

EFFECT OF ANGLED INSTALLATION OF ORTHODONTIC MINI-IMPLANTS ON PRIMARY STABILITY

ABSTRACT

AIM: The aim of this work was evaluate the insertion and removal torque for orthodontic mini-implants inserted in different inclination. **MATERIALS AND METHODS:** Ten self-drilling mini-implants from the brand SIN (Sistema de Implantes Nacional, São Paulo/SP, Brazil), and the surgical kit for their insertion were used. Two plaques of synthetic bone of 120 mm x 170 mm x 41,5 mm were used (Sawbones, Pacific Research Laboratories Inc, Vashon, Wash), with 1,5 mm height, simulating the cortical bone (density 40 pcf) and 40 mm simulating the medullary bone (density 15 pcf). In each block, five areas were demarcated for each mark, totalizing ten areas. The ten mini-implants were inserted by the same operator, previously calibrated; five of them at 90° and five at 60°, using the manual key kit. After the insertion of all the mini-implants, the final threading and the reading of insertion torque value were carried out with a manual torque wrench digital Lutron TQ-8800 (Lutron Electronic Enterprise Co., Ltd, Taipei, Taiwan) until the transmucosal profile achieve the cortical bone. The maximum insertion torque value was registered in N/cm. After all the implants inserted, the measurement of removal torque was started, performed in the same way of insertion, but in the opposite anticlockwise. The results were submitted to the T test (parametric) and to a Mann-Whitney test (non-parametric). **RESULTS:** The results demonstrated that the insertion torque was lower than the removal one in both insertion degrees, with statistically significance. Despite insertion torque at 90 degrees had been lightly higher than that inserted at 60 degrees, they were not statistically significant. **CONCLUSION:** In view of the results, it was possible conclude that insertion at 60° angulation does not offer advantages to the primary stability for orthodontic mini-implants.

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KEYWORDS

Orthodontics. Orthodontic mini-implant. Insertion angle.

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INTRODUCTION

For a successfully orthodontics treatment, efficient anchoring is fundamental. Therefore, finding efficient anchoring ways has been a challenge for orthodontists and researchers. Orthodontic mini-implants were introduced as a promising solution for this. Their low cost, easy install and the possibility to be installed in several places, further the unnecessary collaboration by patient become this device in a solution for many conventional issues of orthodontics¹.

However, absolute anchoring technique presents possible complications, like the root iatrogenic injury (it can generates the loss of tooth vitality, osteosclerosis, ankylosis), screw fracture during the insertion or removal, and more commonly its failure². The success index and the factors which affect the orthodontic mini-implant stability have been widely studied in order to adjust the plan of treatment, installation technique, the screw design for each case and minimize its failure¹.

Mechanical imbrication of thread screw to the bone immediately after its insertion is called primary stability; the fixation to the bone during the necessary time for the treatment is called secondary stability. Primary stability may be affected both for screw and the patient; wherefore, the mini-implant design, the bone quality, the technique and the inclination of install are factors to be

carefully analyzed previously the mini-implant installation³.

Clinically, the mini-implants are loaded immediately after their installation, what demonstrates fundamental importance of primary stability. Lack of primary stability generally leads to the mobility and consequently screw failure⁴. Despite the importance of an excellent primary stability, high values of tension between the bone and the screw may generate bone micro fractures, which would result in necrosis in the bone region near to the screw, and consequently lead to the failure.

By awareness of importance of primary stability and of the factors which may affect this stability, this work has as aim verify the primary stability of orthodontic mini-implants installed at different angulation.

MATERIALS AND METHODS

Ten self-drilling mini-implants of the brand SIN (SIN-Sistema de Implantes Nacional, São Paulo/SP, Brasil) were used: they were 6mm length, 1.6mm diameter and 1mm transmucosal profile. Evidently, the same brand surgical kit was necessary to insert the mini-implants. In order to standardize the bone surface evaluated, synthetic bone polyurethane base was the choice (Sawbones, Pacific Research Laboratories Inc, Vashon, Wash). Two synthetic bone plaques in 120 mm x 170 mm x 41,5 mm, with 1,5 mm height was used

to simulate the cortical bone (density 40 pcf) and 40 mm to simulate the medullar bone (density 15 pcf).

Two bone blocks were demarked with areas in 20mm x 20mm, delimitating the insertion field for each mini-implant. In each block, five areas were marked, in a total of ten areas.

