J. Int Oral Health 2012

P- ISSN
0976 – 7428

E- ISSN
0976 – 1799

Journal of International Oral Health

Orthodontics

Original Research

Received: Nov, 2011
Accepted: Jan, 2012

Bibliographic listing:
EBSCO Publishing
Database, Index
Copernicus, Genamics
Journalseek Database,
Proquest, Open J Gate.

Evaluation of clinical efficiency of micro implant as an anchorage in comparison with conventional first molar anchorage

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Abstract:
The present study was been designed to evaluate and compare the anchorage value of the mini-implant to the first molar used conventionally as anchorage unit. Ten cases were treated with preadjusted edgewise appliance where, in five cases anchorage was secured from implants placed between second premolar and first molar in the maxillary arch. Changes in the incisal retraction had also been evaluated cephalometrically in both the implant and control groups. The results have shown that there was a very minimal mesial molar movement in implant supported cases than with the conventional first molar anchorage. Also, the implants were found be easily acceptable to the patients and risk factors associated with their use are minimal. The results are tabulated and discussed. It was concluded that implants are absolute anchorage devices which are helpful in minimizing the anchorage problems to a considerable degree.
Key words: Orthodontics, clinical research, clinical decision making.

Introduction:

Function, stability and esthetics are the prime goals of orthodontic treatment. To achieve these goals, the prime motivation is to develop, obtain and improve a good control over the tooth movement and also to resist unwanted tooth movement for which there should be a perfectly devised anchorage system.

In recent years lot of work is being done on micro-implant screws, which are small in size, can be easily placed by an orthodontist under local anesthesia, can be loaded immediately up to a force of 200-300 grams for the entire length of treatment, do not require osseo-integration and can be easily removed by the orthodontist after completion of treatment.

Present study was designed to compare the micro implant screw as an anchorage unit against the conventional first molar anchorage. Risk factors, patient comfort and clinical efficiency of the micro-implant were also studied and documented.

Materials and Methods:

The sample consisted of 10 subjects with class II/ Bimaxillary protrusion malocclusions who were treated with pre-adjusted edgewise appliance system. All the selected cases were those with high anchorage requirement. After leveling and aligning was completed with NiTi arch wires and stabilized with stainless steel (SS) arch wires, five cases were treated by placement of micro implant and the other five cases were used as controls where anchorage was secured from the first molar. A transpalatal arch was used to reinforce the anchorage in the control cases where retraction was carried out by using a continuous arch wire via friction mechanics. The implants were placed under local anaesthesia in the buccal cortical bone on the attached gingiva[1] between the second premolar and the first molar in the maxillary arch. Implants that were used were cylindrical in shape, 8 mm in length and 1.5 mm in diameter. They were cylindrical in shape with a tapering edge and a button head. The button type of head prevents any impingement of elastomeric rings or ligature wires onto the soft tissue mucosa during retraction. They were made of titanium, manufactured by S.K. Surgicals of Pune, India.

In the five implant cases, radiographic evaluation of the region between the second premolars and the first molars in the maxillary arch had been done with a specially made gauge (jig) and IOPA's. The gauge was placed in the accessory slot of the first molar tube. With the gauge in place, local anaesthesia was administered and a stab incision was given with a BP blade no. 12, the periosteum was reflected to expose the buccal cortical bone (Fig. 1). A slow speed contra-angle hand piece device with cylindrical carbide bur (diameter of 1 mm) along with saline irrigation was used to drill a hole in the cortical plate for about 2-3 mm (Fig. 2). The Implants were then loaded onto a screw holding device and were threaded in the hole assessing the direction of implant through the gauge in place and the buccal root prominences (Fig. 3). Implant was driven until only the button head was visible in the vestibule (Fig.4).

Implants were then loaded after a period of 2-3 days after the soft tissue around the implant site had been completely healed. To obtain a consistent range of pressure, 6 mm closed coil NiTi springs were used for retraction from the implant to the canine or to the lateral incisor delivering a force of about 300-350 Gms (Dontrix gauge, Dentaurum) (Fig. 5). Retraction was carried out on 0.017 X 0.025 SS arch wires in both the implant and the control cases. Retraction in the control cases was enmasse and accomplished by elastomeric chains with the same force range used in the implant cases.[2] Arch wires were removed and the study models, photographs and lateral cephalograms were obtained, after six months, or after obtaining required retraction of the anterior segment, whichever happened earlier.

