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Comparative evaluation of four types of orthodontic miniscrews in high angle and low angle cases during en mass retraction – A 6 months follow up in vivo study

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ABSTRACT

Aim: To determine the stability and retraction achieved after 6 months of placement of four types of Orthodontic Miniscrews (TADs) in low angle and high angle cases during en masse anterior retraction.

Materials and Methods: 4 different interradicular miniscrews [FavAnchor (Favourite Supplies), VectorTAS (Ormco), JJ Orthodontics, SK Surgicals] of similar dimensions were placed on the 4 quadrants of maxilla and mandible in 20 patients (10 High Angle and 10 Low Angle) undergoing all I premolar extraction requiring group-A Anchorage and retraction was done using 0.019 x 0.025 Stainless Steel archwire closed coil NiTi springs for 6 months. OPG and Lateral cephalogram was taken before and immediately after 6 months of loading. The retraction, stability and maxillary anterior intrusion achieved by the miniscrews was assessed by measuring the distance of movement occurred in 6 months between marked landmarks before and after retraction.

Results: The most efficient miniscrew in high angle cases was found to be Vector TAS (Retraction=6.11±0.202mm, Displacement=1.40±0.37mm) followed by Favanchor (Displacement=6.00±0.41mm, 1.25±0.44mm) in both maxilla and mandible. Similarly, in low angle cases it was Favanchor (Retraction=6.04±0.24mm, Displacement=0.99±0.46mm) followed by Vector TAS (Retraction=5.91±0.36mm, Displacement=.095±0.35mm) in both maxilla and mandible. There is miniscrew failure with a significant percentage of 1.87% excluding which, there was no statistic difference in the displacement in High angle as well as Low angle cases, whereas, with the inclusion of failure, there is statistically significant difference in the stability. The least efficient in retraction and stability were SK Surgicals and JJ Orthodontics.

Conclusion: There is significant difference in the stability and retraction among the four miniscrews used in High angle and Low angle as well as Maxilla and Mandible owing to the density of the bone at the implant site and the soft tissue present apart from the material and make of individual miniscrew systems.

1. Introduction

The field of orthodontics has seen a tremendous increase in the use of Temporary Anchorage Devices (TADs), which cater to the anchorage demands of different treatment situations while reducing unwanted effects of orthodontic forces as well. Miniscrews are the most used TADs, which are effective in most clinical situations. TADs are anchored in the bone and are removed once the intended orthodontic tooth movement is completed. They are designed to overcome the limitations of conventional orthodontic anchorage devices. The use of TADs provides independence from patient compliance, either by supporting the teeth of the reactive unit or by eliminating the need for a reactive unit.

Anchorage plays a crucial role in orthodontics as it determines the success of the treatment. The term

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"orthodontic anchorage" refers to the resistance offered by a specific anatomical unit against displacement. To achieve the desired treatment goals, it is important to maximize the desired tooth movements while minimizing any undesirable effects.

In the past, orthodontic therapy relied on using teeth, extraoral, and/or intermaxillary appliances for anchorage. Before the use of TADs, Compliance Orthodontic Anchorage Devices (COADs) offered the only possibility for sufficient anchorage to control undesired tooth movements. The main disadvantage of many of these devices was the fact that treatment outcomes depended to a high degree on patient compliance (Nanda & Kierl 1992). However, due to suboptimal patient cooperation, TADs were introduced.[1,2] Anatomical concerns place a limit on the mini-screw length and diameter that can be used in a clinical procedure. On average, a screw of length 8mm and a diameter of 1.5mm would surface for most of its clinical applications.[3] Hence, the comparison of survival and failure rates of the different types of TADs is of great prognostic value in future orthodontic treatment planning.

Absolute anchorage is required when the treatment objective requires minimum anchorage loss. It requires that the entire extraction space be used for retraction with negligible posterior segment involvement. Based on the diagnosis of the malocclusion in bimaxillary protrusion, the treatment plan may involve the extraction of all 4 first premolars combined with maximum anchorage of the posterior teeth. The present study focuses on bialveolar protrusive in high angle and low angle cases requiring extraction of all first premolars and retraction following absolute anchorage using TADs (miniscrews).

