary during treatment. However, there is some disagreement about the precise effects of

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Submitted, February 2015; revised and accepted, August 2016.

0889-5406/\$36.00

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<http://dx.doi.org/10.1016/j.ajodo.2016.08.029>

TISADs during space closure; several recent studies have demonstrated significant anchorage losses, whereas others found the opposite effect.¹¹⁻¹⁴ Moreover, there is conflicting evidence relating to their effectiveness vs alternative approaches to anchorage supplementation.

The aim of this systematic review and meta-analysis was to compare the effectiveness of TISADs and conventional anchorage augmentation during space closure by retraction of anterior teeth.

MATERIAL AND METHODS

We performed this study according to PRISMA guidelines, and the main research question was defined in PICO format (Table I).

Eligibility criteria

1. Study design: randomized controlled trials (RCTs) and controlled clinical trials (CCTs).
2. Participants: orthodontic subjects requiring extraction of the maxillary first premolars and closure of the spaces without anchorage loss.
3. Interventions: study group, anchorage reinforcement with TISADs; control group, conventional anchorage reinforcement.
4. Exclusion criteria: language other than English, animal studies, case reports, case-series reports, literature reviews, lack of control group or fewer than 10 subjects in the study group, patients not treated with sliding mechanics, or comparison of anchorage loss after retraction of canines only.
5. Outcome measures: the primary outcome was anchorage loss defined as mesial movement of the maxillary first molars. Secondary outcomes were change in the angulation of the maxillary molars, amount of incisor retraction, change in the angulation of the maxillary incisors, and treatment duration.

Search strategy, study selection, and information sources

The search strategy of the electronic databases, PubMed, EMBASE, Cochrane Central Register of Controlled Trials, and Web of Science (1990 to March 2016) is shown in Table II. Based on information from the titles and abstracts, relevant articles meeting the following inclusion criteria were selected: written in English, research on humans treated with extraction of the maxillary first premolars and retraction of all 6 anterior teeth with absolute anchorage, sliding mechanics used, and more than 10 subjects in the study group. Electronic searching was supplemented with review of the

Table I. PICO format

Population	Subjects requiring absolute anchorage in maxillary arch
Intervention	Retraction of anterior teeth with TISADs
Comparison	Retraction of anterior teeth with conventional anchorage
Outcome	Anchorage loss, change in angulation of maxillary molars, amount of incisors' retraction, change in angulation of maxillary incisors, and treatment duration

bibliography in each identified article. The following journals were manually screened: *European Journal of Orthodontics*, *Journal of Orthodontics*, *Journal of Clinical Orthodontics*, *Seminars in Orthodontics*, *American Journal of Orthodontics & Dentofacial Orthopedics*, and *Angle Orthodontist*. The literature search, assessment of relevance, risk of bias analysis, and data extraction were performed independently by 2 authors (J.A.S. and J.L.). All authors discussed disagreements until consensus was reached.

Data extraction

The following data were extracted from the included studies: year of publication, sample size, age of the patients at the beginning of the treatment, types of appliances used for anchorage reinforcement, types and dimensions of the TISADs, amounts of mesial molar movement and tipping, amounts of incisor retraction and tipping, and treatment duration.

Risk of bias in individual studies

The Cochrane Collaboration tool for assessing risk of bias in randomized controlled trials was applied using the following criteria: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of assessors, incomplete outcome data, selective reporting of outcomes, and other potential sources of bias. The quality of the CCTs was assessed according to a modified Newcastle-Ottawa Scale (Appendix) comprising 3 sections.

1. "Selection," evaluating case definition, representativeness of cases, control selection, and definition of controls. Each aspect was assigned 1 mark, giving 4 marks in total.
2. "Comparability," appraising extraction patterns in the maxilla and the mandible; therefore, 2 marks could be obtained in this section.
3. "Outcome assessment," evaluating outcome measures, treatment changes, and blinding of assessors, giving 3 marks in total.

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