Study models were used for the measurement of the anchorage loss of the first molar. On each maxillary cast, a line through anterior raphe point and posterior raphe point was used to construct a median reference line. Then the

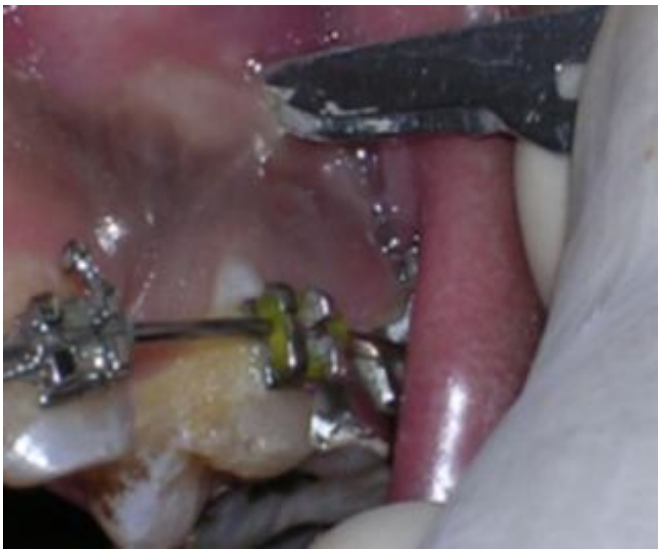

Figure 1: Incision being given

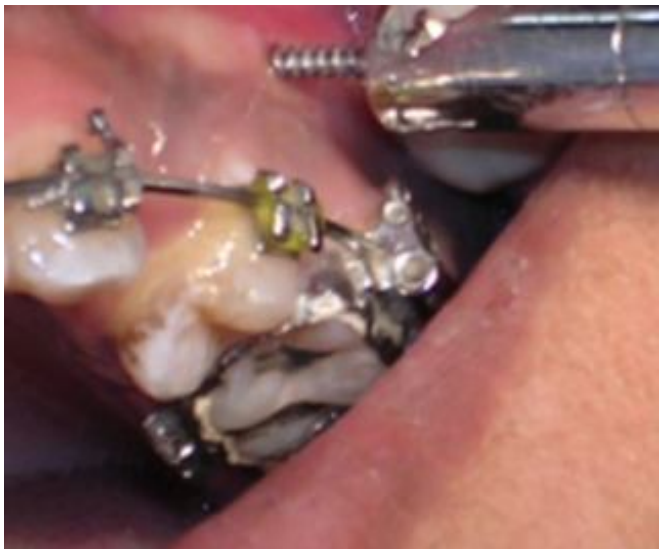

Fig 3: Figurte 3:Microimplant loaded

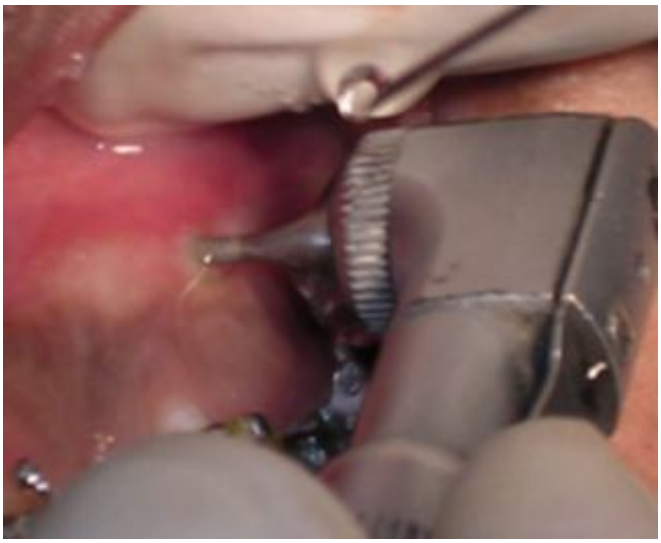

Figure 2: Drilling of hole using micromotor

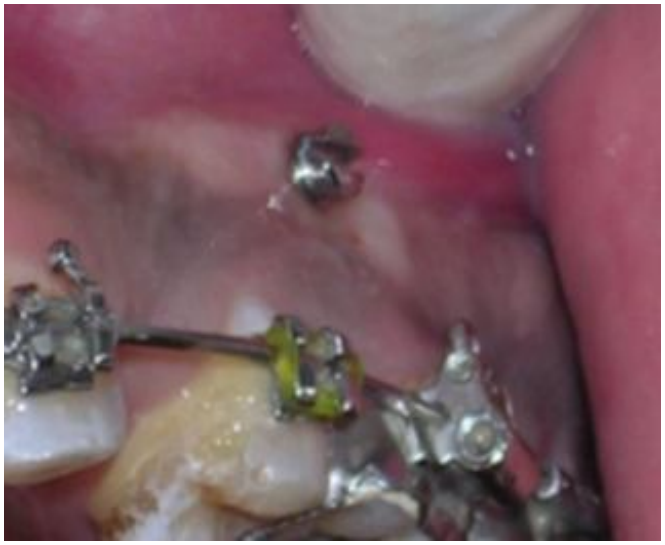

Figure 4: microimplant placed

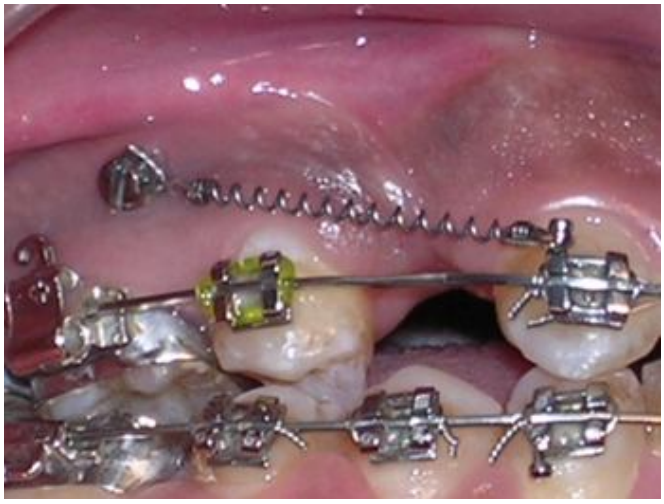

Figure 5: Retraction of canine using closed coil spring

median end of the distinct third rugae, which is considered the most, stable by Almeida M. et al.[3], Bailey T.J. et al.[4] and Hoggan B.R and Sadowsky C.[5] was marked. Now, the points needed for the measurements were marked on the mesial occlusal pit of the first permanent molars.

The orthodontic study models were then scanned using a HP Scanner and a 1:1 reproduction of the occlusal surface of the plaster models was obtained. The image was then transferred to the software (Adobe photo deluxe, home edition 3.1), were the measurements were carried out.[6] Bringing the scale to 0 at the marked rugae to the occlusal pit was considered as X at the end of the study period, the same measurements were carried out which is X'. The anchorage loss was assessed by subtracting X from X', which gave the amount of anchorage loss. The readings from the left and right side were calculated for an average to obtain the anchorage loss in that case.

