ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Research Article

Effect of Low Level Laser on Miniscrew Displacement during Canine Retraction. (A Randomized Controlled Clinical Trial)

Aly Osman[1]*, Ahmed Abdel Moneim[2], Nadia El Harouni[2] and Mohamed Shokry[3]

[1]Developmental Sciences Department, Division of Orthodontics, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon

[2]Professor, Orthodontic Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt

[3]Associate Professor, Oral Surgical Sciences Department, Division of Oral and Maxillofacial Surgery, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon

***Corresponding Author:** Aly Osman, Developmental Sciences Department, Division of Orthodontics, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon.

Received: August 28, 2019; **Publisded:** October 23, 2019

Abstract

Background: Anchorage is an important consideration for successful orthodontic treatment. Skeletal anchorage by miniscrews provided better anchorage control then the ordinary extra-oral and intra-oral appliances. However, the stability of the miniscrews are still questionable since they might move under orthodontic loading.

Objectives: The aim of this study was to evaluate the effect of low level laser on the miniscrew displacement when subjected to orthodontic force during canine retraction using CBCT.

Methods: Twelve patients who required bilateral extraction of upper first premolar and absolute anchorage were recruited from the outpatient clinics of the Department of Orthodontics, Faculty of Dentistry, Beirut Arab University of age ranging 14 - 28 years. Twenty four miniscrews were assessed, two miniscrews were inserted into the buccal alveolar bone between the second premolar and first molar on the right and left side for each patient in a 60° oblique direction at the mucogingival junction to avoid root injury. They were divided into 2 sides; test side and a control side, the test side received 4 application of low-level laser therapy during the first twelve days of insertion with a 60 seconds for each application. While the control side did not receive any laser application. After waiting a period of twelve days from miniscrew insertion to allow for soft tissue healing, the upper right and left canines were retracted by 150g of nickel-titanium (NiTi) closed coil springs. A cone-beam computed tomography was taken to evaluate the miniscrew position before application of the force at baseline (T0) and after canine retraction at 6 months (T1).

Results: There was no statistically significant difference of miniscrew head and tail displacements of the test side and a statistically significant difference of the heads for the control sides when compared to baseline.

Conclusion: Miniscrews used in the current study with the suggested protocol underwent non-significant displacement when using low level laser. The miniscrews remained stable throughout the follow-up period (6 month) without any significant displacement on the test side.

Keywords: *Low Level Laser; CBCT; Miniscrews*

Introduction

One of the important factors to achieve successful orthodontic treatment is to find an ideal anchorage system that provides the desired orthodontic movement with maximum control and minimum loss of anchorage [1]. Skeletal anchorage provided by orthodontic mini-implants attracted much attention as an ideal alternative for maintaining anchorage [2]. Kanomi, presented the miniscrews which had become well known in the recent years due to their low invasiveness during insertion and removal, their versatility and low costs [3].

Successful orthodontic anchorage reinforcement depends mainly on miniscrew stability. The preservation of bone in the region surrounding the mini-screw is essential to ensure the stability and maintenance of the mini-screws in the oral cavity [4]. Stability could be described by the rate of MSI success in orthodontic patients [5]. Success of MSI is dependent on primary or initial stability, and secondary or long-term stability. Primary stability could be defined as the absence of mobility of the miniscrew in the bone cortex immediately after its placement and depends on the mechanical interlocking of the implant with the bone [6]. Secondary stability depends on bone remodeling which is considered to be responsible for the integration and maintenance of the implant in bone [7]. Factors affecting the stability and success of MSIs could be categorized as patient related factors, MSI-related factors and treatment factors. Patient related factors include tobacco usage, skeletal and dental consideration, soft tissue characteristics and age.

