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Advance in contemporary orthodontics: a systematic review

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Abstract

Introduction: During orthodontic treatment, careful planning is essential for its success, taking into account aspects such as facial harmony, functional occlusion, and esthetics. The anchorage system has been widely used by orthodontists due to its high level of success. In addition to replacing the use of extra and intraoral devices, mini-implants show a simple technique that does not require patient cooperation and less discomfort, enabling more movements predictable and balanced in a short treatment time. **Objective:** To report the types of mini-implants and their characteristics, addressing their advantages and disadvantages, insertion locations, indications, and contraindications, in order to promote general knowledge of orthodontic treatment with skeletal anchorage. **Methods:** Clinical studies with qualitative and/or quantitative analysis were included, following the rules of the systematic review-PRISMA. **Results:** The mini-implants are made in two types, such as self-tapping requires a drill and self-drilling that has a cut. Their use provides advantages such as a set of more agile, simple, and less invasive techniques, with minimal anatomical limitations, less cost, not depending on the patient's contribution, allowing the application of immediate load and increased predictability of movements. Disadvantages are considered when there is movement and loosening of the mini-implant, involvement of nerves and blood vessels during surgery, mucosal irritation, and gingival hyperplasia caused by poor hygiene causing pain and swelling. **Conclusion:** It is concluded that the mini-implant emerged to revolutionize orthodontic treatment through more precise movements, in a short time, facilitating more complex movements that other devices had difficulty performing. Its main characteristic is a high success rate, in addition to having a reduced size, which allows its insertion in several sites. Consequently, the skeletal anchorage device is an excellent method, as long as it is used according to indications and taking meticulous care from the ideal choice of the device to the moment of its insertion.

Keywords: Orthodontic treatment. Mini-implants. Anchoring system. Skeletal anchorage.

Introduction

Several ways to promote an optimal maximum anchorage have been tested until today, they are the extra and intraoral devices, despite their use, these devices have some restrictions and flaws in their use [1]. Extraoral devices do not have absolute anchorage by themselves, being dependent on the patient's cooperation, in addition, these removable devices entail the fact that they are not aesthetic and also the possibility of iatrogenic injuries. On the other hand, intraoral devices, although not dependent on the patient, also revealed failures in their function, depending on an anchorage associated with a large number of dental units and favorable periodontal support [1,2].

Also, mini-implants emerged to revolutionize contemporary orthodontics, featuring as a characteristic their reduced size, which facilitates their insertion and provides more precise movements, being indicated even in more complex cases where other anchorage devices were not able to obtain a satisfactory result [3].

However, there are reports of early failure involving loss of stability during treatment, due to being placed transgingivally, being accessible to all types of microorganisms present in the oral cavity, especially

bacteria associated with periodontitis and peri-implantitis. Different variables that can influence the success rate are related to the patient's characteristics; characteristics of mini-implant location and cleaning, surgical placement technique, and orthodontic mechanics [3,4].

Therefore, the present study reported the types of mini-implants and their characteristics, addressing their advantages and disadvantages, insertion sites, indications, and contraindications, to promote general knowledge of orthodontic treatment with skeletal anchorage.

Methods

Study Design

The present study was followed by a systematic literature review model, according to the PRISMA rules. Access available at: http://www.prisma-statement.org/

Data sources and research strategy

Clinical studies were included as case reports, retrospective, prospective and randomized trials with qualitative and/or quantitative analysis. Also, some review studies were included. Initially, the keywords were determined by searching the DeCS tool (Descriptors in Health Sciences, BIREME base) and later verified and validated by the MeSH system (Medical Subject Headings, the US National Library of Medicine) to achieve consistent search.

Mesh Terms

The main MeSH Terms were *Orthodontic treatment. Mini-implants. Anchoring system. Skeletal anchorage*. The literature search was conducted through online databases PubMed, Periodicos.com, Google Scholar, Ovid, Scopus,Web of Science and Cochrane Library.

