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Research Article

A COMPARATIVE ASSESSMENT OF STABILITY OF VARIOUS ORTHODONTIC MINISCREWS – AN INVITRO STUDY"

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A R T I C L E I N F O

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Miniscrew implants, maximum insertion torque, maximum removal torque, neoteric goat mandible.

A B S T R A C T

Objective: The aim of this study was to compare the maximum insertion torque value, maximum removal torque value and primary stability of four different commercially available miniscrew implants.

Materials and methods: In this study a total of thirty two self drilling miniscrew implants from different manufactures were made into four groups.

Each group consisting eight miniscrew implants. Group I - Dentauram (tomas), Group II- S K Surgicals, Group III-3M Unitek, Group IV- Absoanchor (Dentos). This study was done on neoteric goat mandible, which is histologically and morphologically similar to human mandible, is used for insertion of miniscrew implants. Maximum insertion torque value and maximum removal torque value will be measured for each miniscrew implants with a torque wrench (Ncm) which is inserted in the retromolar region of neoteric goat mandible.

Result: The results of this study showed that the 3M Unitek miniscrew implant had a high insertion torque and high primary stability. Insertion torque of all samples mean is compared by one-way ANOVA test followed by Tukey's HSD post Hoc analysis. Statistically significant differences were observed in all groups. There were no significant differences for maximum removal torques between all groups.

Conclusion: Based on the results of this study, the primary stability is directly proportional to the insertion torque values. If the insertion torque value is high, stability of mini implants will also increase. Success in orthodontic treatment using miniscrew implants in terms of anchorage depends on miniscrew implants stability. Hence according to result achieved from this study, it concludes that 3M Unitek miniscrew implant and Absoanchor miniscrew implants has got results more than 15 Ncm, which has highest stability and better results.

INTRODUCTION

"Orthodontic anchorage refers to the nature and degree of resistance to displacement offered by an anatomic unit when used for the purpose of moving teeth. Teeth serving as anchor units invariably undergo unwanted tooth movement. Therefore, auxiliary sources of conventional anchorage system, such as headgears, palatal buttons, and transpalatal and lingual arches are typically employed. Although these devices improve the level of anchorage control, they do not allow for complete control over dental movements.[1,2] To overcome the shortcomings of the conventional anchorage system, Creekmore and Eklund in 1983 introduced miniscrew implants in orthodontics.They have gained popularity due to their simple placement, low cost, patient-acceptance, and ability to eliminate patient compliance issues in treatment. [3,4]Stability is necessary for the miniscrew implant to act as a successful anchor and be able to resist orthodontic forces.

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Primary stability,a mechanical phenomenon, refers to the initial stability of the miniscrews implants and is a function of the interdigitation of the implant with the bone.[5] The factors which affect the primary stability are bone characteristics(quantity and quality)of the insertion site and geometric design, length and diameter of the miniscrew implants, timing of loading, implant placement torque.[6,7]

Early studies they used organic bone to measure stability,organic bone has homogenous density,mineral contents and morphology allover.The results are variable in the organic bone. Hence this study was taken on the neoteric goat mandible because studies have shown that histologically and morphologically it is similar to human mandible and the upcoming results are more precise and accurate in the neoteric goat mandible when compared to organic bone.[8]

Insertion torque is the measure of the rotational force needed to insert the miniscrew implants into bone and is reported in most literature as Newton cm. High insertion torque results in high primary stability, thus higher insertion torque is

favourable. Insertion torque is synonymous with primary stability.[9]

Removal torque is the measure of the rotational force needed to remove the miniscrew implants from bone and is quotedas Newton cm.Greater removal torque value shows superior secondary stability. This reflects sufficient secondary stability of miniscrew implants to fulfil their purpose as anchors in three dimensional tooth movements.

Previous studies regarding evaluation of implant stability during various phases of treatment have been very limited, and it was done using synthetic bone.[10] Hence the purpose of this study is to evaluate the insertion and removal torques of miniscrew implants from different manufactures using neoteric bone.

MATERIALS AND METHODS

Thirty two miniscrew implants were classified into the four groups according to different commercially available brands (Figure 1-4) .

Figure 1 Tomas Dentauramminiscrew implants (Group –I) were used during study.

Figure 2 S K Surgicalminiscrew implants (Group –II) were used during study.

Figure 3 3M Unitekminiscrew implants (Group –III) were used during study.

Figure 4 Absoanchorminiscrew implants (Group –IV) were used during study.