Endosseous implants and palatal on-plants are thought to provide absolute or rigid anchorage, thus a waiting period or delayed loading is essential to allow the implant to integrate with the surrounding bone and thus remain absolutely stationary under loading. Whereas For the miniscrews, it is suggested that a waiting period for bone healing and osseointegration before loading is unnecessary because the primary stability (mechanical retention) of the miniscrews is sufficient to sustain regular orthodontic loading. However, the behavior of miniscrews under orthodontic loading is not yet definitely documented. However, the behavior of miniscrews under orthodontic loading is not clear clinically [8]. Few studies have been done to assess the stability of mini-implants under orthodontic loading using lateral cephalograms. Moreover, Poggio., *et al.* [9] found that even when the miniscrews were placed in the safe zones, there is possibility of root injury resulting from the movement of miniscrews under orthodontic load, as reported previously [1].

Although mini-screws are aimed to provide skeletal anchorage, some authors reported that they might move when subjected to orthodontic force [10]. This displacement could cause the mini-implant's to contact with important oral structures, such as root surfaces or even vessels and nerves [8]. Therefore, it becomes important to evaluate the stability of these devices under loading when used as orthodontic anchorage.

Orthodontics had experienced a noticeable breakthrough with the introduction of diode lasers. There was increasing application for phototherapy in areas of wound healing, tissue repair, regeneration, reduction in dental sensitivity and post-orthodontic pain [11]. Phototherapeutic applications were reliant upon the biostimulatory effects of phototherapy. The term "biostimulation" was first introduced in the 1960's to describe the "photochemical interactions" of low intensity lasers with tissues and had been referred to as photo stimulation, photomodulation or photobiostimulation. It was hypothesized that phototherapy produce biostimulatory effects from increased blood circulation [12] and pro-inflammatory mediators, increasing ATP availability and cell metabolism. The basic principle of laser therapy is that light is capable of affecting cell behavior without significant heating effects which might enhance implant stability and decrease displacement.

Cone beam computed tomography (CBCT) is a widely accepted diagnostic tool. CBCT provide cross-sectional images while structural relationships can be investigated through 2D scrolling or 3D volume rendering [13]. Furthermore, it allows the visualization of structures without superimposition and magnification, enabling highly reliable and accurate measurements [14] which would be ideal for measuring displacement accurately.

Alves Jr., *et al.* [15], assessed the mini-implant stability when submitted to orthodontic loading for upper molar's intrusion through CBCT. Forty-one mini-implants were assessed for their displacement with a 200g force application during a 5-month follow-up period. It was concluded that all mini-implants showed some displacement (mean value < 0.78) when submitted to force, however there was no statistical significant difference and could be aimed to provide a stable skeletal anchorage. Chen., *et al.* [16] evaluated the positional stability of miniscrews during orthodontic treatment change using CBCT. Twenty adult patients were enrolled in the study, where the maxillary first premolars were extracted because of protrusion. Six miniscrews were inserted in the maxilla of each patient, two loaded miniscrews for retraction of anterior teeth and four unloaded miniscrews. CBCT scans were taken at the start of space closure (T1) and 12 month later (T2). The CBCT images showed that both the loaded and unloaded miniscrews was positionally stable during the en-masse retraction. On the other hand, Prasanpong., *et al.* [17] evaluated miniscrew displacements loaded with 50 and 150g to retract upper canines using CBCT. The study concluded that miniscrews could be significantly displaced with 50 and 150g during 3 months.

Aim of the Study

The aim of the present study was to evaluate the effect of low level laser on the miniscrew displacement when subjected to orthodontic force using CBCT.

Materials and Methods

This study was carried out as a randomized controlled clinical trial; split-mouth design. The estimated sample size was calculated according to http://epitools.ausvet.com.au/, by taking the mean stability from a previous similar study conducted by Pongsamart., *et al*. [17] in which mean ± SD for test side; 0.295 ± 0.066 (mm) and mean ± SD for the control side; 0.398 ± 0.089 (mm), assuming a confidence level of 95% and a study power of 80%. The calculated sample size was 10 patients. Twenty percent was added to the sample size to eliminate the probability of dropout through the treatment.

