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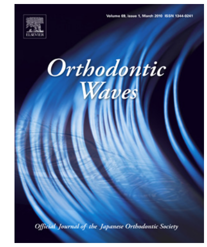

Research paper

Stability of miniscrews with different continuous orthodontic forces as measured by cone-beam computed tomography

Prasanpong Pongsamart DDS[a], *Suwannee Luppanapornlarp DDS, MSc, PhD*[a,*], *Suchaya Pornprasertsuk-Damrongsri DDS, MSc, PhD*[b], *Supatchai Boonpratham DDS, PhD*[a], *Peerapong Santiwong DDS, PhD*[a]

[a] *Department of Orthodontics, Faculty of Dentistry, Mahidol University, Bangkok, Thailand*
[b] *Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Mahidol University, Bangkok, Thailand*

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ABSTRACT

Purpose: Miniscrew stability is a key for successful orthodontic anchorage reinforcement. Light force as 50 g has been proposed to efficiently retract canine; however, for miniscrew stability, its efficiency is still questionable. This study aimed to evaluate and compare miniscrew displacements loaded with 50 and 150 g to retract upper canines.

Subjects and methods: Twenty four miniscrews (1.4 mm diameter and 7 mm length) were placed in twelve orthodontic patients (female, 22.55 ± 4.8 years old) who required miniscrews for maximum anchorage. Cone-beam computed tomography (CBCT) was taken to assess the miniscrew displacement in three dimensions. The *X*, *Y*, *Z* coordination points at the miniscrew head and tail with anterior nasal spine as a reference point were recorded and analyzed the displacements during 3 months using one-sample *t*-test and pair *t*-test.

Results: Miniscrews were significantly displaced after loading 50 and 150 g at 2 and 3 months compared to baseline ($P < 0.001$). At 2 months, the displacement of the miniscrews at head and tail had no statistical significance between 50 and 150 g ($P > 0.05$). However, at 3 months, there were statistically significant displacements between 50 and 150 g. This displacement was found to be greater in 150 g and at head more than at tail ($P < 0.05$).

Conclusion: This study concluded that miniscrews could be significantly displaced with 50 and 150 g during 3 months wherein the heavier loading force essentially caused more miniscrew mobility. Clinically, it is suggested to use proper magnitude of force to miniscrews with care in order to overcome orthodontic anchorage failure.

1. Introduction

The main purpose of anchorage reinforcement in orthodontic treatment is to resist unwanted tooth movement. Generally, the methods used to reinforce anchorage include increasing the number of teeth and/or using other tools such as intra- and/or extra-oral appliances. Nowadays, temporary anchorage devices, or other terms as mini-implants or miniscrews,

* *Corresponding author at*: Department of Orthodontics, Faculty of Dentistry, Mahidol University, 6 Yothi Street, Rajathevi, Bangkok 10400, Thailand. Tel.: +66 2 2007813; fax: +66 2 2007812.
E-mail addresses: suwannee.lup@mahidol.ac.th, wifi2smile@gmail.com (S. Luppanapornlarp).
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become more useful to achieve anchorage control due to their many advantages: less patient compliance, less anchorage loss, more convenience to use, and so forth [1,2]. However, stability of miniscrews is still an important issue for researchers and clinicians because of the need to enhance its stationary ability in order to increase success rate.

It has been stated that failure rates of miniscrews were possible if the mobilized and displaced miniscrews were not counted as successful. It was suggested to distinguish between success and stability so as to clearly define the achievement of orthodontic treatment [3]. In addition, there are many parameters that affect miniscrew stability such as miniscrews themselves [4], patients [5], and location of insertion [6]. Moreover, time of force application, whether immediate or delayed loading has been one of the parameters being debated on. It was reported that a success rate of 87.5% was found for immediate loading [7], while the success rate for delayed 2–4 weeks loading was about 89% [8]. Concerning this parameter, it is still unclear whether immediate of delayed loading is better for the stability of miniscrews.

Magnitude of force loading to the miniscrew has also been reported to relate with miniscrew stability. Many studies have shown the variety of force magnitudes ranged from 50 to 400 g at various locations of miniscrew placement. It was suggested to use loading force as low as 25 or 50 g at the beginning of force application to prevent some extent of the load transfer mechanism [9]. However, it seems that most studies used forces of 150–200 g or more at miniscrews [10]. Stability of miniscrews with various force magnitudes is still questionable and needs to be resolved in order to increase success rate.