The length and diameter of all the miniscrew implants were kept similar (8mm length) to get more precise and accurate results. Miniscrew-implants were inserted in a 16 female neoteric goat mandible (Figure 5) aged between 2-4 years, which were stored in 4% formalin to preserve the cellular contents. All miniscrew-implants were placed in the retro molar region of neoteric goat mandibles (Figure 6).

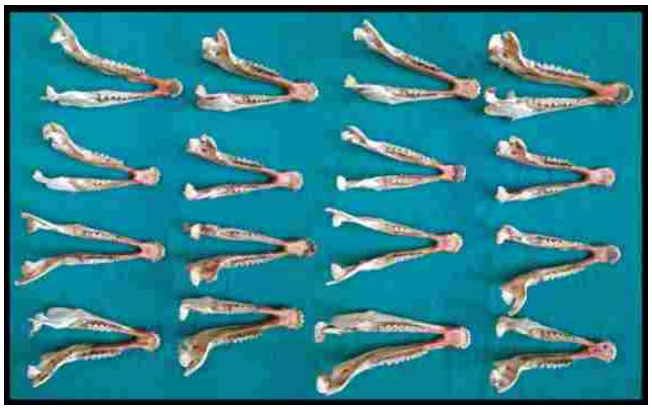


Figure 5 16 Neoteric goat mandible which were used in the study

Figure 6 Modified Torque wrench device (FTD50CN2-S)

MIT values were measured with the aid of a modified torque wrench device (FTD50CN2-S) (Figure 7).The miniscrew implants were carefully inserted in to the neoteric mandible by giving a clockwise rotation to measure the insertion torque. The measurement was made by attaching the modified torque wrench device to the head of the miniscrew implant. The peak placement torque value obtained during the final turn of the modified torque wrench device during miniscrew-implant placement was recorded for analysis(Figure 8).The removal torque was measured by the same device as the miniscrew implants were removed by giving an anticlockwise rotation(Figure 9). The insertion torque value and removal torque values were measured in Newton Centimetre (Ncm) (Figure 10).Digital photographs are taken using digital camera (EOS 1200D-EF S18-55 IS II) to illustrate the procedure.

Figure 7 Round dial of the modified torque wrench device (FTD50CN2-S)

Figure 8 Miniscrew implant hand driver (SKD 02)

Figure 9 Measurement of angulation of the miniscrew implant before insertion

Figure 10 Insertion of miniscrewimplant into the goat mandible

RESULTS

Mini-implant maximum insertion torques in goat mandible bone were 12.1 ±1.8 ,11.4 ±1.2,16.5 ±1.4 and 16.3 ±1.0Ncm for groups- 1,2,3 and 4 respectively (Table 1-4).

Table 1 Torque values of DentauramMiniscrew-implants- 8mm length,1.3mm diameter

Group I- Dentauram Miniscrew-implants	Insertion torque (Ncm)	Removal torque(Ncm)
1	11	9
2	12	9
3	14	10
4	10	8
5	15	11
6	10	8
7	13	9
8	12	10

Mean insertion torque values are(12.1 ±1.8 Ncm)and mean removal torque values are (9.3 ±1.0Ncm) for group I Miniscrew-implant (Tab. I). There is a statistical significant difference seen in group I miniscrew implants and the mean difference between insertion and removal torque are (2.9 Ncm).

Table II Torque values of S K Surgical Miniscrew-implant-8mm length,1.3mm diameter

Group II- S K Surgical miniscrew implants	Insertion torque(Ncm)	Removal torque(Ncm)
1	11	8
2	13	10
3	10	7
4	11	9
5	12	9
6	13	10
7	10	8
8	11	9

Mean insertion torque values are (11.4 ±1.2Ncm)and mean removal torque values are (8.8 ±1.0Ncm) for group II Miniscrew-implant (Tab. II). There is a statistical significant difference seen in group II miniscrew implants and the mean difference between insertion and removal torque are (2.6 Ncm).

Table III Torque values of 3M UnitekMiniscrew -implants (8mm length,1.3 diameter)

Group III-3M UnitekMiniscrew – implants	Insertion torque (Ncm)	Removal torque(Ncm)
1	18	10
2	16	11
3	15	9
4	19	13
5	15	9
6	17	12
7	16	10
8	16	9

Mean insertion torque values are (16.5 ±1.4Ncm)and mean removal torque values are (10.4 ±1.5Ncm) for groups IIIMiniscrew -implants (Tab. III).There is a statistical significant difference seen in group III miniscrew implants and the mean difference between insertion and removal torque are (6.1 Ncm).

