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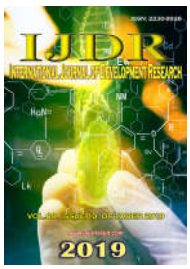

RESEARCH ARTICLE OPEN ACCESS

CHARACTERISTICS AND TYPES OF MINI-IMPLANTS: LITERATURE REVIEW

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ABSTRACT

Introduction: Orthodontic Movements are given by means of the specific wires inserted in brackets. For such a movement to occur it is necessary to have a force of resistance to this movement, known as anchoring. For this purpose, they suggest mini implants, which are devices used as an auxiliary mechanism for resistance to movement required. Since they reduce the need for patient cooperation, thus facilitating the planned and necessary biomechanics. It also makes the treatment more predictable. **Objectives:** This paper proposes, through a literature review, to point out the characteristics of mini-implants and their variations in shape. **Methodology:** To elaborate it, a search for scientific articles was performed in the various databases *online*, using specific descriptors. The articles used were selected according to the inclusion criteria of this literature review. **Conclusion:** After analyzing the articles, it was observed that there are a number of variations in screw shapes (mini implants) and that each of these variations has different clinical applications. We can also observe that mini implants are ancillary elements to orthodontic treatment and their knowledge is fundamental to the orthodontic practitioner.

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INTRODUCTION

In Orthodontics, some studies have indicated that certain dental movements are undesirable, especially when teeth are subjected to the application of a pressure and / or traction force exerted using orthodontic appliances. In this sense, it may be necessary to use devices to aid resistance to these movements using the devices. The mini-implant, as it is known, is used as an anchor for orthodontists because of the need to prevent this unwanted movement. In this sense, the use of mini-implants has become a reality in current orthodontics (Buj, Vargas e Hernández, 2005; Zucoloto e Carvalho, 2008; Chung *et al.*, 2016; Kim *et al.*, 2016; Marigo, Elias e Marigo, 2016; Becker *et al.*, 2018). As an adjunctive treatment, mini-implants are currently one of the major innovations and technological advances of the last 10 years. They are an important means of treatment anchorage, because they largely eliminate the need for patient cooperation, as well as facilitate the applied mechanics and make treatment more predictable (Squeff *et al.*, 2008; Marigo, Elias e Marigo, 2016; Ntolou, Tagkli e Pepelassi, 2017; Becker *et al.*, 2018). These materials are made of grade V titanium alloy, having as main characteristics complete non-osseointegration and greater fracture resistance (Janson, Sant e Vasconcelos, 2006; Consolaro *et al.*, 2008). The constituent parts of this device are head, transmucosal profile and thread. The mini-implant head supports orthodontic appliances and will usually be exposed in the oral cavity. It should be small and polished and rounded so as not to injure the patient or retain biofilm and have holes and retentions for orthodontic accessories. Another component of the mini implant is the transmucosal profile, which is also called a necklace or brace. This may or may not be present in the device and corresponds to the smooth surface just below the head. In addition to this structure, there is also the thread, which corresponds to the part that becomes intraosseous after its installation and may vary according to the manufacturer of the mini implant (Pithon *et al.*, 2008). As for the types the

devices also suffer variation differing in functions and mycological variations. They are classified into self-tapping, in need of a micromotor cortical perforation in their installation, and self-drilling self-tapping, which can perforate the cortical by its active tip (Jardim, 2008; Squeff *et al.*, 2008). Due to their advantages in orthodontic treatment, mini implants have become increasingly prominent and gaining ground in the orthodontic market, especially as an adjunct to appliance treatment. In this sense, it is extremely important that studies continue the analysis of this device. Given this, the constant studies on the subject are valid. Thus, the aim of this paper is to address, through a literature review, the characteristics and types of mini implants present in the dental market, also highlighting the clinical implications of different device types for each specific clinical application.

MATERIALS AND METHODS

This study is a literature review based on scientific articles on features and types of mini implants. Researches related to the selected theme were searched. For searching the articles, the following databases were used *online*: PubMed and Google Scholar. We searched scientific articles, abstracts, monographs, theses and books for the last 15 years, using the following descriptors: "Mini-implants"; "Anchoring"; Orthodontics. After the research, articles were selected for the preparation of this work, in Portuguese and English, being read in full, and which served as the basis for conducting a review of classic literature focusing on the objective of the present work.