Recently, continuous force of 50 g has been purposed to efficiently retract upper canines [11] with less pain and similar canine movement when compared to 150 g. It is hypothesized that magnitude as low as 50 g loading force might not affect miniscrew stability. Therefore, the aim of this study was to determine the stability of miniscrews with light continuous loading force of 50 g and with a heavier one of 150 g to retract canines, and to compare the miniscrew displacement distances from those different forces during 3 months as measured by CBCT.

2. Subjects and methods

This study protocol was approved by the Committee on Human Rights Related to Human Experimentation of Mahidol University, Bangkok, Thailand (MU-IRB 2010/103.0804). All subjects had met the criteria as followed: (1) age of 18 to 30 years old; (2) good oral and gingival health; (3) no systemic or bone diseases; (4) orthodontic treatment plan of upper first premolars extraction with or without lower premolars; (5) maximum anchorage with miniscrews in the upper arch for canine retraction; and (6) completed orthodontic record. Thirteen patients agreed to participate in this study and signed informed consent forms. But during the experiment period, one subject was excluded due to too much miniscrew mobility and tissue inflammation. All twelve subjects were female with a mean age of 22.55 ± 4.8 years old.

2.1. *Experimental design*

Brackets (0.022 inch slot, Ormco Corp., Orange, California, USA) were placed on the left and right upper canines and second premolars. Molar bands with transpalatal arch were inserted at upper first molars. Segmented archwires (0.018 inch stainless steel wire) were used on both sides. Twenty four miniscrews (AbsoAnchor® SH 1413-07, Dentos, Daegu, Korea) were inserted between second premolars and first molars. Miniscrew position was 6–8 mm below the CEJ between second premolars and first molars where the interradicular distance was more than 3–4 mm. This position was controlled by a custom-made miniscrew-placement guide with loop components on left and right sides (0.036 inch stainless steel wire; Fig. 1). Moreover, miniscrew angulation was controlled by the loops with adjusted angle of insertion of 60–70°, according to Wilmes et al. [12]. Bone density at the miniscrew placement area of each patient was recorded as D1 to D4 based on a tactile sense and assessed using Hounsfield Unit value or HU [13]. D1 or homologous compact bone (more than 1250 HU) represents the hardest bone density defined as oak or maple wood. D2 or thick layer compact bone surrounding a core of dense trabecular bone (850–1250 HU) is equal to white pine or spruce with lower density than the first group. D3 or thin layer of cortical bone surrounding a core of dense trabecular bone (350–850 HU) is equal to balsa wood. D4 or thin layer of cortical bone surrounding a core of low-density trabecular bone (lower than 350 HU) is the softest density as Styrofoam. All data were performed by one operator (Pongsamart P) who placed the miniscrews and had calibrated for accuracy of this tactile sense before the miniscrew placement. All subjects were instructed to clean soft-tissue area around miniscrews to prevent peri-miniscrew soft-tissue inflammation, and were evaluated throughout the experimental study. Two weeks after miniscrew placement, upper left and right canines of each subject were randomly retracted by 50 and 150 g of nickel–titanium (NiTi) closed coil springs (Tomy®, Tokyo, Japan) loading from miniscrews (Fig. 2). The force magnitude of each coil spring was measured and recorded with a calibrated orthodontic force gauge (Gram Gauges, Mecmesin Asia Co. Ltd., Bangkok, Thailand).

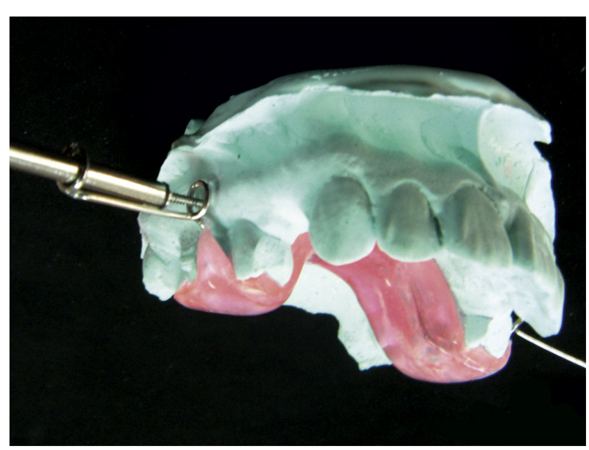

Fig. 1 – A miniscrew surgical guide was customized to control the miniscrew's position and angulation.