Table IV Torque values of Absoanchor Miniscrew-implants-8mm length,1.3mm diameter

Group IV-Absoanchor Miniscrew-implants	Insertion torque (Ncm)	Removal torque(Ncm)
1	16	9
2	17	10
3	15	8
4	16	9
5	18	10
6	15	8
7	16	10
8	17	11

Mean insertion torque values are (16.3 ±1.0 Ncm)and mean removal torque values are (9.4 ±1.1Ncm) for groups IVminiscrewimplants (Tab. IV). There is a statistical significant difference seen in group IV miniscrew implants and the mean difference between insertion and removal torque are (6.9 Ncm).

Insertion torque means were compared by one-way ANOVA test(Table 5)followed by tukey's HSD post hoc analysis. Statistically significant differences were observed in all groups, (Table 6) demonstrating that maximum insertion torque for group-3 was significantly greater than all other groups(Figure 11).

Table V Comparison of mean values of Insertion Torque between the four study groups using One-way ANOVA test followed by Tukey's HSD Post hoc Analysis

Groups	N	Mean	SD	Std. Error	Min	Max	F	P-Value
Group 1	8	12.1	1.8	0.6	10	15	29.871	<0.001*
Group 2	8	11.4	1.2	0.4	10	13		
Group 3	8	16.5	1.4	0.5	15	19		
Group 4	8	16.3	1.0	0.4	15	18		

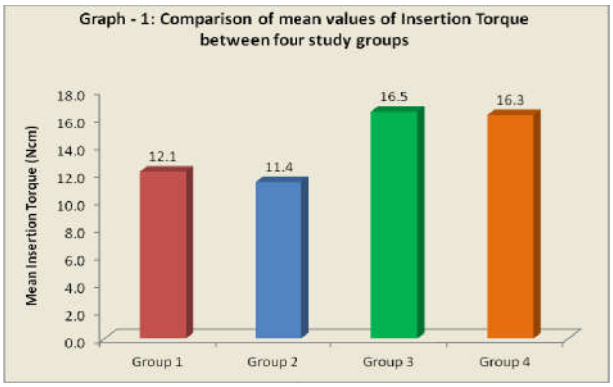


Table IV Multiple Comparison of Insertion Torque using Tukey's HSD Post hoc Analysis

Groups	G1 Vs G2	G1 Vs G3	G1 Vs G4	G2 Vs G3	G2 Vs G4	G3 Vs G4
P-value	0.71	<0.001*	<0.001*	<0.001*	<0.001*	0.98

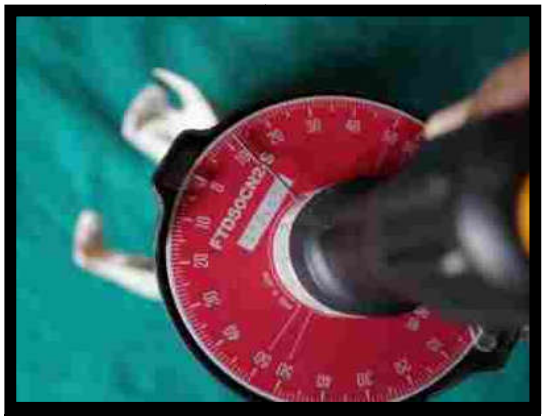


Figure 11 Insertion torque value measured using modified torque wrench device.

Mini-implant maximum removal torques from cortical bone were also measured. Observed means were 9.3 ± 1.0, 8.8 ± 1.0,10.4 ± 1.5 and 9.4 ± 1.1 Ncm for groups-1,2,3 and 4 respectively (Table 7). Maximum insertion torque values were greater than those for removal for all groups.maximum removal torque for group-3 was significantly greater than all other groups(Figure 12). There were no significant differences for maximum removal torques between all groups (Table 8).For each group, means for maximum insertion and removal torques were compared by student paired t test (Table 9). All groups showed significantly statistical difference, maximum insertion torque was significantly greater than removal torque(Figure 12), even though all other groups showed the same behaviour.