Therefore, the aim of the present study was to compare and evaluate the retraction and stability of four types of miniscrews in high angle and low angle cases during en-mass retraction at the end of 6 months.

2. Materials and Methods

This prospective in vivo study was conducted at the Department of Orthodontics and Dentofacial Orthopaedics, Thai Moogambigai Dental College and Hospital, Chennai, India and was approved by the Institutional Ethical Clearance Committee.

2.1. Inclusion criteria

1. Age 18-25 years
2. Patients of low angle [FMA < 23°] and High angle [FMA >28°]
3. Extraction of first premolars requiring anterior en mass retraction

2.2. Exclusion criteria

1. Medically compromised patients
2. Periodontally compromised
3. Poor oral hygiene
4. Syndromic patients
5. Patients on medication

The entire procedure was explained to the patient and their parents and the study commenced only after acquiring due consent from the patients and patient's parents.

2.3. Evaluation of the patients

All patients were examined clinically with the following records. The following pre-retraction records were obtained from each patient.

1. Panoramic radiograph
2. Lateral cephalograms
3. Standard Intra oral photographs

2.4. Armamentarium

20 patients of age ranging from 18-25 years were selected for each group in this study. Of these, 10 patients were of high angle and 10 patients were of low angle. All the patients had undergone extraction of all four first premolars for anterior en masse retraction as a part of their treatment plan.

Post Extraction, four brands of miniscrews of same length were inserted on 4 different quadrants of each patient under local infiltration. The miniscrews used are namely:

For en mass retraction of anterior teeth, the most suitable site for placement of miniscrews was selected as the alveolar bone (or interdental space) between upper second premolar and upper first molar in the maxillary arch and between second premolar and first molar of mandibular arch at the level of mucogingival junction. Insertion of each miniscrew was done using manual hand driven method using the drivers given by the manufacturers of each miniscrew taking sterile measures and administering local infiltration at the site of insertion. The miniscrew insertion was done in the following two patterns to avoid bias between the maxilla and mandible.

Post insertion healing period of 3 weeks was given for each patient. Total of 6 months was divided into: T0 = starting of retraction and T1 = End of 6 months. At T0, before the start of retraction, the following records were taken: 1. Lateral cephalogram 2. OPG 3. Standard Intra oral photographs

Posterior arch wires were formed from 0.019 x 0.025 Stainless steel wires by placing power arm of 6 mm mesial to canine on both arches. Consolidation of anterior and posterior segments was done prior to en masse retraction of anterior segment. Measurements were done using digital Vernier Callipers. 9mm closed coil Nickel-Titanium springs (Figure 2) were loaded onto each power arm and the head of the miniscrew using ligature wire such that the force is

adjusted to 150g on each quadrant using Dontrix Guage. Review was done every month to maintain 150g force for 6 months.

At T1 (post 6 months retraction) the same records were taken (OPG, Lateral Cephalogram and standard intra oral photographs) for comparison with the same from T0. The amount of space closure and the displacement of miniscrews is assessed using OPG. The amount of upper incisor intrusion is assessed using lateral cephalogram. Both the radiographs were calibrated to ensure uniform image procurement at T0 and T1 for every patient. The magnification of the lateral cephalogram was scaled as per the ratio 1.1:1 (1.1mm on Radiograph = 1 mm in patient). In the OPG, pterygoid vertical (considered as Y-axis) is marked which is drawn at 90° to the pterygoid plane (considered as X-axis). The extraction space is measured between the cusp tips of the canine and II premolar at T0 and T1 and the amount of retraction is derived from their arithmetic difference. The initial and final positions of miniscrew head measured as the distances between the pterygoid vertical and head of the miniscrew at T0 and T1 respectively. The displacement of head of the miniscrew is derived from their arithmetic difference. The stability of the miniscrew is assessed by the displacement of the head of the miniscrew from T0 to T1 using the OPGs taken at T0 and T1. The amount of maxillary incisor intrusion is measured using Lateral Cephalogram. Two perpendicular lines passing through the Centre of Resistance (CR) and Incisal Edge (IE) were dropped from the SN Plane. The distance between the centre of resistance of upper incisor to SN plane (CR-SN) and the distance between the incisal edge of upper central incisor to the SN plane (IE-SN) at T0 and T1 are considered to determine the amount of intrusion.

