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Review Article

Orthodontic mini-implant success–Analysis and review

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ABSTRACT

Successful orthodontic treatment demands the need for adequate anchorage reinforcement. The growing need for minimum compliance and maximum curative effects has made the mini-implants more acceptable as an excellent substitute to traditional orthodontic anchorage. Mini-implants as skeletal anchorage sources can be used to carry out intrusion, extrusion, anterior retraction, molar protraction and distalization, and correction of midline and occlusal canting etc. Endosseous dental implants have begun to be more reliable sources of anchorage. However, because of complicated surgical procedure, long healing time, and limited implant sites—their use as routine clinical anchorage has remained subtle till date. Also, patient acceptability, rate and severity of adverse effects of miniscrews, and variables that influenced success remain unanswered. In the present article, we systematically reviewed some of the available and unswerving literature to quantify success and complications encountered with the use of mini-implants for orthodontic anchorage, to evaluate factors associated with success or failure.

1. Introduction

Mini-implants are sources of absolute anchorage in fixed orthodontic treatment. In addition to size, their advantages include lower costs, less anatomic limitations, minor surgery, increased patient comfort, and immediate loading. They have been used to accomplish optimal dental movement in traditional treatment plans, such as molar protraction (Giancotti et al., 2004), canine retraction (Herman et al., 2006), correction of the dental midline (Youn, 2006), space closure (Carano et al., 2004), maxillary incisor retraction (Hong et al., 2005), and maxillary molar distalization (Velo et al., 2007).

These devices mostly rely on mechanical retention that do not always osseointegrate. They are used for specific time periods after which they are discarded. Terms such as miniscrews, miniscrew implants, microscrews, and temporary anchorage devices have been used invariably and unquestionably for these devices. We have used the term "mini-implant" in the title, because of its frequent use in the orthodontic literature.

Mini-implant (1.3–2.0 mm of diameter) insertion is devoid of flap surgery, which is associated with pain and swelling. Damages such as damage to nerves, blood vessels, maxillary sinuses, and dental roots can occur in cases of incorrect insertion of mini implants. A correctly applied surgical procedure and sufficient bone tissue between the roots to support the mini-implant ensures elimination of such mishaps.

1.1. Evolution of the implant system

In 1700's John Hunter, Scottish Surgeon suggested the possibility of transplanting human teeth.[1] In the 18th

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century it was common practice to replace lost teeth with teeth of another individual which met with failure as human immune system rejected the foreign body leading to infection.[1] Maggiolo in 1809 placed single tooth sized gold implant in fresh extraction site just above gingiva. In 1983, Creekmore and Eklund placed a vitallium screw in the anterior nasal spine of a patient with a deep impinging overbite to intrude the maxillary incisor.[2] The technique, however, did not gain immediate popularity because it was premature to be used clinically without a sufficient understanding of reliability or pathology, even though the clinical results were stimulating. In 1997, Kanomi reported a successful case with a mini-screw (diameter, 1.2 mm; length, 6 mm), with the mandibular incisors intruded 6 mm with no root resorption or periodontal pathologic evidence. Surgical microscrews have now taken a back seat and specially designed orthodontic mini-implants have largely replaced them as conventional orthodontic anchorage fixtures. Park had presented a case using 1-stage surgical microscrews with healing in an open method in 1999, generating serious interest in mini-implants as a source of skeletal anchorage because of their superiority for few anatomic limitations, simple placement, and versatile applications.[3]

1.2. Classification of implants

1. According to site of placement/ anchorage components
   (a) Subperiosteal implant
   (b) Transosteal implant
   (c) Endosteal/ Endosseous implant
2. According to surface texture –
   (a) Threaded
   (b) Perforated
3. According to form –
   (a) Solid
   (b) Hollow
   (c) Vented
4. According to spray of coating of hydroxyapatite or plasma sprayed titanium –
   (a) Coated
   (b) Non-coated
5. Based on head type –
   (a) mall head type
   (b) Long head type
   (c) Circle head type
   (d) Fixation head type
   (e) Bracket head type
6. According to implant morphology –
   (a) Plate design
   (b) Skeletal anchorage implant
   (c) Graz implant supported system
   (d) Zygoma anchorage system
   (e) Screw design
   (f) Orthosystem implant
   (g) Straumann ortho implant
   (h) Aarhus implant
   (i) Mini implant system
   (j) Micro- implant
   (k) C – implant
   (l) Spider screw
   (m) Implant disc
7. According to March 2005 classification –
   (a) Biocompatible TADS10
   (b) Biological TADS

2. Protocol Followed in the Review Process

2.1. Objective

The objective of this study is to evaluate and analyze the factors that affect the success or failure rate of orthodontic mini-implants and predict their degree of clinical significance.