Therefore, twelve patients who required bilateral extraction of upper first premolar and absolute anchorage were recruited from the outpatient clinics of the Department of Orthodontics, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon. The inclusion criteria were patient 's age ranging from 14 to 28 years, having a full set of teeth in the maxillary arch until the second molar, with good oral hygiene and gingival health. On the other hand, the exclusion criteria were patients with any systemic disease affecting the bone of the jaws and those who were taking any medications affecting gingival health and periodontal status. Randomization was performed using computer generated randomization table through the website: Randomizer.org. At the study side, the soft tissue surrounding the miniscrew received laser irradiation for 60 seconds through a biostimulation tip, whereas the control side did not receive any laser irradiation. This study was revised and approved for scientific validity and methodology by the Institutional Research Review Board of the Beirut Arab University, Faculty of Dentistry, with the approval code 2015H-0026-D-P-96. Consent forms were collected from the patients for dose consideration of patient safety; the maximum exposure of the radiation in each patient was less than exposure limits reported from the recommendations of the International Commission on Radiological Protection, publication 103.

Consort flow diagram

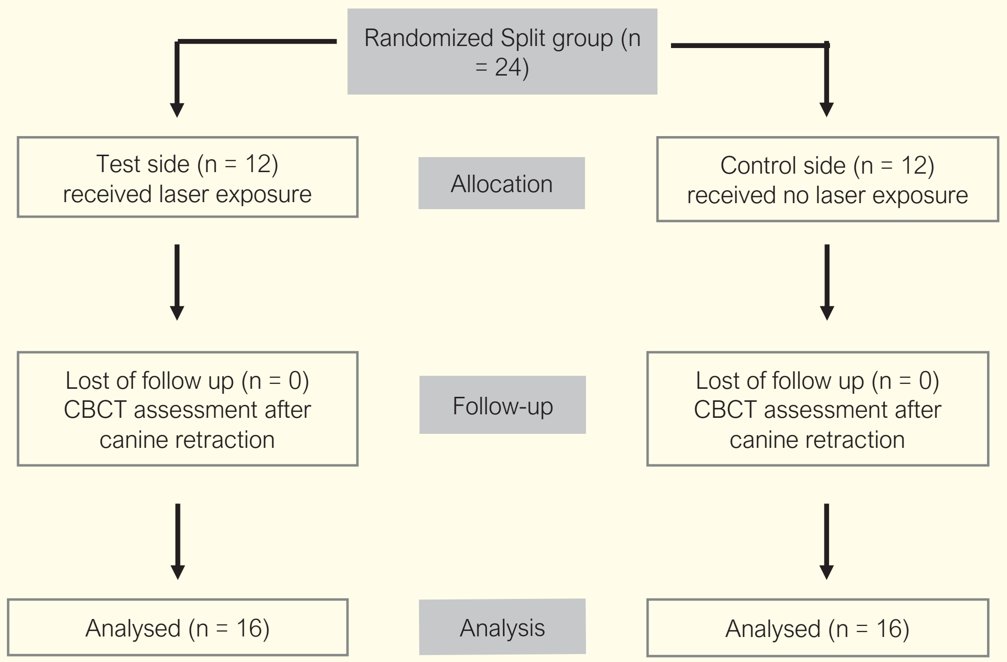

Figure 1: *Consort Flow Diagram.*

Initial alignment

All the patients completed their diagnostic records; including study casts, photographs, and lateral cephalometric and panoramic radiographs. Complete leveling and aligning of the upper arch was done until reaching a rigid stainless-steel wire (0.017 X 0.025 stst). The patient was then referred to an oral surgeon for extraction of upper first premolars.

Mini-implant placement

At the buccal region between the roots of second premolar and first molar, Two miniscrews (Absoanchor; Dentos, Daegu, South Korea) were inserted one on each side of the patient under local anesthesia, consisting of 2% lidocaine with epinephrine (3M ESPE, St. Paul, Minn). The miniscrew was inserted in a 60^o oblique direction at the mucogingival junction to avoid root injury. A periapical x-ray was taken to ensure it's position.

Laser irradiation

The soft tissue surrounding the miniscrew on the laser side was irradiated with a 910-nm diode laser (Biolase Technology, Inc.; San Clemente, Calif, USA) using 0.7 watts for 60 seconds after insertion of the miniscrew. The irradiation was applied over the miniscrew insertion area without any contact with the miniscrew. This process was repeated throughout the duration of 14 days with an interval of 72 hours between each application (four applications). On the contralateral side in the same arch, the biostimulation tip of the laser was directed toward the miniscrew for the same duration of time while the laser device was switched off to act as a placebo.