Statistical Analysis of the data was done using IBM SPSS Statistics for Windows, version 22.0. Descriptive Statistics including mean, standard deviation, were calculated for various parameters. Normality of the data was assessed using Kolmogorov-Smirnov test which proved the normal distribution of the data. Hence the further analysis was done using Parametric test. Statistical difference between the angle and arches were assessed using Paired Sample t-test. Mean rank comparison was done using Friedman's test. The level of significance was kept as 1%.

3. Results

3.1. Determination of amount of Retraction

1. In High angle Cases, the mean retraction produced by TAD 1 was 6.11±0.020mm, TAD 2 was 6.00±0.410mm, TAD 3 was 5.20±1.027mm and TAD 4 was 5.76±0.275mm. Chi-Square obtained was 14.767 with degree of freedom 3.000 and asymptotic significance being 0.002. Since the p value is < 0.01

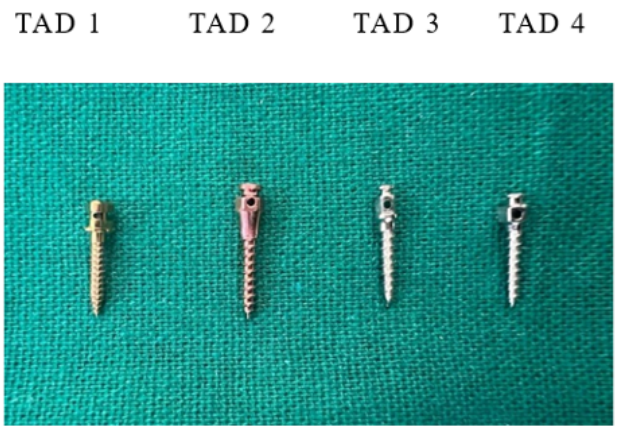

Figure 1: Fourminiscrews that were used

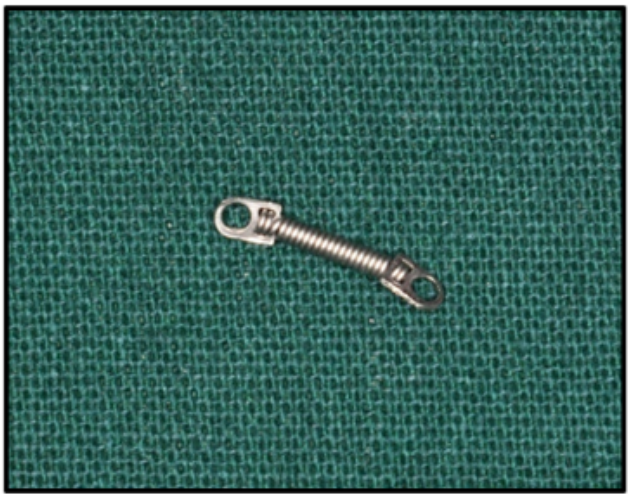

Figure 2: 9mm Niti closed coil spring

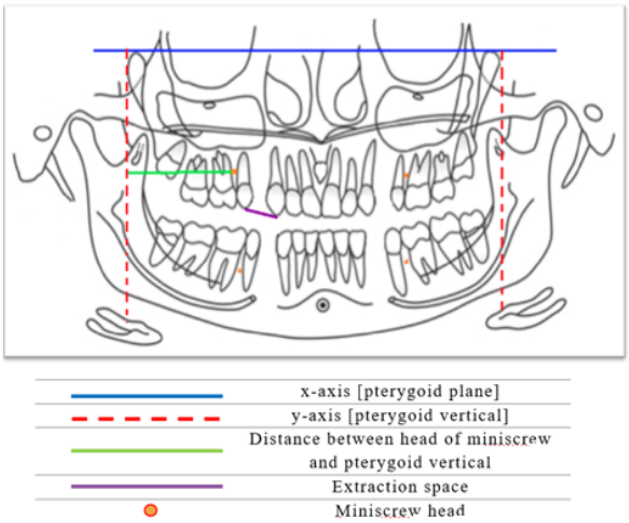

Figure 3: Measurementsdone on OPG

Table 1: Comparison of retraction in high angle and low angle cases

Retraction in High Angle Cases						**TAD 1**	**TAD 2**	**TAD 3**	**TAD 4**
Sample	**TAD 1**	**TAD 2**	**TAD 3**	**TAD 4**	**Sample**	**6.2**	6.0	5.9	6.2
Maxilla 1	6.3	6.2	4.1	5.3	Maxilla 6	6.3	6.0	5.6	5.9
Mandible 1	6.2	6.3	6.0	6.0	Mandible 6	5.9	6.3	6.1	5.8
Maxilla 2	6.2	6.4	3.7	5.9	Maxilla 7	5.9	6.3	5.8	5.7
Mandible 2	5.9	6.1	5.9	5.3	Mandible 7	6.1	5.6	5.8	6.2