2.2. Study design

Retrospective analytical study undertaking noteworthy peer-reviewed articles on orthodontic mini implants to provide an overall review of the factors causing mini-implant success or failure.

2.3. Inclusion criteria

1. Peer-reviewed articles dealing with mini-implants and micro-implants were included.
2. Articles on mini-implants used as orthodontic anchorage.
3. Randomized controlled studies (RCTs), prospective and retrospective clinical studies were included.
4. Data only from human subjects were taken.

2.4. Exclusion criteria

1. Articles in a language other than English.
2. Articles on standard dental implants, miniscrews, palatal implants, onplants, miniplates used as orthodontic anchorage, and implant materials research.
3. Animal studies and in-vitro studies.
4. Various presentations of mini-implant and microimplant methodology.

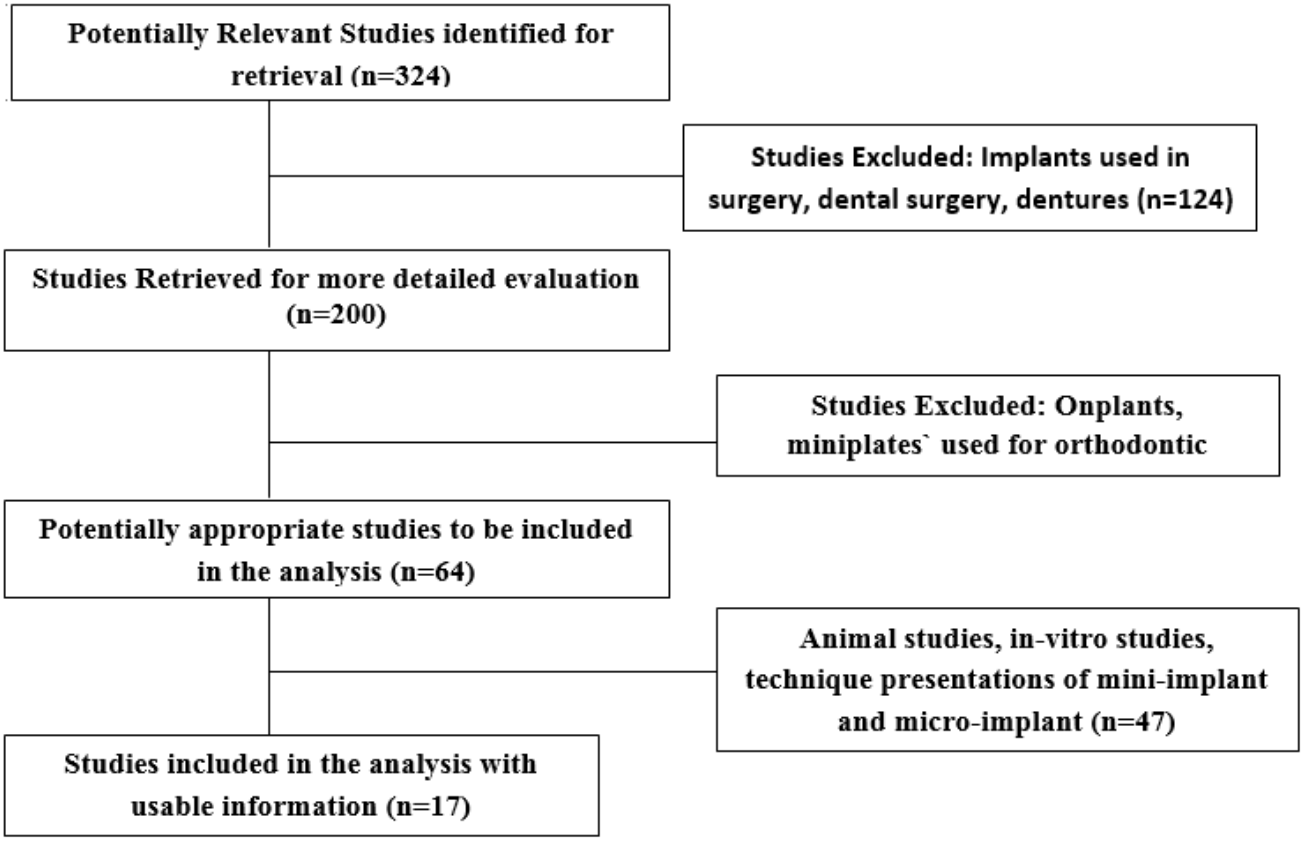

Fig. 1: Flow Diagram of the Literature search

2.5. Analysis

A total of 324 titles and abstracts on implants as anchorage were identified, of which 124 were excluded at the first stage according to the inclusion criteria. Remaining 200 potentially helpful articles were retrieved. From them, 136 studies were excluded that had exclusion criteria such as those dealing with mini plates or onplants for orthodontic anchorage.