CBCT assessment

Cone-beam computed tomography (Care stream Kodak 9000c, USA) using 5 cm X 7 cm field of volume (FOV) with exposure factors of 76 kV, 5-6.3 mA and 32.4 sec was taken to evaluate the miniscrew position at before loading force as baseline (T0) and after canine retraction at 6 months (T1). The CBCT data were exported in Digital Imaging and Communications in Medicine (DICOM) multi-file format and imported into 3D imaging software (CS 3D imaging version 3.5.15). Head and tail of miniscrews together with posterior nasal spine, as a reference point, were manually digitized and recorded. Displacement distances of miniscrew heads and tails were measured on the software (Figure 2).

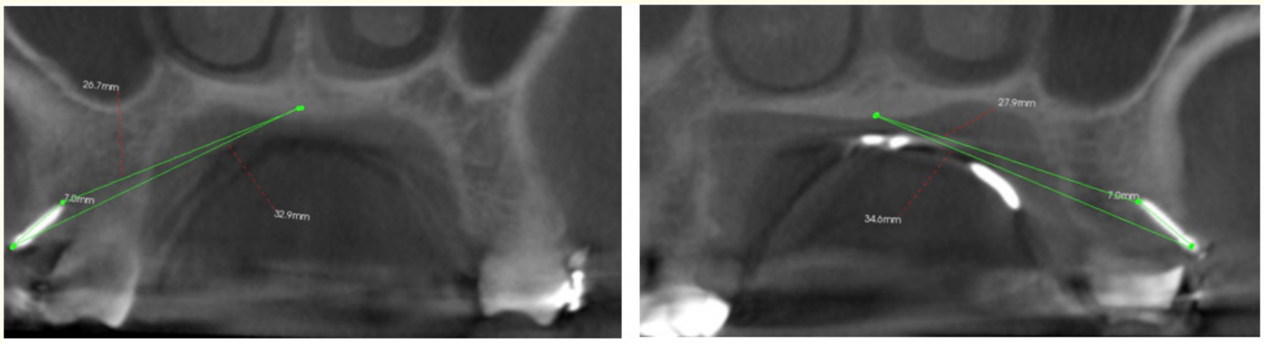

Figure 2: *Displacement measurement of the miniscrew head and tail to the posterior nasal spine. (a) Measurement of the right miniscrew with the posterior nasal spine. (b) Measurement of the left canine with the posterior nasal spine.*

Force application

After waiting a period of two weeks from miniscrew insertion to allow for tissue healing, the upper right and left canines were retracted by 150g of nickel-titanium (NiTi) closed coil springs (Ormco Corporation, Orange, CA) loading from the miniscrews. The force magnitude of each coil spring was measured with a force gauge (Dentaurum, GmbH & Co. KG, Ispringen, Germany).

Statistical analysis

The data were tested for normality using the Kolmogorov-Smirnov test and it showed a normal distribution. Hence, the comparison of the means of the test and control sides regarding the clinical study variables was done using unpaired t test (parametric test) with a P value less than 0.05. Significance was set at the 5% level. Statistical analysis was performed using SPSS version 21.0 (IBM Corp, Chicago, IL).

Results

This study was conducted as a randomized controlled clinical trial: split-mouth design. Twelve patients with a mean age of 18 years, who required bilateral upper first premolar extraction and absolute anchorage for their orthodontic treatment, were recruited to the study. All 12 patients completed a 6-month follow-up period during the canine retraction with no dropout from the sample (Figure 3).