Maxilla 3	5.8	6.3	5.2	5.6	Maxilla 8	6.1	6.2	4.3	5.2
Mandible 3	6.0	5.8	5.8	5.8	Mandible 8	5.4	5.9	6.1	5.9
Maxilla 4	5.9	5.9	5.9	5.8	Maxilla 9	5.8	5.8	4.9	5.3
Mandible 4	6.4	6.2	6.1	5.9	Mandible 9	5.2	6.0	5.3	5.3
Maxilla 5	6.1	5.8	3.5	5.9	Maxilla 10	6.2	6.3	5.3	5.8
Mandible 5	6.3	5.0	5.8	6.1	Mandible 10				
One Sample Statistics							95% Confidence Interval of the Difference		
High Angle	Pair 1	RMAXTAD 1 - R MANTAD 1	-0.1	0.3082	-0.4827	0.2827	-0.725	4	0.508
	Pair 2	R MAXTAD 2 - R MANTAD 2	0.24	0.445	-0.3125	0.7925	1.206	4	0.294
	Pair 3	R MAXTAD 3 - R MANTAD 3	-1.44	0.9711	-2.6458	-0.2342	-3.316	4	0.029
	Pair 4	R MAXTAD 4 - R MANTAD 4	-0.12	0.4658	-0.6984	0.4584	-0.576	4	0.595
Low Angle	Pair 1	RMAXTAD 1 - R MANTAD 1	-0.3	0.4243	-0.8268	0.2268	-1.581	4	0.189
	Pair 2	R MAXTAD 2 - R MANTAD 2	-0.16	0.2881	-0.5177	0.1977	-1.242	4	0.282
	Pair 3	R MAXTAD 3 - R MANTAD 3	0.66	0.6504	-0.1476	1.4676	2.269	4	0.086

Table 1 Cont...

Paired Samples Test					t		df		Sig. (2-tailed)
Group	Mean	Std. Deviation	Paired Differences						
	Pair 1	RMAXTAD 1 - R MANTAD 1	-0.1	0.3082	-0.4827	0.2827	-0.725	4	0.508
	Pair 2	R MAXTAD 2 - R MANTAD 2	0.24	0.445	-0.3125	0.7925	1.206	4	0.294
	Pair 3	R MAXTAD 3 - R MANTAD 3	-1.44	0.9711	-2.6458	-0.2342	-3.316	4	0.029
	Pair 4	R MAXTAD 4 - R MANTAD 4	-0.12	0.4658	-0.6984	0.4584	-0.576	4	0.595
	Pair 1	RMAXTAD 1 - R MANTAD 1	-0.3	0.4243	-0.8268	0.2268	-1.581	4	0.189
	Pair 2	R MAXTAD 2 - R MANTAD 2	-0.16	0.2881	-0.5177	0.1977	-1.242	4	0.282
	Pair 3	R MAXTAD 3 - R MANTAD 3	0.66	0.6504	-0.1476	1.4676	2.269	4	0.086
	Pair 4	R MAXTAD 4 - R MANTAD 4	0.3	0.5612	-0.3969	0.9969	1.195	4	0.298