Literature Review

Orthodontic mini-implants are made of pure V or IV grade titanium that allow skeletal anchorage through a safe surgical procedure (Villela *et al.*, 2006; da Nova *et al.*, 2008; Becker *et al.*, 2018). These devices have demonstrated significant versatility in clinical application, especially due to their small size, relatively low cost, simplified installation technique and removability (Villela *et al.*, 2006; Pithon *et al.*, 2008; Marigo, Elias e Marigo, 2016; Ntolou, Tagkli e Pepelassi, 2017). Contrary to what happens with traditional implants, in mini implants the osseointegration process does not occur, favoring the application of an immediate load (Brandão e Mucha, 2008). Another positive feature is mechanical stability, which favors greater fracture resistance(da Nova *et al.*, 2008; Yao *et al.*, 2015).

Mini-implant parts

Mini implants can be divided into 3 parts: (1) head; (2) transmucosal profile; and (3) body / active part / thread, as can be seen in Figure I (Villela *et al.*, 2006). The head consists of the part that will be exposed clinically and will serve as a means for coupling with the proper orthodontic devices such as strings, elastic bands or springs. Ideally, this part of the mini implant should be small, polished and rounded, so that there are no lesions in the areas, as well as prevent biofilm buildup on this surface. Despite needing these basic characteristics, each manufacturer will define its shape for the mini-implant head(Brandão e Mucha, 2008; Brown *et al.*, 2014; Ntolou, Tagkli e Pepelassi, 2017). The transmucosal profile, also known in the literature as collar or brace, corresponds to the portion that lies between the intraosseous part and the head of the mini-implant, ie, the intermediate part, in which the periimplant soft tissue (MAH) accommodation occurs (Brown *et al.*, 2014). In choosing this part, the orthodontist must consider the thickness of the soft tissue above the installation, in which the mini implant must be inserted into the bone at least 6 to 8mm[5] (Suguino, 2006). The literature addresses some techniques for measuring this thickness, such as the use of the tomographic guide. Another technique is direct measurement using a millimeter probe and a rubber cursor / stop (Matzenbacker da Silva *et al.*, 2008; Nienkemper *et al.*, 2016).

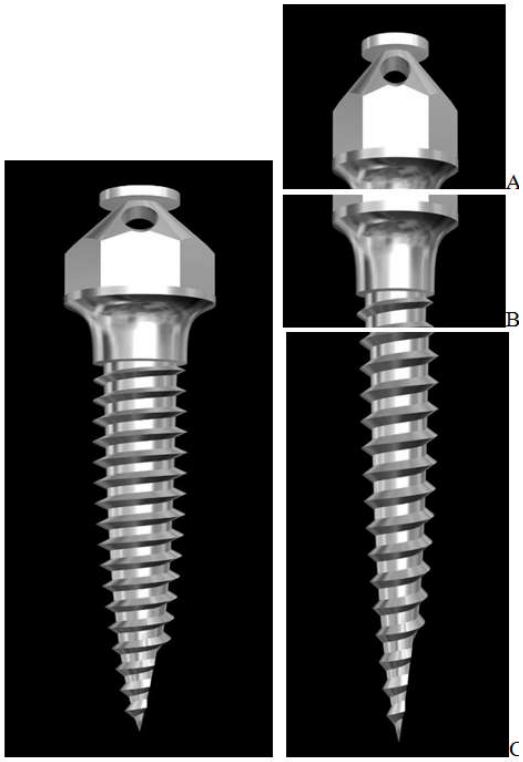

Figure 1. Schematic drawing showing a mini-implant with button head and its constituent parts. Note the mini-implant head (A), transmucosal profile (B) and threads (C)
Source: Ladeia Jr; Ladeia, 2011