Figure 3: *[a] At T0 of canine retraction [b] At T1 at the end of canine retraction.*

Table 1 displays the mean and standard deviation of the position and displacement of miniscrews heads and tails at T0 (Baseline) and T1 (after 6 months). At T0, the position of miniscrews heads and tails for the test side were 31.43 ± 3.14m m and 25.91 ± 1.74 mm respectively. For the control side, position of miniscrews head and tails were 32.4 ± 2.3 mm and 24.71 ± 2.71 mm respectively. At T1, the position of miniscrews head and tails for the test side were 31.65 ± 3.16 mm and 26.04 ± 1.84 mm respectively. For the control side, the head and tail position were 32.73 ± 2.28 mm and 25.10 ± 2.75 mm respectively. There was no statistically significant difference of miniscrew head and tail position of the test side when compared to baseline (P = 0.31, 0.44). At the control side there was a statistically significant movement of the miniscrew head when compared to baseline (P = 0.007) although the miniscrew tail did not show such difference (Figure 4).

	Test		Control		Comparison between heads Paired t test (P value)	Comparison between tails Paired t test (P value)
	Head	Tail	Head	Tail		
T0: mean (SD)	31.43 (3.14)	25.91 (1.74)	32.40 (2.30)	24.71 (2.71)		
T1: mean (SD)	31.65 (3.16)	26.04 (1.84)	32.73 (2.28)	25.10 (2.75)		
Difference: mean (SD)	0.23 (0.74)	0.13 (0.58)	0.33 (0.34)	0.39 (0.86)	0.50 (0.63)	1.27 (0.23)
Paired t test P value (Baseline- final)	1.06 0.31	0.80 0.44	3.32 0.007*	1.58 0.14		

Table 1: *The means and standard deviations of the miniscrew head and tail displacement at baseline (T0) and after canine retraction (T1).*

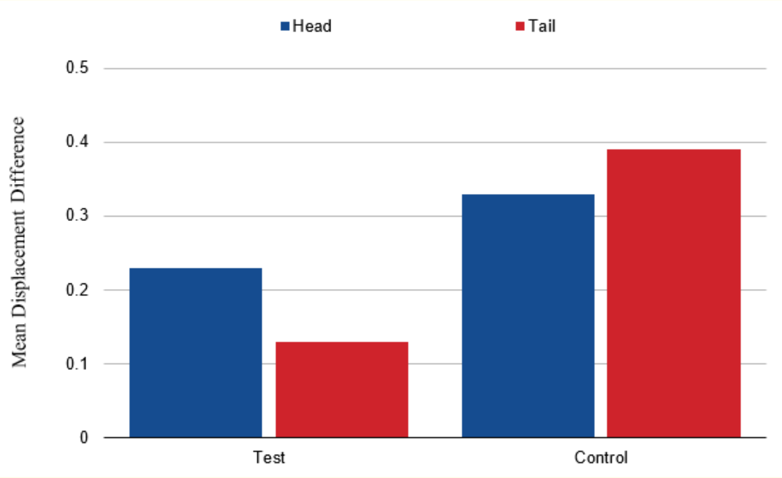

Figure 4: *Bar chart showing the mean displacement difference of the test and control side.*

The mean difference of displacement for the miniscrew's heads and tails at the test side was 0.23 ± 3.16 mm and 0.13 ± 0.58 mm respectively. While the mean difference of displacement for the miniscrew's heads and tails at the control side was 0.33 ± 0.34 mm and 0.39 ± 0.86 mm respectively (Figure 4). There was no statistically significant difference between the miniscrew's heads and tails at the test and control side.

Discussion

The control of Anchorage; resistance to unwanted tooth movement, is an important factor affecting the results of orthodontic treatment [18]. Intra-oral and extra-oral appliances have been used to fulfill the anchorage requirement, but because of the side effects and compliance issues, new methods as implants have been developed aiming to obtain effective anchorage without the drawback of conventional methods [19].

However, the behavior of miniscrews under orthodontic loading is not clear clinically [8]. Few studies have been done to assess the stability of mini-implants under orthodontic loading using lateral cephalograms. Moreover, Poggio., *et al*. [9] found that even when the miniscrews were placed in the safe zones, there is possibility of root injury resulting from the movement of miniscrews under orthodontic load, as reported previously [1].