To assess the amount of incisor retraction, pre and post lateral cephalometric radiographs were traced on acetate by a single investigator. The radiographs for each subject were traced at the same time to aid in the proper identification of structures.[5] The following angular and linear measurements were then constructed to assess the retraction of the anterior teeth and to measure the inter incisal angle: U1 to NA (angular and linear), U1 to SN (angular), U1 to L1 (angular) and SN to MP (angular).

Results:

The anchorage loss during the period of observation in the Implant and control groups are given in table 1 and 2. Table 3 shows the statistical analysis of the anchorage loss in both the Implant and the Control groups. Table 4 shows the statistical analysis of the cephalometric changes in both the Implant and the Control groups.

The mean anchorage loss in the implant group over the study period of six months was 0.65 mm, and the same in the control group was 2.7 mm, the difference when compared is significant statistically.

When comparing the angular and linear measurements between the Implant and Control groups, changes in angular measurement of U1-NA and SN-MP are significant, and changes in U1-SN, U1-L1 and linear measurement of U1-NA are not significant.

Implants became loose in one of the cases on both the sides and they were removed. The particular case was deleted from the study. In one other case, implant became loose on one side, where it was removed and placed at a higher level after a week. None of the patients in the implant group reported of any pain during implant insertion, loading or retraction period.

Descriptive continuous data that included Mean and Standard Deviation are calculated for both Implant and Control groups. Post-treatment changes within groups were analyzed by Wilcoxon's signed rank test and between both group comparisons by Mann-Whitney Test. For all the statistical tests, a p-value of less than 0.05 was considered as significant.