Table VII Comparison of mean values of Removal Torque between four study groups using One-way ANOVA test followed by Tukey's HSD Post hoc Analysis

Groups	N	Mean	SD	Std. Error	Min	Max	F	P-Value
Group 1	8	9.3	1.0	0.4	8	11	2.680	0.07
Group 2	8	8.8	1.0	0.4	7	10		
Group 3	8	10.4	1.5	0.5	9	13		
Group 4	8	9.4	1.1	0.4	8	11		

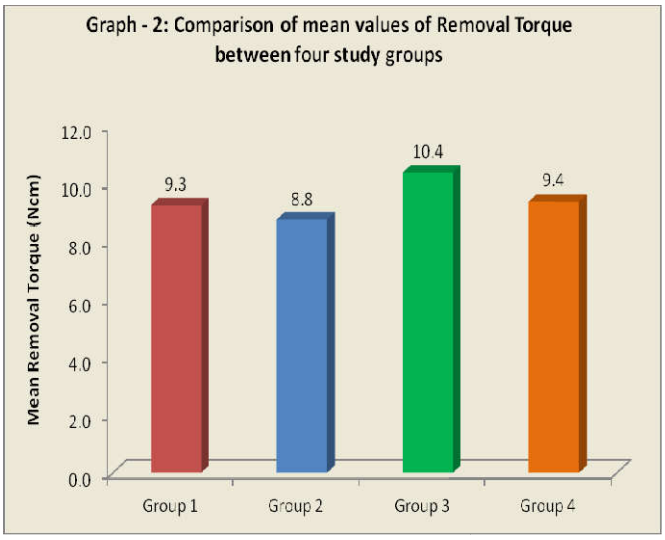


Table VIII Multiple Comparison of Removal Torque using Tukey's HSD Post hoc Analysis

Groups	G1 Vs G2	G1 Vs G3	G1 Vs G4	G2 Vs G3	G2 Vs G4	G3 Vs G4
P-value	0.83	0.25	1.00	0.05	0.72	0.34

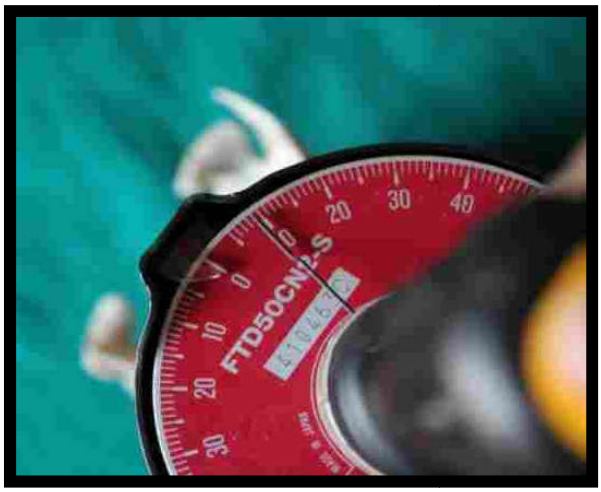
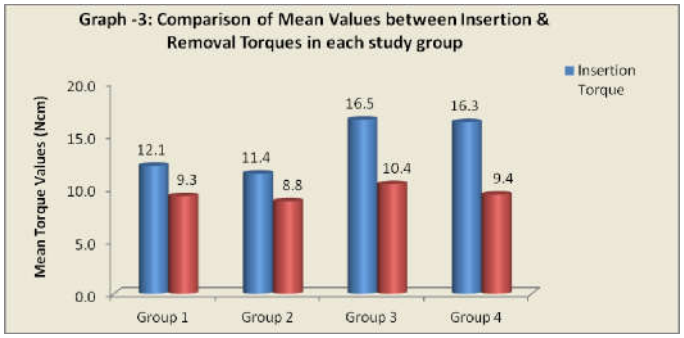


Figure 12 Removal torque value measured using modified torque wrench device.

Table IX Comparison of Mean Values between Insertion & Removal Torques in each study group Student Paired t Test

Groups	Torques	N	Mean	SD	S.E.M	Mean Diff	t	P-Value
Group 1	Insertion	8	12.1	1.8	0.6	2.9	8.205	<0.001*
	Removal	8	9.3	1.0	0.4			
Group 2	Insertion	8	11.4	1.2	0.4	2.6	14.346	<0.001*
	Removal	8	8.8	1.0	0.4			
Group 3	Insertion	8	16.5	1.4	0.5	6.1	17.481	<0.001*
	Removal	8	10.4	1.5	0.5			
Group 4	Insertion	8	16.3	1.0	0.4	6.9	30.342	<0.001*
	Removal	8	9.4	1.1	0.4			



DISCUSSION

In orthodontics, anchorage is essential for the success of treatment. When used for orthodontic purposes the miniscrew implants require immediate loading; hence it is a prerequisite that they have a high primary stability. Miniscrew-implants are stabilized using mechanical interlocking with the surrounding bone tissue .This enables us to start orthodontic loading immediately after miniscrew implant insertion. According to Miyawakiet[11]al in 2003 primary stability is regarded as the key indicator of success. Throughout the treatment, the stability of an orthodontic miniscrew implant depends on peri-implant soft tissues, miniscrew design, insertion technique, force load, and bone density.