The ten mini-implants were inserted by the same operator, previously calibrated; five of them inserted at 90° and five inserted at 60°, using the manual key kit. After the insertion of all the mini-implants, the final threading and the reading of insertion torque value were performed with manual torque wrench digital Lutron TQ-8800 (Lutron Electronic Enterprise Co., Ltd, Taipei, Taiwan) until the transmucosal profile achieve the cortical bone. The maximum torque value was registered in N/cm. After the insertion of all the mini-implants, the measurement torque removal was started, carrying out the same way as the insertion, but in the anticlockwise. The results were submitted to the Mann-Whitney test (non-parametric).

RESULTS

The results demonstrated the insertion torque was higher than removal in both insertion degrees, and statistically significant. Despite the insertion torque at 90° is lightly higher than inserted at 60°, this difference was not statistically significant (Table 1, Graph 1).

DISCUSSION

Orthodontic mini-implants are devices which come to solve one of the orthodontic problems: anchoring control; however, this technique still dispose the failure possibility, and the most common is the loss of stability before the time necessary to the treatment. Nowadays, studies have been focused in discovery how the loss of stability of these screws occur.

Primary stability of orthodontic mini-implants indicates that screw is retained to the bone after its installation. One of the primary stability indicators is the maximum value of insertion torque. Secondary stability is the verification of retention after its installation; therefore, it depends on the body response to the mini-implant insertion. It is important clarify that primary stability cannot be associated to the success rate of technique^{1,5}, in other words, a good primary stability is not always consistent with good secondary stability. Mini-implant stability to the bone can be associated with several factors, discussed next.

Regarding to the insertion methods, they can be divided into: inserted by motorized devices, which enable an insertion with controlled wrench; or by manual insertion, that can be performed with manual torquimeters or without their help. The insertion method may also be differenced according to the type of mini-implant used:

self-drilling or self-tapping; self-drilling ones do not need previous perforation and the self-tapping does. A study performed by Pauls *et al.*, (2013)⁵ demonstrated that both motorized insertion, where there is an insertion torque control and the manual insertion, which did not present this control, provide a maximum torque value within preconized limit. However, a study performed by Barros *et al.* (2012)⁶, verified that, when the manual key is used, the

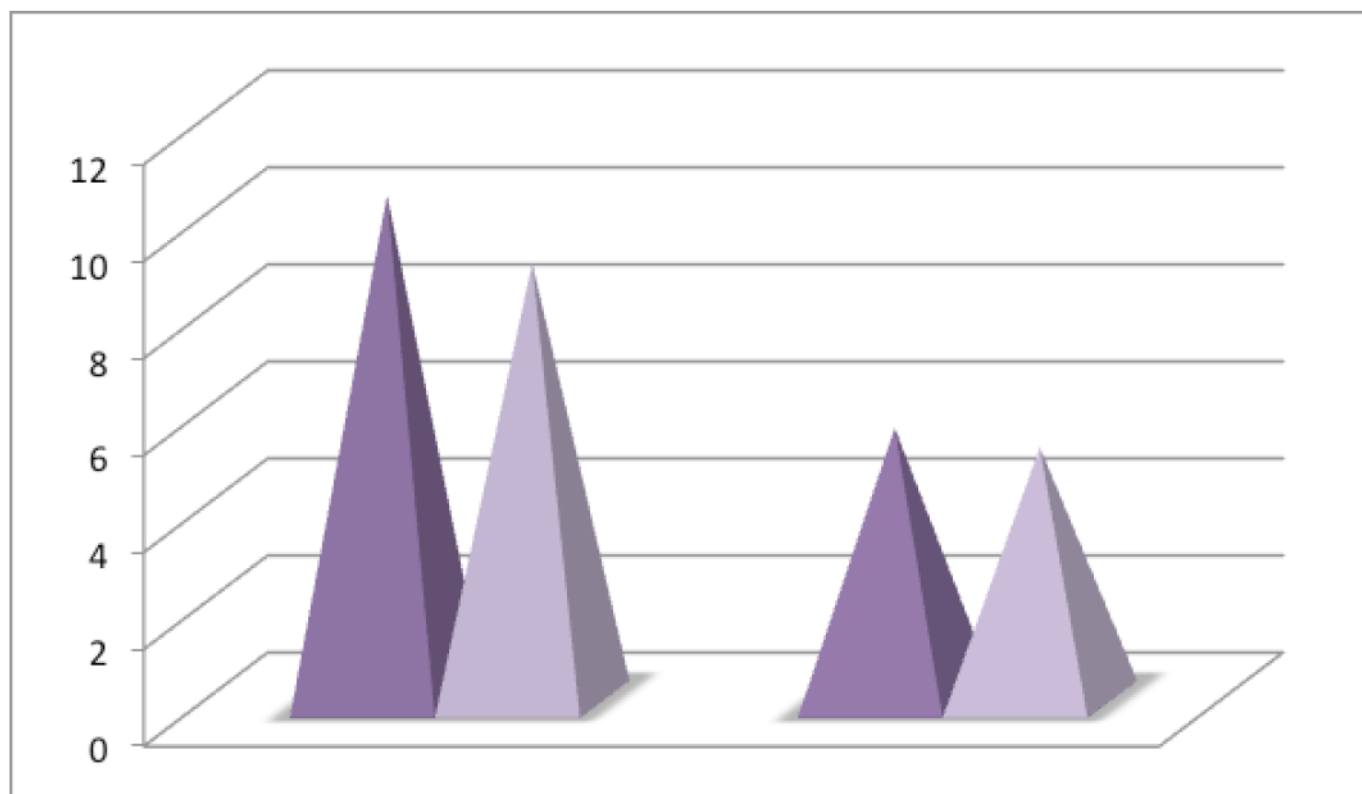
use of digital force produce low tension than that produced by the forearm, than mechanically safer and biologically consistent with the digital in orthodontic mini-implants installation, because it helps in the fracture prevention of mini-implants and possible bone micro-fractures. It justifies the use of manual insertion with digital turning in this study.