Discussion:

The preservation of molar anchorage remains one of the orthodontists' most persistent and troubling technical problems. First molars are the teeth, which are generally pitted against the anteriors for their decrowding or retraction. Inclusion of second molars and/or a transpalatal arch may enhance anchorage but does not make the anchor unit immobile. All these movements are in

Table-1: Anchorage Loss in Implant group

S. no.	Pre			Post			Difference
	Right	Left	Average	Right	Left	Average	
1	11	11	11	8.5	7.5	8	3
2	10.5	10	10.25	7.5	7	7.25	3
3	14.5	15.5	15	12	13	12.5	2.5
4	11.5	12.5	12	10	11	10.5	2.5
5	12	11	11.5	9.5	9.5	9.5	2.5
Mean	11.9	12	11.95	9.5	9.6	9.55	**2.7**
SD	1.56	2.15	1.82	1.69	2.48	2.08	0.65

Table-2: Anchorage Loss in Control group

S.no.	Pre			Post			Difference
	Right	Left	Average	Right	Left	Average	
1	8.5	8	8.25	7.5	8	7.75	0.5
2	8	9.5	8.75	8	8.5	8.25	0.5
3	12	10.5	11.25	11.5	9.5	10.5	0.75
4	10	9.5	9.75	9	9.5	9.25	0.5
5	10	11	10.5	9	10	9.5	1
Mean	9.7	9.7	9.7	9	9.1	9.05	0.65
SD	1.56	1.15	1.23	1.54	0.82	1.08	0.22

All values in mm

Table-3: Comparison of anchor loss between Implant and Control groups

Group	Pre	Post	Anchorage loss (pre-post)		Implant Vs. control **
			Mean±SD	P- Value*	
Implant	9.7±1.23	9.05±1.08	0.65±0.22	0.06, NS	<0.05,S
Control	11.95±1.82	9.55±2.08	2.7±0.65	0.04, S	

*Wilcoxon's signed Rank Test (Pairs)

**Mann-Whitney Test

p<0.05 significant

p>0.05 not significant

Table-4: Comparison of changes in various cephalometric variables

Parameter	Group	Pre	Post	Difference		Implant Vs Control**
				Mean±SD	*p-value**	
U1-NA (degrees)	Implant	28.4±4.88	20.2±4.21	8.2±5.21	P=0.04, S	P<0.05,S
	Control	30.6±5.6	25.8±2.17	4.8±4.38	P=0.04, S	
U1-NA (mm)	Implant	8.00± 4.18	1.8±2.49	6.2±2.59	P=0.06, NS	P>0.05,NS
	Control	6.8±1.92	2.6±2.6	4.2±2.77	P=0.04, S	
U1-L1 (degrees)	Implant	118.8±11.28	130.4±11.76	-11.76±9.48	P=0.04, S	P>0.05,NS
	Control	111.0±9.92	123.6±8.96	-13.6±12.89	P=0.1, NS	
U1-SN (degrees)	Implant	110.0±7.35	98.8±9.93	12.0±7.18	P=0.08, NS	P>0.05,NS
	Control	114.4±3.2	104.8±4.66	9.6±5.96	P=0.04, S	
SN-MP (degrees)	Implant	27.8±7.2	27±6.28	.08±1.30	P=0.2, NS	P<0.05,S
	Control	28.2±4.76	33.0±5.79	-3.6±1.34	P=0.04, S	

*Wilcoxon's signed Rank Test (Pairs)

**Mann-Whitney Test

p<0.05 significant

p>0.05 not significant

anteroposterior direction only. Moments created in transverse and vertical direction are untoward unless the case requires it. Hence, an ideal anchor should be expected to be stable in all the three planes and be so until the anchor requirements are completed. The mean anchor loss in the implant group was found to be 0.65mm during the study period, which is not statistically significant. This amount of anchor loss can be considered as even clinically insignificant. Though the implants are known to be absolute anchors, this movement must have been occurred due to the physiological mesial migration of the posterior segment during the six-month study period. Probably this would not have occurred if indirect anchorage from implant were secured.

On the contrary, the mean anchor loss in the Control group was found to be 2.7 mm, which is significant both statistically and clinically. By this, we can infer that in a typical high anchorage case a minimum of 2 mm should be calculated for the mesial molar movement. Assuming the premolar width to be 7 mm, the maximum retraction of anteriors that can be achieved in the absence of crowding is only 5 mm owing to a minimum anchor loss of two mm.[6] Saelens NA et al[7], observed a 4.4 mm of mesial molar movement in upper first premolar extraction cases, Ong HB et al[8], observed a mean anchorage loss at 3.7 mm and Geron et al[9] found the mesial molar movement in the same upper first premolar extraction cases to be 3.9 mm. These values are in agreement with the anchorage loss of 2.7 mm in the present study as anchorage loss was considered only during the period of retraction, while in the studies mentioned, anchorage loss was that observed throughout the treatment. Maxillary molar anchorage with first bicuspid extractions is about equal to half the extraction space.[10] These findings can influence our clinical decision making process in many ways, like extraction decisions to suit the patients' needs without anchorage unit preparation or probably eliminating the need for surgery in specific cases. The obvious choice in a class II situation would be securing anchorage from an implant as they help in closing the complete extraction space by purely anterior retraction without disturbing the existing Class II molar relation. In addition, with conventional molar anchorage, use of Class II elastics may have an extruding effect on the lower molars thereby increasing the mandibular plane angle and worsening the already existing Class II profile. Implants can also be used in the camouflage treatment of mild to moderate skeletal Class III problems without compromising on the occlusal relations.