The thread, also known as the active part or body, of the mini implant is the intraosseous part, and may also vary by manufacturer. In general, the thread can be single or double, presenting triangular shape, according to Figure II. It is worth noting that the higher the number of threads, the greater the bone-implant interface and therefore the stability of the mini-implant (Marassi e Marassi, 2008; Brown *et al.*, 2014; Yao *et al.*, 2015). Regarding the shape, this part of the mini implant may have a single diameter from beginning to end, being known in this situation as cylindrical; or it may have diameter thinning as it approaches the extremity, in these cases it is known as the tapered. Another highlight for the mini-implant threads is in relation to the cut, which can be self-tapping or self-tapping and self-drilling. These features can be seen in Figure III. One noteworthy point about the thread is that the mini implants can have right or left threads. Usually, those with right-hand thread have clockwise insertion, just as the left-hand screw has counterclockwise direction, as shown in Figure IV. Thus, when the orthodontist plans a rotational anchorage, he must consider the threading direction so that the desired biomechanics is in the direction of insertion of the device in the bone (Di Matteo, Villa e Sendyk, 2005; Nienkemper *et al.*, 2016).

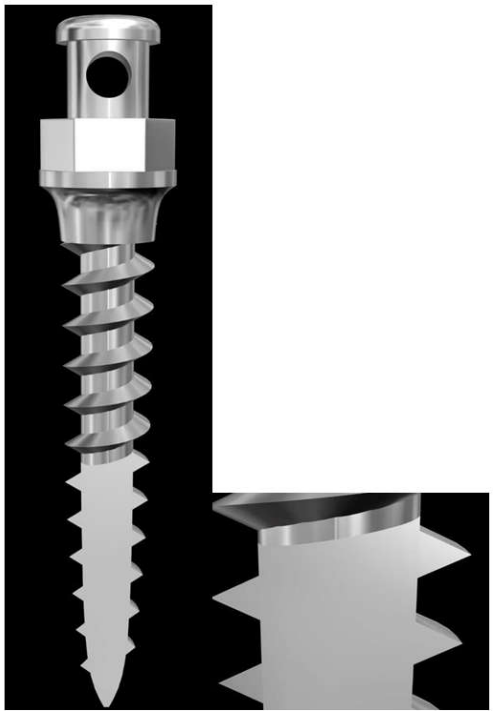

Figure 2. Sagittal section of the mini-implant, showing a triangular thread shape Source: Ladeia Jr; Ladeia, 2011

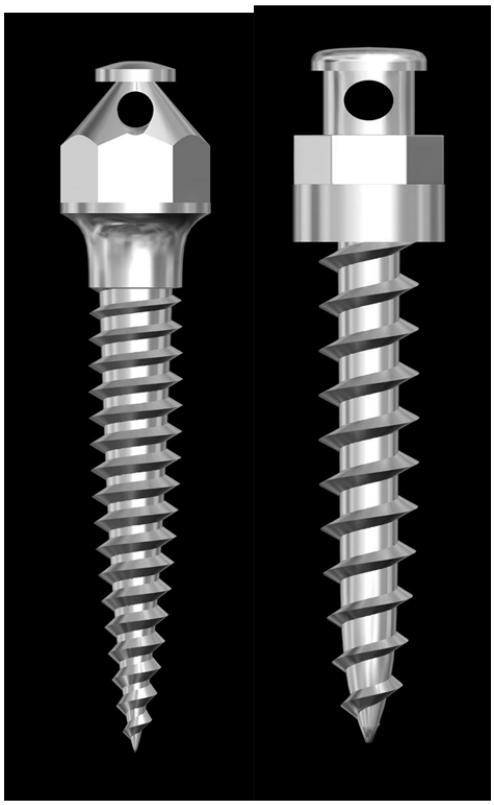

Figure 3. Schematic drawing of conical thread and cylindrical thread Source: Ladeia Jr; Ladeia, 2011

Only Mini-Implants xMini-Implants The only self-drilling

Self-Drilling Self-Drilling Only Self-Drilling Mini-implants feature the need for cortical drilling with specific material at the time of installation, as their active tip does not allow cortical perforation bone(Buj, Vargas e Hernández, 2005; Di Matteo, Villa e Sendyk, 2005; Brandão e Mucha, 2008; Sekima *et al.*, 2009).