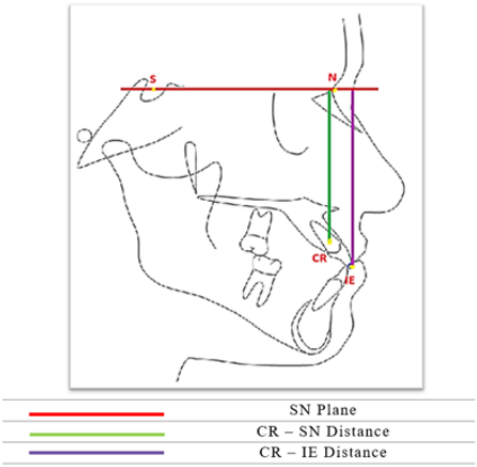

Figure 4: Measurements done on Lateral Cephalogram

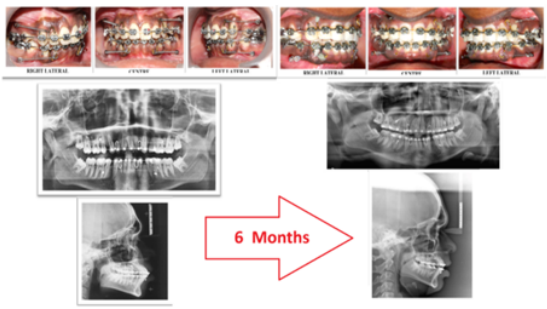

Figure 5: Pre and Posttreatment

there is statistically significant difference between the groups compared with 5% level of significance. When the comparing the mean ranks, the TADs are arranged as per the amount of retraction from high to low as follows: TAD 1 – TAD 2 – TAD 4 – TAD 3.

2. In Low angle Cases, the mean retraction produced by TAD 1 was 5.91±0.36mm, TAD 2 was 6.04±0.24mm, TAD 3 was 5.51±0.57mm and TAD 4 was 5.53±0.36mm. Chi-Square obtained was 6.34 with degree of freedom 3 and asymptotic significance being 0.006. Since the p value is < 0.01, there is statistically significant difference between the groups compared with 5% level of significance. When comparing the mean values, the four types of TADs are arranged according to the amount of retraction exerted from high to low as follows: TAD2 – TAD1 – TAD4 – TAD3.
3. While comparing the amount of retraction that occurred in High angle and Low angle using TADs, the p-value was >0.05, in both high angle and low angle cases, hence there was no statistically significant difference between the groups. When comparing the mean value, maxilla in Low angle case and Mandible in high angle case shows increased amount of retraction comparatively. Since the mean difference is very less, there was no statistically appreciable significant results.
4. While comparing the amount of retraction between maxilla and mandible, the p-value was <0.001, there is a statistically significant difference among the TADs used when compared with Maxilla and Mandible at 1% level of significance. Likewise, it states that mandible shows comparatively higher amount of retraction than

Table 2: Comparison of dispalcement of TAD head in high angle and low angle case

Displacement of TAD head in High Angle Cases					**Displacement of TAD head in Low Angle Cases**				
Sample	**TAD 1**	**TAD 2**	**TAD 3**	**TAD 4**	**Sample**	**TAD 1**	**TAD 2**	**TAD 3**	**TAD 4**
Maxilla 1	1.4	1.1	1.5	1.2	Maxilla 6	1.3	0.8	0.6	1.1
Mandible 1	0.9	1.6	1.4	2.2	Mandible 6	0.8	fail	fail	1.0
Maxilla 2	1.8	1.0	2.3	1.3	Maxilla 7	0.8	0.7	fail	1.0
Mandible 2	1.2	1.6	1.3	1.3	Mandible 7	1.0	1.2	1.1	1.5
Maxilla 3	1.5	0.6	1.5	1.3	Maxilla 8	0.3	1.8	1.5	0.9
Mandible 3	1.5	1.3	1.0	1.7	Mandible 8	0.5	1.0	0.6	0.6
Maxilla 4	0.9	0.6	1.3	1.5	Maxilla 9	1.3	1.3	1.6	1.2
Mandible 4	1.2	1.9	1.4	1.7	Mandible 9	1.2	1.0	0.5	0.9
Maxilla 5	1.5	1.6	1.1	1.3	Maxilla 10	1.0	1.1	1.7	1.1
Mandible 5	2.1	1.2	1.9	1.3	Mandible 10	1.3	1.0	1.5	1.6