Study quality and risk of bias

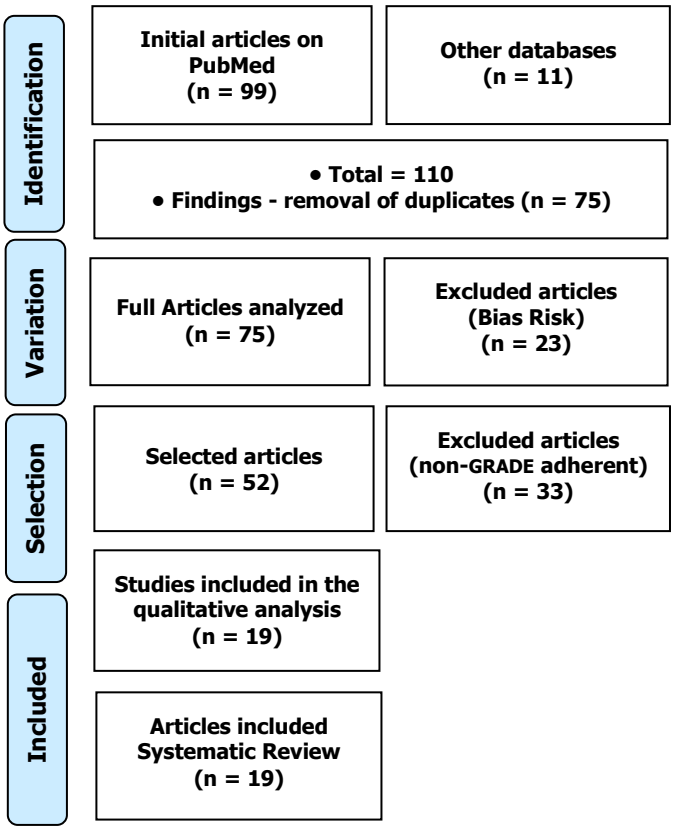
The quality of the studies was based on the GRADE instrument, with randomized controlled clinical studies, prospective controlled clinical studies, and studies of systematic review and meta-analysis listed as the studies with the greatest scientific evidence. The risk of bias was analyzed according to the Cochrane instrument.

Results

Literature Review and Discussion

A total of 110 articles were found involving Orthodontic treatment and Mini-implants. Initially, was held the exclusion of existing title and duplications following the interest described in this work. After this process, the summaries were evaluated and a new exclusion was held. A total of 52 articles were evaluated in full, and 19 were included and discussed in this study (**Figure 1**).

Figure 1. The selection process of scientific articles.



With the advancement of technology, skeletal anchorage, known as mini-implant, has emerged, which has had a great expansion in orthodontic practice over the past two decades, replacing conventional anchorage in situations where it is considered critical, insufficient or that may result in side effects undesirable, such as vertical displacements [1,5]. The use of skeletal anchorage systems has become a new strategy in orthodontic treatment due to the gradual reduction of dimensions, which allows its insertion in several sites, aiming to overcome the problems found with conventional implants [6].

In this scenario, there are a variety of mini-implants with designs, diameters, lengths, titanium purity grades, and surface treatment [7,8]. Regarding the size of mini-implants, the most used are between 4 to 12 mm in length and 1.2 to 2 mm in diameter, ensuring primary stability and resistance to mechanical forces, being selected as long as possible, provided that it does not present a risk to the neighboring anatomical structures [9].

Without damaging the physiology of the bone tissue due to the distribution of the functional load, the most used shapes are conical and cylindrical, with a smooth or treated surface. The shape is related to primary stability and mechanical anchorage through the bone contact surface, where studies reveal that the conical shape has superior stability to the cylindrical shape [10].

The concept of skeletal anchorage, characterized by the use of elements inserted into the intraosseous area, can osseointegrate. This concept implies a direct contact between living bone and the implant surface, without the formation of a fibrous layer between them [11]. The percentage of contact must be adequate to support orthodontic forces and increase stability success rates, however, it must not be excessive to allow the anchorage devices to be removed at the end of treatment, without leading to bone fracture [11].

In this sense, seeking to solve the problems in the control of anchorage, mini-implants appear as an extremely useful alternative, having as their indications in patients in need of maximum anchorage, patients not collaborating with the treatments, patients in need of dental movements considered difficult or complexes for conventional orthodontics and as in asymmetric and intrusion cases, replacement of extraoral anchorage and patients with a reduced number of dental elements [12].

There are several clinical cases in which mini-implants can be indicated, such as molar mesialization, anterior and total anterior teeth retraction, occlusal plane correction, incisor, and posterior teeth intrusion, anterior open bite correction, molar distalization, verticalization and molar disimpaction, posterior crossbite correction, impacted teeth traction, midline correction [13].