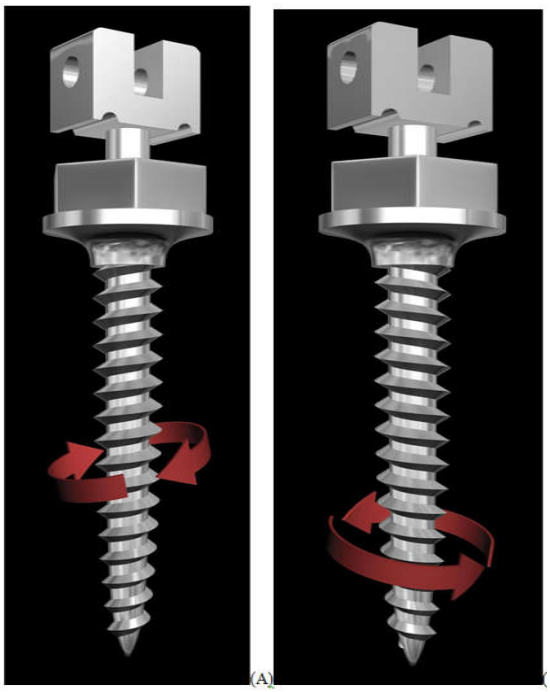

Figure 4. Schematic drawing showing thread direction (A) Right-hand mini-imp. Note clockwise on bone insertion, (B) Left-hand mini implant with counterclockwise insertion of bone. Source: Ladeia Jr; Ladeia, 2011

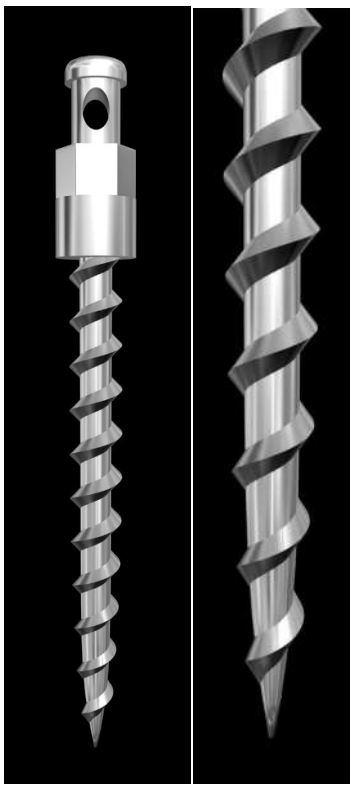

Figure 5. Schematic drawing of the active part of the only self-tapping mini-implant. Source: Ladeia Jr; Ladeia, 2011

On the other hand, mini implants that are self-tapping and self-drilling (Figure VI) do not require this clinical stage. This is since this type can pierce the cortical through its active tip, facilitating its insertion. This type of mini implant, because it allows drilling, favors the root drilling rate in the use of devices such as drills (Buj, Vargas e Hernández, 2005; Consolaro *et al.*, 2008; Gigliotti *et al.*, 2011; Brown *et al.*, 2014; Nienkemper *et al.*, 2016).

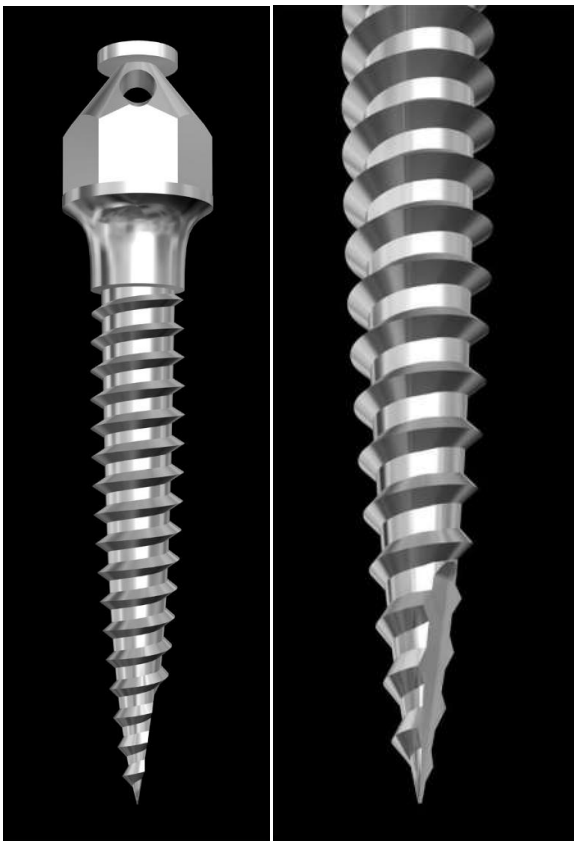

Figure 6. Schematic drawing of the active part of the self-drilling and self-drilling mini-implant Source: Ladeia Jr; Ladeia, 2011