Miniscrews are used as temporary fixtures for orthodontic tooth movement and will be removed at the end of treatment. It seems that miniscrews, as temporary fixtures, do not have to remain absolutely stationary under orthodontic loading, as long as the treatment effects are achieved. Nevertheless, the displacement of miniscrews would be a serious matter when the displacement could harm adjacent vital organs, such as dental roots, nerves, and blood vessels. This is very important, yet overlooked possibility. Therefore, miniscrews should not be placed at a site adjacent to any vital organ. A suitable implant site for miniscrews could be in a non-tooth-bearing area that has no foramen or pathway for any major nerves and blood vessels.

This study was carried out as a randomized, controlled clinical trial: split mouth design; this type of study was selected to prevent the effect of confounding variables. The aim of this study was to evaluate the effect of low level laser on the mini-implant displacement when subjected to orthodontic force through CBCT.

The results of the current study showed no statistically significant displacement for the miniscrews on either the test and the control side after loading 150g of force for canine retraction throughout the entire follow-up period when compared to the baseline. The displacement mean difference was within the security limits (< 0.4) as proposed by Poggio., *et al.* [9]; that established a minimum distance of 1mm around the miniscrews for periodontal health maintenance of the adjacent teeth.

In agreement with the current results, Alves Jr., *et al.* [15] assessed the mini-implant stability when submitted to orthodontic loading for upper molar's intrusion through CBCT. Forty-one mini-implants were assessed for their displacement with a 200g force application during a 5-month follow-up period. It was concluded that all mini-implants showed some displacement (mean value < 0.78) when submitted to force, however there was no statistical significant difference and could be aimed to provide a stable skeletal anchorage.

In addition to these results, Chen., *et al*. [16] evaluated the positional stability of miniscrews during orthodontic treatment change using CBCT. Twenty adult patients were enrolled in the study, where the maxillary first premolars were extracted because of protrusion. Six miniscrews were inserted in the maxilla of each patient, two loaded miniscrews for retraction of anterior teeth and four unloaded miniscrews. CBCT scans were taken at the start of space closure (T1) and 12 month later (T2). The CBCT images showed that both the loaded and unloaded miniscrews was positionally stable during the en-masse retraction.

An animal study compared two types of orthodontic mini-implants, self-tapping and self-drilling, by measurement of the insertion torques and the displacements under lateral loading. After pre-drilling of host sites, 27 self-tapping and 27 self-drilling mini-implants were inserted *in vitro* in the ilia of pigs. The axial drilling forces at each host site and the insertion torques during placement were recorded and the displacements applied by variable lateral force (1 to 9 N) were measured. Based on the displacements under lateral loading, however, both the self-tapping and self-drilling implants showed similar resistance to lateral forces [5].

In another studies on mini-implant stability, Santiago., *et al*. [20] used 451 oblique lateral cephalometric radiographs and observed no changes in the mini-implant positions during canine retraction movement. Wehrbein and Gollner [21] evaluated the stability of twenty mini-implants inserted in the palatal raphe for anchorage purposes and none of them exhibited any movements.

On the other hand, Prasanpong., *et al*. [17] evaluated miniscrew displacements loaded with 50 and 150g to retract upper canines. Twenty four miniscrews were placed in twelve orthodontic patients who required minis-crews for maximum anchorage. This study concluded that miniscrews could be significantly displaced with 50 and 150g during 3 months. This difference from the current results could be due to different measurement techniques on the CBCT and using the anterior nasal spine as the reference landmark instead of the posterior nasal spine used in the current study. Also, this could be due to that all the patients were female, so different bone quality than males.

El-Beialy., *et al*. [10] found mean displacement values of 1.08 and 0.82 mm for the head and the tail, respectively, evaluating mini-implant movement during canine retraction using CT. However, the minimum displacement was 0.17 mm and the maximum was 4.12 mm for the head while for the tail the minimum displacement was 0.34 mm and the maximum was 1.79 mm.

Conclusion

Miniscrews used in the current study with the suggested protocol underwent non-significant displacement when using low level laser therapy. The miniscrews remained stable throughout the follow-up period (6 month) without any significant displacement on the test side.