One-Sample Statistics								Significance		95% Confidence Interval of the Difference
group			Mean	Std. Deviation	Std. Error Mean	t	df	p value	Lower	Upper
Maxilla	TAD1	10	1.18	0.43	0.14	8.596	9	<0.000	0.8695	1.4905
	TAD2	10	1.06	0.41	0.13	8.146	9	<0.000	0.7656	1.3544
	TAD3	10	1.31	0.63	0.2	6.56	9	<0.000	0.8583	1.7617
	TAD4	10	1.19	0.17	0.05	21.767	9	<0.000	1.0663	1.3137
Mandible	TAD1	10	1.17	0.43	0.14	8.561	9	<0.000	0.8608	1.4792
	TAD2	10	1.18	0.51	0.16	7.262	9	<0.000	0.8124	1.5476
	TAD3	10	1.07	0.56	0.18	6.022	9	0.0001	0.6681	1.4719
	TAD4	10	1.38	0.46	0.15	9.409	9	<0.000	1.0482	1.7118

One-Sample Statistics									95% Confidence Interval of the Difference	
						t	df	Significance One-Sided p	Lower	Upper
High Angle	TAD1	10	1.4	0.37	0.12	11.83	9	0	1.1323	1.6677
	TAD2	10	1.25	0.44	0.14	9.03	9	0	0.9368	1.5632
	TAD3	10	1.47	0.38	0.12	12.23	9	0	1.198	1.742
	TAD4	10	1.48	0.31	0.1	15.18	9	0	1.2594	1.7006
Low Angle	TAD1	10	0.95	0.35	0.11	8.57	9	0	0.6993	1.2007
	TAD2	10	0.99	0.46	0.15	6.8	9	0	0.6605	1.3195
	TAD3	10	0.91	0.65	0.21	4.4	9	0.001	0.4422	1.3778
	TAD4	10	1.09	0.29	0.09	11.79	9	0	0.8809	1.2991

Table 3: Amount of intrusion in maxillary inciosrs

Maxillary Intrusion							
High Angle				**Low angle**			
Pt no	**CR-CN**	**IE-SN**	**Pt no**	CR-CN	**IE-SN**		
1	4.7	3.0	6	5.6	3.2		
2	3.9	2.5	7	4.3	2.6		
3	4.3	3.1	8	5.1	3.2		
4	4.2	3.0	9	3.9	2.8		
5	5.1	3.8	10	4.8	2.6		
Pair/Samples		Mean	Std. Deviation	95% Confidence Interval of the Difference of the difference	t	df	P value
				Lower	Upper			
Pair 1	Int MaxHi – Int MaxLo	1.61	0.44	1.28	11.4	9	<0.001

the mandible. Yet, considering the means of all the TADs, in Maxilla, TAD2 - TAD1 - TAD4 - TAD3 shows the amount of retraction in descending order and in Mandible, TAD1 - TAD2 - TAD4 - TAD3 shows the amount of retraction in descending order.