Types of Mini implants

Several types of mini implants have been presented in the literature since the emergence of these devices as an aid in orthodontics(Araújo *et al.*, 2006). These devices differ according to their morphology, especially regarding the head. Considering that this structure directly supports orthodontic mechanisms. The transmucosal profile is also determinant for the diversity of mini implants. These may vary according to the thickness of the mucosa and the anatomical region in which the device will be installed. These details can be seen in Figure VII. More recently, commercially available mini implants have diversity in size, shapes and application methodologies. In this sense, there is a variation on the world market of designs, diameters, lengths, degrees of purity of the material and surface treatments. What is observed is that this diversity is associated with the trademark of this orthodontic device (Brandão e Mucha, 2008).

Extralveolar stainless steel

Mini implants as already discussed; mini implants are commonly made of titanium in varying degrees of purity. This material is biocompatible, allowing direct bone contact, however, the high degree of osseointegration required for implants is not required for mini implants (Brown *et al.*, 2014). Thus, developed studies allowed the use of stainless steel to be used in the making of mini implants. This material, too, is biocompatible. Steel ends up demonstrating a good combination of mechanical strength, ductility, cost and ease of fabrication (Dalvi e Elias, 2015). This material does not allow osseointegration, making it suitable for use in some specific situations, such as those in which it is intended to be removed after its temporary use, idealized in the case of mini implants.