Table 1. Average (Ncm) insertion and removal torque values of orthodontics mini-implants brand SIN inserted at 900 and 600.

| | | |
|-------------------------|---------|--------|
| Insertion torque | 10.4 aA | 9 aA |
| Removal torque | 5.6 bB | 5.2 bB |

Different low case in column and uppercase in line are significantly different ($p < 0.05$).

Graph 1. Average (Ncm) insertion and removal torques of orthodontics mini-implants brand SIN inserted at 900 and 600.



Both self-drilling and self-tapping mini-implants can be efficiently used as absolute

anchoring. However, it is evident that self-drilling mini-implant, similar to the used in this

study, provides higher primary stability, easier to insert (because it does not need previous drilling), further facilitate the use of orthodontic loads immediately after its installation. The use of self-tapping mini-implants presents the benefit to provide lower quantity of cracks in the cortical bone during the insertion, what reduces the chances of bone reabsorption after insertion provoked in response to the necrosis, resulting from micro-fractures^{7,8}. It is preferable, wherefore, the use of light loads soon after the insertion of self-tapping mini-implants, because they produce lower insertion torques due to the previous drilling.

The mini-implants shape is also responsible by changes in the primary stability. Mini-implants in conical shape result in higher primary stability when compared to the cylindrical shape⁴. The increase of length⁹, and the increase in width¹⁰⁻¹² also contribute to the increase in the primary stability.

Factors in the mini-implant shape, responsible by the increase in the primary stability, should be considered and used carefully when inserted in a denser bone surface¹², because it can result in higher quantity of cracks and consequently bone reabsorption, and reduction of secondary stability. Previous drilling performed in order to avoid micro-cracks, and also the presence in the surface treated, would stimulate osseointegration points¹³, seem relevant as

preventive measurement to improve the secondary stability in these cases¹⁰.

Insertion torque also increases with the increase of depth, of mini-implant diameter³, higher bone density^{14,15}, and the use of self-drilling mini-implants¹⁶.

This work demonstrated the removal torque is lower than the insertion one, corroborating with works performed by Suzuki and Suzuki (2011)¹⁷ and Nova et al. (2008)¹⁸. Now, in vivo studies also reported the higher the insertion torque, the lower the secondary stability, what reduce consequently the removal torque¹⁷.

Cho et al. (2013)², in an in vitro study, demonstrated that even the low values of insertion torques may provide deformation, or even the screw fracture when in contact with root.

Regarding the inclined insertion, matter in evidence in this work, while authors like Meira et al. (2013)¹⁹; and Xu et al. (2013)²⁰ revealed higher values of torque insertion with inclination supposedly occurred by the increase of contact with cortical bone; studies like those performed by Lee et al. (2013)²¹, Petrey et al., (2010)²²; Heo, Cho, Baek (2012)²³ and Woodall et al., (2011)²⁴ revealed that inclined insertion is not an advantage, because it creates a bigger lever arm for outside the bone, reducing its resistance to the forces applied on it, further, of course, contributing

for accumulation of food in the head, due to the inclination.

Our result is opposite the works performed by Meira et al. (2013)¹⁹ and Xu et al. (2013)²⁰, because we found insertion lower torque values in angulated installation; however, it is difficult to compare, because mini-implants used were in different shapes, and the work carried out by Xu et al. (2013)²⁰ was an in vivo experiment. Therefore, when associate our results to those found in the literature, the orthodontic mini-implants insertion seems to be more advantageous at 90°.

CONCLUSION

In view of the results, it was possible conclude that the insertion with angulation at 60° does not offer advantages to the primary stability of orthodontic mini-implants when compared to the installation at 90°.

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