3.2. Determination of amount of Dispalcement

1. In High angle Cases, the mean retraction produced by TAD 1 was 6.11±0.020mm, TAD 2 was 6.00±0.410mm, TAD 3 was 5.20±1.027mm and TAD 4 was 5.76±0.275mm. Chi-Square obtained was 14.767 with degree of freedom 3.000 and asymptotic significance being 0.002. Since the p value is < 0.01 there is statistically significant difference between the groups compared with 5% level of significance. When the comparing the mean ranks, the TADs are arranged as per the amount of retraction from high to low as follows: TAD 1 – TAD 2 – TAD 4 – TAD 3.
2. In Low angle Cases, the mean retraction produced by TAD 1 was 5.91±0.36mm, TAD 2 was 6.04±0.24mm, TAD 3 was 5.51±0.57mm and TAD 4 was 5.53±0.36mm. Chi-Square obtained was 6.34 with degree of freedom 3 and asymptotic significance being 0.006. Since the p value is < 0.01, there is statistically significant difference between the groups compared with 5% level of significance. When comparing the mean values, the four types of TADs are arranged according to the amount of retraction exerted from high to low as follows: TAD2 – TAD1 – TAD4 – TAD3.
3. While comparing the amount of retraction that occurred in High angle and Low angle using TADs, the p-value was >0.05, in both high angle and low angle cases, hence there was no statistically significant difference between the groups. When comparing the mean value, maxilla in Low angle case and Mandible in high angle case shows increased amount of retraction comparatively. Since the mean difference is very less, there was no statistically appreciable significant results.
4. While comparing the amount of retraction between maxilla and mandible, the p-value was <0.001, there is a statistically significant difference among the TADs used when compared with Maxilla and Mandible at 1% level of significance. Likewise, it states that mandible shows comparatively higher amount of retraction than the mandible. Yet, considering the means of all the TADs, in Maxilla, TAD2 - TAD1 - TAD4 - TAD3 shows the amount of retraction in descending order and in Mandible, TAD1 - TAD2 - TAD4 - TAD3 shows the amount of retraction in descending order.

4. Determination of Amount of Maxillary Anterior Intrusion

The mean intrusion in high angle cases was 4.59 ± 0.56 mm and that in low angle cases was 2.98 ± 0.38 mm. The correlation factor for comparing maxillary intrusion between high angle and low angle cases was 0.612 and the and the p value <0.001, there is statistically significant difference between the groups compared. When comparing the mean values high angle cases show more intrusion than low angle cases.

5. Discussion

Bennemann et alstated that Panaromic radiographs is allowed for the evaluation of orthodontic miniscrews in relation to the surrounding structures,[4] while Schnelle et al.[5] found that the positioning error was negligible and that comparisons could be made using Panaromic radiographs. Hence, Panaromic radiographs were used for assessing the positions of miniscrews before and after retraction in the current study.

The present study also visualises the intrusion of maxillary incisors and their evaluation is done using lateral cephalogram.

The loading of the miniscrews was done after 3 weeks of insertion to allow for healing of the gingival tissues and primary stabilization.

5.1. Retraction

The need for absolute anchorage in high angle and low angle cases is irrespective of the retraction rate in maxilla versus mandible. Therefore, the present study considers to compare the retraction amongst the 4 selected miniscrews in high angle and low angle cases.

In high angle cases, maximum retraction has occurred in the TAD 1 (Vector TAS, Ormco) and the least in TAD 3 (S K Surgicals). In low angle cases, maximum retraction has occurred in the TAD 2 (Favanchor) and the least in TAD 3 (S K Surgicals).

This means that in High angle and Low angle cases, TAD 1 and TAD 2 have close values of retraction and show high retraction rate compared to the other TADs.

The retraction in maxilla and mandible is fairly equal with the average rate in maxilla being 5.84±0.31 mm and mandible being 5.73±0.56 mm and there are no statistically significant differences between the two arches. According to a study by Deguchi et al. in 2008, the rate of tooth movement in maxilla is greater than that in mandible.[6] This also does not agree with a similar study by Monini et al. in 2019 where canine retraction was done using conventional anchorage and the maxillary canines showed a greater rate of tooth movement than the mandibular canines.[7]

The difference in retraction rate in high angle and low angle cases is statistically insignificant as per the paired t-test done in comparison between TADs in high and low angle cases.