Assessment of the retraction of anterior teeth cephalometrically both in the implant and the control group show that there is a decrease in the linear and angular measurements of UI-NA and U1-SN and an increase in the interincisal angle. On comparing the changes among the groups, the measurements did not show any statistically significant difference except U1-NA (angular). Another interesting finding was the change in the SN-MP angle in both the groups, which was significant. The pre and post treatment change in implant group was insignificant statistically while it was significant in the control group. The actual slight decrease in the SN-MP angle showed that the mandibular plane angle was well maintained in the implant cases with both the upper and lower molars undisturbed in the vertical dimension.

The increase in the SN-MP angle in the control cases can be attributed to the retracting force being applied at the molar tube level, which is quite below the crest of the upper molar thereby creating a moment. This moment displaces the distal cusp down and mesial cusp up thereby rotating the mandible downward and backward. This increase in the angle is detrimental to the already existing convex profile in skeletal Class II patients further worsening the profile. This also may deceive us of faster bite opening owing due to molar extrusion but is quite unstable in comparison with that of absolute incisor retraction and intrusion seen in the implant group.[1]

Stability of the implants is one of the important factors to ensue the smooth progress of treatment. Factors associated with the stability of titanium screws were; diameter of screw (1.0 mm

or less), inflammation of the periimplant tissue, and a high mandibular plane angle (thin cortical bone). However, there was no significant association between the success rate and the following variables: screw length, kind of placement surgery, immediate loading, location of implantation, age, gender, crowding of teeth, antero-posterior jaw base relationship, controlled periodontitis and TMJ symptoms.[11] The present study did not attempt to evaluate the stability of the implant.

To prevent miniscrews hitting any vital organs because of displacement, it was recommended that they be placed in a non-tooth bearing area that has no foramen, major nerves or blood vessel pathways, or in a tooth bearing area allowing 2 mm of safety clearance between the miniscrew and dental root. All the implants that have been placed in the implant group cases have been checked for their proper placement immediately after their placement with the aid of IOPA's.

The problems encountered in this study, though few, are noteworthy. As found by Miyawaki et al.[12], implants failed by becoming loose in one of the case, which was a high mandibular plane case and the patient's poor oral hygiene. The failure can be attributed to either or both of the factors. The case was deleted from the study. In one other case, implant became loose on one side, one week after commencement of retraction, in which implant was replaced at a higher level after a period of one month. This could be probably due to improper insertion of the implant and/or with a wide hole created.

A case was also reported with inflammation around the implant on one side. On clinical examination, it was found that implant was stable but there was plaque accumulation around the implant(fig.9). Retraction was ceased, plaque was cleared and the force was applied after the inflammation completely subsided after proper periodontal therapy.

Implants should not be used without an adequate biologic rationale and without an adequate understanding of reliability, stability, rejection, infection, or other pathology.[13] The psychological aspects of the doctor-patient relationship and the medico-legal implications of implantology for orthodontic purposes should be assessed before starting the treatment.[14] In certain situations adjustment of the treatment plan or modifications in the technique of implant placement may lead to improved success rates.[15]

Single micro-implants are still unable to withstand rotational forces. However, further development may make them even more useful in simplifying biomechanics.[16] Implants with a bracket slot of different dimensions giving them the control in all three planes of space are highly desirable to control the anchorage in all three planes of space.

Conclusion:

Implants form an absolute orthodontic anchorage device in comparison with the conventional first molar as anchorage and are clinically efficient with no reports of pain, sensitivity or allergic reactions during or after insertion or loading period. Probable complications that could be encountered in securing anchorage from implants are loosening of the implants, inflammation around the implant.

The present study aptly evaluates the amount of dental correction with implant anchorage as against the conventional first molar anchorage, in terms of anchorage loss and anterior retraction. It lists the probable complications that could be encountered in securing anchorage from implants. In addition, it ascertains the risk factors and clinical efficiency associated with the use of micro implant anchorage.

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Source of Support: Nil

Conflict of Interest: No Financial Conflict