In this study mean values for maximum insertion torque varied between 10 to 18 Ncm. These values are smaller than those found in study done by Wilmes *et al* [12], that varied from 11.3 to 23.4 Ncm. The diversity in results can be attributed to the mineral density and histological differences between saw bone and natural bone. In another study which was done by Motoyoshi *et al* [13] using dried human mandible, the insertion torque value ranged from 7.2 to 13.5 Ncm. These values were also lesser than the values obtained in the present study. This may be due to the difference of osteoid bone volume between dried human mandible bone and neoteric bone. According to a study done by Elias *et al* [14], miniscrew-implants with 2 mm in diameter when inserted in human dried mandibular bone, a mean torque value of 23.2 Ncm was obtained which was significantly higher when compared to the present study, which suggested that higher the diameter, higher the insertion torque values. The higher insertion torque values were observed in group 3 miniscrewimplants and least in group-2miniscrew implants, this may be due to morphological difference between each group, even all were inserted in neoteric mandible.

While performing the study the insertion torque values gradually increased during insertion of the miniscrew implants. This was the similar pattern observed in all the four groups. The group-3miniscrew implants showed high insertion torque (16.5 ± 1.4 Ncm). The group-2 had the lowest insertion torque (11.4 ± 1.2 Ncm). This may be due to morphological characteristics which differ from each miniscrew implant group. Based on success rate study done by Motoyoshi *et al* [15], it was recommended that insertion torque should be atleast a minimum of 5-10 Ncm, below which the miniscrew implant fails. Chen *et al* [16]conducted a study which showed a success rate of 96.2% withminiscrew implants having insertion torque between 5-10 N cm. But this is in contrast to a study done by Chaddad *et al*[17], who found that MSIs with insertion torques over 15 Ncm had 100% success rates and MSIs with insertion torques less than 15 Ncm had 69% success rates. The insertion torque values in the present study ranged between 11.4±1.2 to 16.5±1.4 Ncm, which showed 100% success rate, as none of the miniscrew implants were below the minimum range.

In this present study the removal torque in group I ranged from 8-11 Ncm, in group-2 it is 7-10 Ncm, in group-3 insertion torque value found is 9-13 Ncm and in group-4 insertion torque value obtained is 8-10 Ncm. There is no statistical significant difference seen in between the four groups.

Mean values for maximum removal torque obtained in this present study varied from 8.8±1.0 Ncm (group-2) to 10.4± 1.5 Ncm (group-3) and there were no statistical significant

differences between groups. Elias *et al*[14] evaluated maximum removal torques with miniscrew implants of 6.0mm in length , 1.5 to 2.0 mm in diameter and found values of 5.4 ± 0.7 Ncm to 6.8 ± 0.8 Ncm. The values were lesser than those found in this study, even though we used miniscrew implants of lesser diameter. Nevertheless, miniscrew-implants were not inserted in natural bone.

When comparing insertion and removal torque values, the mean difference are observed is 2.9Ncm, 2.6 Ncm, 6.1 Ncm and 6.9 Ncm in group 1, group 2, group 3 and group 4 respectively. Elias *et al*[14] observed that removal torque is smaller than insertion torque irrespective of the type of bone or miniscrew-implant diameter, this finding was also observed in our study. However, there is statistically significant difference between insertion and removal torques in each group. According to Vannet *et al* in 2007, demonstrated in his study that even immediately loaded implants in clinical application can become partially Osseointegrated with bone to implant contact, but in this study the miniscrew implants were inserted and removed immediately after torque values were measured.

In this present study the maximunm insertion torque values were in group- 3 (16.5±1.4 Ncm), it reflects the maximum stability among the four groups. The maximum removal torque value were found in group- 3 (10.4±1.5 Ncm), which showed that the sufficient stability among all groups. This suggested that the torque values are directly proportional to stability of miniscrew implants. The more stable an miniscrewimplant, more load it can resist and it may be subjected to early loading or function. Insertion torque describes the force necessary for miniscrew implant inserted in clinical applications in orthodontic field.