5.2. Displacement

The dynamics of TAD loss (loss over time) is an important factor for decision-making in orthodontic treatment planning. The Kaplan–Meier analysis of Wiechmann et al.[8] reported that the cumulative failure rate of implants was found to be significantly higher when implants were placed in the lingual aspect of the mandible compared with the other localizations showed that the major miniscrew failures occurred within 100 – 150 days after the start of orthodontic loading.[8]

The present study involves the loading of miniscrews for 180 days post insertion and in agreement with the above study, 3 of the total number of miniscrews failed at the end of 4th month. TAD 2 and TAD 3 (namely, one Favanchor and two S K Surgicals respectively) were unstable after force loading in both maxilla and mandible. The failure rate of 1.87% which is significant, given the number of sample TADs inserted.

With respect to mini-implants, reports indicate that implant loss occurred predominantly in the unloaded healing period. This in turn means that once a palatal implant is osseointegrated, no implant loss is to be expected.[8] The present study did not observe any failures during unloaded healing period.

There were two miniscrew failures in the mandible among the 40 mandibular miniscrews inserted. A possible explanation for the higher unfavourable result in miniscrew installed in the mandible could be the lack of an adequate attached gingival area. Also, the results could be related to the cortical bone present in the mandible, where vascularization may be insufficient, resulting in bone necrosis and the loss of the miniscrew.[9,10]

A retrospective clinical study showed that factors such as the diameter, inflammation of the peri-implant tissue, and thin cortical bone could be associated with the mobility (that is, failure) of a titanium screw placed in the facial alveolar bone of the posterior region.

Since the vestibule of the mandible is narrower than that of the maxilla, it is difficult to ensure oral hygiene. Consequently, this area is vulnerable to soft tissue inflammation and infection. It is well known that inflammation of the peri-implant tissue can cause peri-implant bone loss, leading to implant mobility. Therefore, well maintained oral hygiene following miniscrew implant placement is suggested to minimize the implant failure rate.[11]

From the above chart it is seen that the displacement of the miniscrews is relatively higher in all 4 TADs in high angle cases compared to the low angle cases. According to a study by Hwang et al.[11] and Li et al.,[12] the failure rates of miniscrews is higher in High Angle cases compared to Low angle cases. The reason might be that high-angle patients had lower bone density and cortical bone thickness; the primary stability and final osseointegration of miniscrew implants would therefore be compromised, which is critical to the overall stability and clinical success of miniscrew implants.[13]

5.3. Intrusion

Intrusion is seen with the changes in both the selected landmarks (IE and CR) in relation to the SN plane. As seen in the graph below, the high angle cases have shown more amount of intrusion compared to the low angle cases, probably owing to the significant differences in the collum angle between high angle and low angle cases.[14] This was in concurrence with a study by Nanda et al.[15] that stated that miniscrews were efficient in the retraction and intrusion of maxillary anterior teeth with minimal loss of anchorage in horizontal and vertical planes.

6. Conclusions

Within the limitations of the present study,

1. The most efficient TAD in high angle cases was found to be TAD 1 (Vector TAS) followed by TAD 2 (Favanchor) in both maxilla and mandible.
2. The most efficient TAD in low angle cases was found to be TAD 2 (Favanchor) followed by TAD 1 (Vector TAS) in both maxilla and mandible.
3. There is TAD failure with a significant percentage of 1.87% excluding which, there was no statistic difference in the displacement among the TADs in High angle as well as Low angle cases, whereas, with the inclusion of TAD failure, there is statistically significant difference in the stability.
4. There was statistic difference in displacement of TADs between High angle and Low angle cases
5. The least efficient in retraction and stability were TAD 3 (S K Surgicals) and TAD 4 (J J Orthodontics)
6. The amount of intrusion in maxillary central incisors was higher in High angle cases compared to Low angle cases.

There is significant difference in the stability and retraction among the four TADs used in High angle and Low angle as well as Maxilla and mandible owing to the density of the bone at the implant site and the soft tissue present. There is statistical difference between the 4 TADs used in combination of High angle, Low angle and Maxilla and Mandible probably owing to the material and design of the miniscrew.

This study has not included the material and make of the mini screws used, therefore, further studies can involve the analysis of the efficiency of the commonly available miniscrews based on their material and design for anchorage in different facial types in three-dimensional views.

7. Source of Funding

None.

8. Conflict of Interest

None.

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