Considered as one of the greatest developments in contemporary orthodontics, its main advantage is its high success rate, with a percentage that can reach 98.2%. Skeletal anchorage devices were chosen for innovating clinical orthodontics, and their advantages can be cited as their reduced size that increases the variety of places for their insertion, especially in the inter radicular regions, easy installation and removal, low cost, comfort, and good acceptance by the patient, immediate activation as long as they present good initial stability, no need for patient cooperation, less invasive surgery, increased predictability of results, in some cases, there is no need for drug therapy, simultaneous movement of several dental units, aesthetics and reduction in treatment time [14].

They can be used either as direct anchorage units, with clinical forces applied to the devices or as indirect anchorage units, with forces applied to dental units such as orthodontic bars and wires that are stabilized by mini-implants [15].

Before starting the method of anchoring the patient, communication is needed, improving the relationship and leading to less misunderstanding. It is important to emphasize that careful planning must be carried out beforehand, to achieve a high level of satisfaction for both the patient and the professional. The planning must contain a careful and complete anamnesis and a specific complementary exam known as computed tomography that serves to determine the thickness of the cortical bone, the best anatomical location for its insertion, and the quality of the bone [16].

The main purpose of micro screw installation surgery is to obtain high initial stability that will provide immobility to the anchorage system due to the mechanical interlocking of fixation to the bone, where the application site must provide bones of good quantity and quality. It can be used in any area of bone tissue, alveolar or apical; to the gingival tissue, it can be inserted into the free gingiva or keratinized gingiva [17].

Thus, a study of the ideal location must be carried out, which constitute several factors such as appropriate regions of insertion inclination, the ideal size for placement of the mini-implant in the region, observe whether there is an adequate amount of cortical bone, soft tissue situation and mainly, the type of tooth movement that will be done. The installation can be done by any dental professional as the procedure is minimally invasive, but periodontists, maxillofacial surgeons, and implant dentists are more in demand. In addition, the material, surgical technique, patient hygiene care, and patient control performed by the professional are also of great importance [18].

The primary stability of implants, that is, mechanical fixation in the first moments after installation, is influenced by three factors such as bone quality, mini-implant design, insertion method, and evolution of the interfacial tissue. It is considered an important factor in the early stages of implant-bone tissue healing. The installation of the mini implant is simple and can be inserted in several places due to its reduced size, using mono or bi-cortical anchors, alone or connected by an interchangeable structure. Possible insertion sites in the maxilla include the area below the nasal spine, the palate, the alveolar process, infra-zygomatic crest, between the buccal and palatal roots, and maxillary tuberosities [19].

In the mandible, they are the retromolar region, mandibular ramus, and body, lateral to the symphysis and mentum and between the buccal and lingual roots. It is recommended that they be placed 2mm of safety clearance between the mini-implant and adjacent structures to avoid any possible damage. The

interventional procedure can be divided into four phases: 1- implant insertion; 2- orthodontic loading; 3- implant maintenance and 4- implant removal [2,3].

In this respect, the mini-implant insertion site must be related to its diameter and length, and the choice of the mini-implant will depend on the area where the orthodontist intends to place the device. For the application of the anchorage device, the surgical guide must first be made and the orthodontic planning prepared. The surgical procedure consists of the application of anesthesia, which should not be deep for the patient to report possible discomfort [6]. Then the OMIs are inserted into the maxillary or mandibular bone. After insertion, they are usually loaded with orthodontic forces, patients are checked every 4 weeks. During these maintenance visits, orthodontic appliances and forces are controlled, implant stability is assessed, and factors related to implant maintenance are reinforced [7,8].

It is recommended to apply low-intensity forces during the first activations, but mini-implants can be loaded immediately because their primary stability is generally sufficient to sustain a normal orthodontic force. The mini-implant, despite having a high success rate, also has its contraindications, which can be classified as temporary and absolute. Disadvantages are considered when there is movement and loosening of the mini-implant, involvement of nerves and blood vessels during surgery, irritation of the palate mucosa and gingival hyperplasia due to poor hygiene causing pain and swelling around the installation site, possible fracture of the mini implant at insertion time due to excessive force, inability to resist rotational forces, approximation with the root surface and screw coverage by the adjacent gingiva [1-4].

Conclusion

It is concluded that the mini-implant emerged to revolutionize orthodontic treatment through more precise movements, in a short time, facilitating the more complex movements that other devices had difficulty in performing. Its main characteristic is a high success rate, in addition to having a reduced size, which allows its insertion in several sites. Consequently, the skeletal anchorage device is an excellent method, as long as it is used according to indications and taking meticulous care from the ideal choice of the device to the moment of its insertion.

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Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

Similarity check

It was applied by Ithenticate@.

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