CONCLUSION

- In this present study results showed the maximum insertion torque value ranged from 11.4 ± 1.2 to 16.5 ± 1.4 Ncm and the maximum removal torque value ranged from 8.8 ± 1.0 to 10.4 ± 1.5 Ncm.
- Since 3M Unitekminiscrew implants had maximum insertion torque(16.5±1.4 Ncm),it reflected maximum stability among four groups, followed by Abso anchor miniscrew implants(16.3±1.0 Ncm), Dentaurum miniscrew implants(12.1±1.8 Ncm) and least insertion torque is found in S K Surgical miniscrew implants(11.4±1.2 Ncm).
- A maximum removal torque value of 10.4±1.5Ncm was found in 3M Unitekminiscrew implants which suggested sufficient stability for miniscrew-implants. Followed by Abso anchor miniscrew implants (9.4±1.1 Ncm), Dentaurum miniscrew implants (9.3±1.0 Ncm) and least removal torque was found in S K Surgical miniscrew implants (8.8±1.0 Ncm) among four groups.
- The recommended ideal range for insertion torque should be 5-10 Ncm. In this present study all groups come under the acceptable range. In another study, insertion torque range over 15 Ncm had 100 % success rate. 3M Unitek miniscrew implant and Abso anchor miniscrew implants has got results more than 15 Ncm, which has highest stability and better results.

References

1. Feldmann I and Bond mark L . Orthodontic Anchorage. Angle Orthod 2006; 76(3): 493-501
2. Nanda R, Uribe FA. Temporary Anchorage Devices in Orthodontics. St.:Louis: Mosby,2008.
3. Creekmore TD, Eklund MK. The possibility of skeletal anchorage. J Clin Orthod 1983 ;17 (4):266–9.
4. Lee J S, Kim J K. Application of orthodontic mini-implants. Hanover Park: Quintessence Pub Co,2007
5. Cope JB. Orthotads: The Clinical Guide and Atlas, 2007.
6. Singh K. Temporary anchorage device-mini implants. Nati J Maxillof Surg 2010 ; 1(1):30-34
7. Kim J W, Ahn S J, Chang Y I. Histomorphometric and mechanical analyses of the drill-free screw as orthodontic anchorage. Am J Orthod Dentofacial Orthop 2005; 128 (2):190–4.
8. Raghavendra V, Reddy YM, Safe zones for miniscrews in orthodontics: A comprehensive review. Int J Dent Med Res 2014;1(4):135-138.
9. Lello D, Sgarbi, Effect of angled installation of orthodontic mini implants on primary stability.JRD 2014;2(2):169-175.
10. Suzuki EY, Suzuki B. Placement and removal torque values of orthodontic miniscrew implants. Am J Orthod Dentofacial Orthop. 2011;139(5):669–78.
11. Miyawaki S, Koyama I, Inoue M, *et al*. Factors associated with the stability of titanium screws placed in the posterior region for orthodontic anchorage. Am J Orthod Dentofacial Orthop. 2003;124:373–378
12. Wilmes B, Ottenstreuer S, Su Y-Y, Drescher D. Impact of implant design on primary stability of orthodontic miniimplants. J Orofac Orthop. 2008 Jan;69(1):42–50.
13. Motoyoshi M, Yoshida T, Ono A, Shimizu N. Effect of cortical bone thickness and implant placement torque on stability of orthodontic mini-implants. Int J Oral Maxillofac Implants. 2007 Oct;22(5):779–84.
14. Elias CN, Ruellas CO, Fernandes DJ. Orthodontic Implants: Concepts for the Orthodontic Practitioner. International Journal of Dentistry. 2012; 1- 7.
15. Motoyoshi M.,*et al*., Recommended placement torque when tightening an orthodontic mini---implant.Clin Oral Implants Res,2006.17(1):p.109---14.
16. Chen YJ, Chang HH, Huang CY, Hung HC, Lai EH, Yao CC. A retrospective analysis of the failure rate of three different orthodontic skeletal anchorage systems. Clin Oral Implants Res. 2007;18:768–775.
17. Chaddad K, Ferreira AFH, Geurs N, Reddy MS. Influence of surface characteristics on survival rates of mini-implants. Angle Orthod. 2008 Jan; 78 (1):107–13.

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