Disclosure

Bibliography

1. Liu H., *et al*. "Drift characteristics of miniscrews and molars for anchorage under orthodontic force: 3-dimensional computed tomography registration evaluation". *American Journal of Orthodontics and Dentofacial Orthopedics* 139.1 (2011): e83-e89.

2. Umemori M., *et al*. "Skeletal anchorage system for open-bite correction". *American Journal of Orthodontics and Dentofacial Orthopedics* 115.2 (1999): 166-174.

3. Kanomi R. "Mini-implant for orthodontic anchorage". *Journal of Clinical Orthodontics* 31.11 (1997): 763-767.

4. Song YY., *et al*. "Mechanical characteristics of various orthodontic mini-screws in relation to artificial cortical bone thickness". *Angle Orthodontist* 77.6 (2007): 979-985.

5. Wilmes B., *et al*. "Parameters affecting primary stability of orthodontic mini-implants". *Journal of Orofacial Orthopedics* 67.3 (2006): 162-174.

6. Cehreli MC., *et al*. "Meta-analysis of methods used to assess implant stability". *International Journal of Oral and Maxillofacial Implants* 24.6 (2009): 1015-1032.

7. Yip G., *et al*. "Micro-computed tomography: High resolution imaging of bone and implants in three dimensions". *Seminars in Orthodontics* 10.2 (2004): 174-187.

8. Liou EJ., *et al*. "Do miniscrews remain stationary under orthodontic forces?" *American Journal of Orthodontics and Dentofacial Orthopedics* 126.1 (2004): 42-47.

9. Poggio PM., *et al*. "‘‘Safe zones'': a guide for miniscrew positioning in the maxillary and mandibular arch". *Angle Orthodontist* 76.2 (2006): 191-197.

10. El-Beialy AR., *et al*. "Loss of anchorage of miniscrews: a 3-dimensional assessment". *American Journal of Orthodontics and Dentofacial Orthopedics* 136.5 (2009): 700-707.

11. Doshi-Mehta G and Bhad-Patil WA. "Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation". *American Journal of Orthodontics and Dentofacial Orthopedics* 141.3 (2012): 289-297.

12. Cruz DR., *et al*. "Effects of low-intensity laser therapy on the orthodontic movement velocity of human teeth: a preliminary study". *Lasers in Surgery and Medicine* 35.2 (2004): 117-120.

13. Brown AA., *et al*. "Linear accuracy of cone beam CT derived 3D images". *Angle Orthodontist* 79.1 (2009): 150- 157.

14. Kau CH., *et al*. "Evaluation of CBCT digital models and traditional models using the little's index". *Angle Orthodontist* 80.3 (2010): 435-439.

15. Matheus Alves Jr., *et al*. "Assessment of mini-implant displacement using cone beam computed tomography". *Clinical Oral Implants Research* 22.10 (2011): 1151-1156.

16. Chen G., *et al*. "A new method to evaluate the positional stability of a self-drilling miniscrew". *Orthodontics and Craniofacial Research* 18.3 (2015): 125-133.

17. Prasanpong Pongsamart., *et al*. "Stability of miniscrews with different continuous orthodontic forces as measured by cone-beam computed tomography". *Orthodontic Waves* 73.2 (2014): 48-54.

18. Kuhlberg AJ and Priebe DN. "Testing force systems and biomechanics-measured tooth movements from differential moment closing loops". *Angle Orthodontist* 73.3 (2003): 270-280.

19. Favero L., *et al*. "Orthodontic anchorage with specific fixtures: related study analysis". *American Journal of Orthodontics and Dentofacial Orthopedics* 122.1 (2002): 84-94.

20. Santiago RC., *et al*. "Correlation between miniscrew stability and bone mineral density in orthodontic patients". *American Journal of Orthodontics and Dentofacial Orthopedics* 136.2 (2009): 243-250.

21. Wehrbein H and Gollner P. "Do palatal implants remain positionally stable under orthodontic load? A clinical radiologic study". *American Journal of Orthodontics and Dentofacial Orthopedics* 136.5 (2009): 695-699.

Volume 18 Issue 11 November 2019