Finally, only 17 articles met all the inclusion criteria. A flow diagram of the same is presented in the Figure.

3. Discussion

Mini-implants are now a preferred method of anchorage during treatment planning in orthodontics because of enough flexibility, slightest invasiveness and a great cost effectiveness. The simplification of procedures for insertion and the versatility of the mechanics have made the use of mini- implants a routine in clinical practice and have eliminated the need for complex laboratory procedures.[4] Mini-implants are inserted in the bone providing effective skeletal anchorage. That is why when maximum anchorage is indispensable the mini-implants appear to be a preferred choice in orthodontic treatment.

Skeletal anchorage, hence, has replaced conventional anchorage in critical circumstances of fixed orthodontic treatment.

The success of mini-implants requires following an atraumatic surgical technique, achieving a short healing time, using biocompatible materials for the screws, and a good patient rapport and understanding. Also, instead of repairing with fibrous encapsulation, a primary healing environment at the bone-implant surface needs to be formed.

A systematic review to analyze the efficacy of mini-implants as orthodontic anchorage, and the factors affecting their success rate was undertaken. The articles were selected according to the stated inclusion and exclusion criteria. After reviewing all published articles on mini-implants, only 17 studies satisfied the inclusion criteria for mini-implants as orthodontic anchorage.

3.1. Miniscrew size

Analysis showed that smaller diameter screws had 50 per cent lower failure risk than larger diameter screws.

3.2. Screw location in the bone

Anterior part of the lower jaw demonstrated higher risk of failure than the same segment of the upper jaw.[5] Similarly, the risk of failure was higher in the posterior part of the lower jaw than the corresponding part of the upper jaw.

3.3. Screw mobilization time

First weeks from insertion sees the most number of failures.

The absence of inflammatory tissue on some miniscrews make them liable to develop mobility upon extreme loading or as a result of the interacting forces.[6] Counterclockwise torquing forces might lead to increased tendency of failure.

Also, Liou et al. (2004)[7] observed that miniscrews are not in a state of absolute stability; this might cause irritation of the adjacent tissues and result in less support given by the bone to the screws.

3.4. Loading-related factors

Immediate loading has been projected as an acceptable approach for orthodontic mini implants. It was because several studies with immediate loading obtained success rates and some failures also happened even before loading. Some of the experimental studies have shown that immediate loading of the threaded implant develops a bone-to-implant contact which is comparable with that of implants that are loaded conventionally.

About the loading quantity, most mini-implants can withstand 100 to 200g of horizontal early or immediate loading successfully; that is enough to sustain the various orthodontic tooth movements.

Overloading should be avoided in order to avoid breakage, dislocation or loosening.

Direct implant anchorage allowed direct transmission of forces to the implants, with the anchor teeth being completely safe. Although, immediate and early loading was associated with dislodgment of mini-implants in low bone quantity. Direct orthodontic loading offered the advantage of shorter treatment time.[8] The mini-implants were stable in the form of indirect anchorage, but a small anchorage loss was shown by maxillary incisor proclination and increased overjet at the end of movement.

4. Conclusion

Anchorage control is a significant factor to be considered while planning orthodontic treatment. Despite the applied different anchorage reinforcement protocols, achieving the desired objectives may not be always possible.

Most of the conventional anchorage devices are unreliable from compliance and teeth-strain point of view.

Hence, the success-determining factors for a mini implant, after the present breakdown and analysis, include the patient's oral hygiene, coexisting diseases, smoking, the state of mucosal membranes, the applied surgical protocol (including mini-screw implant location), the technique of loading (time, force, and its direction), and the type of TADS. So, for that reason, forming a homogenous group of patients with certain common characteristics is necessary for confirmatory conclusions. Mini-implant failure can involve factors related to the clinician, the patient, and the screw itself. Large, multicenter longitudinal studies are needed to shed further light on the processes involved in skeletal anchorage in order to attain more significant and consistent outcomes so that failure rates can be compacted further.

5. Conflict of Interest

The authors declare no relevant conflicts of interest.

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