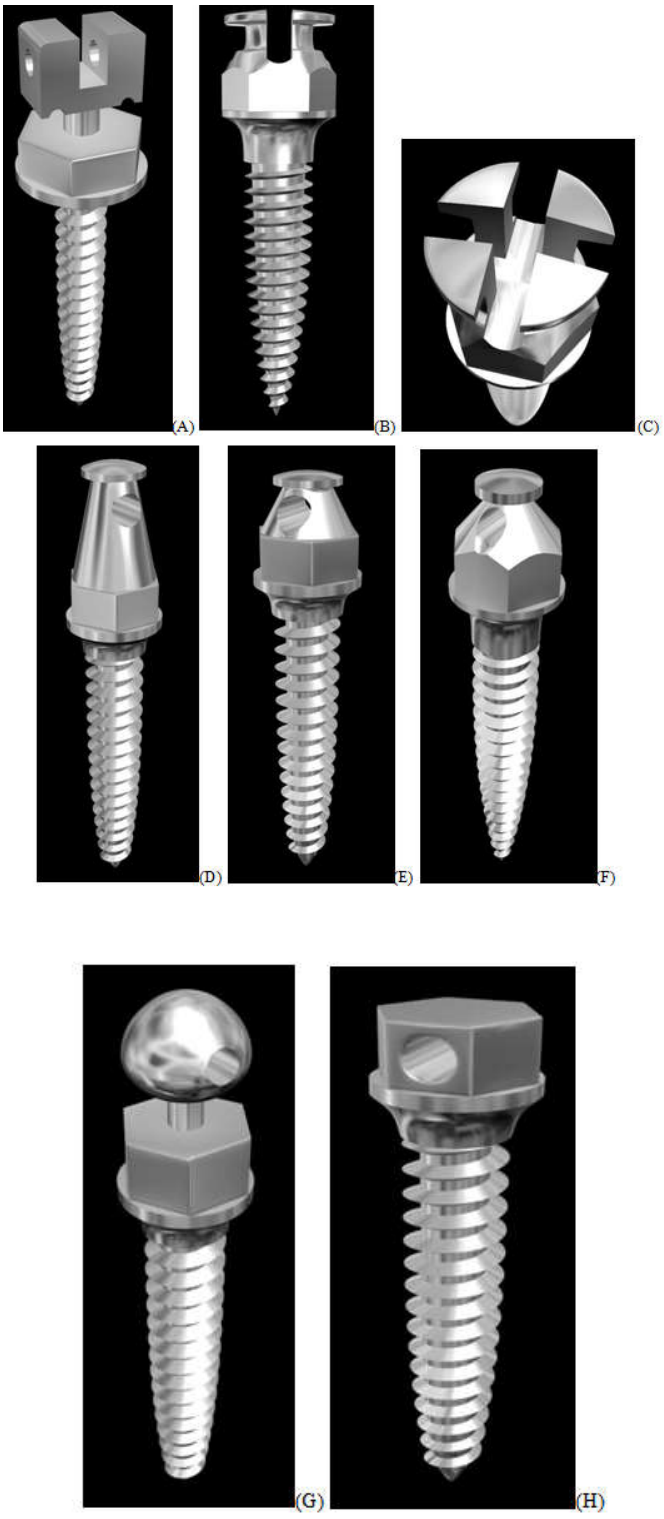

Figure 7. Schematic drawing showing some types of mini-implant heads. Square vane bracket head (A), round vane bracket head (B, C), long (D), medium (E) and short (F) button head, circular head (G) a nd headless (H). Source: Ladeia Jr; Ladeia, 2011

Brown and collaborators (2014) conducted a study to evaluate the detailed mechanical and histological properties of stainless steel mini-implants used as anchors in temporary orthodontic cases, comparing them with titanium alloy mini-implants. The authors obtained as results that the mini implants were stable in the insertion, after a period of 6 weeks. They showed that the only significant difference between the two types of mini implants was the greater insertion torque for stainless steel. They concluded that both types of mini implants have adequate stability(Yao *et al.*, 2015; Meursinge Reynders *et al.*, 2016).

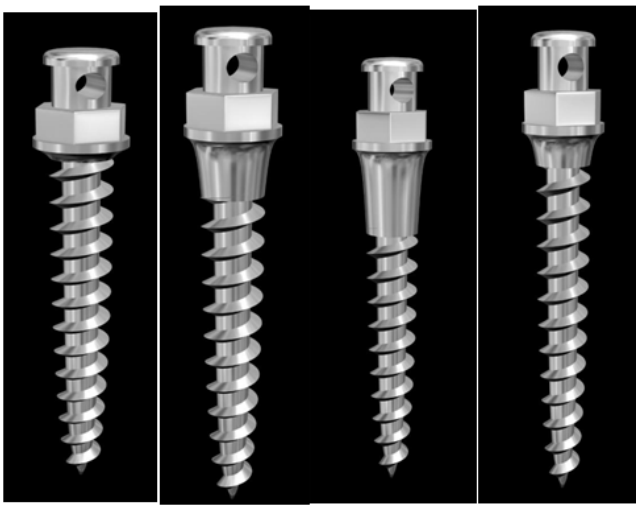

Figure 8. Schematic drawing showing some variations of the transmucosal profile in mini-implants Source: Ladeia Jr; Ladeia, 2011

It is important to note that the stainless-steel mini implants developed by Chang *et al*. (2015), are specific regarding the installation in places with denser bone cortical, such as the posterior region of the mandible. These mini implants are installed in the extra-alveolar region, in the buccal of the first and second lower molars, and do not interfere with the tooth pathway regarding movement within the alveolar process. Stainless steel mini implants also have a higher modulus of elasticity than titanium alloy. It also has greater mechanical resistance, which favors the production of smaller pieces and at a lower cost (Monteiro *et al.*, 2018).

Figure 9. Exemplary stainless steel orthodontic mini-implant Source: Dental América (https://damerica.com.br/produto/mini-paroduso-ortodontico-extra-alveolar-inox-2-0-x-14-mm -f-rahos /)

Conclusion

Given these elucidations, it becomes clear the importance of mini-implants, as ancillary elements to orthodontic treatment. Being these fundamental with means to aid the treatment, as well as their knowledge becomes base to practitioners of Orthodontics. After analyzing the articles, it was observed that there are a number of variations in screw shapes (mini implants) and that each of these variations has different clinical applications.

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