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RESEARCH ARTICLE

INTRAORAL CLINICAL EVALUATION OF EFFECTIVENESS OF MINI-IMPLANTS IN ORTHODONTIC PATIENTS WITH PREMOLAR EXTRACTION

***Abhishek Ranjan, Dr. Bhagyalakshmi, A., Dr. Shivalinga, B. M. and Dr. Nitin, V. M.**

JSS University, Mysore, India

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ABSTRACT

Introduction: Anchorage has been the most important factor of consideration which determines the treatment success and result of orthodontic treatment. Preserving anchorage during retraction has been a challenge for orthodontist with conventional mechanics.

Objective: The study was undertaken to evaluate the effectiveness of orthodontic mini-implants in providing anchorage for the closure of premolar extraction. To evaluate the success rate, positional stability, clinical effectiveness of mini-implants and patient experiences with the implants with the help of a questionnaire.

Materials and Methods: 15 patients between the age group of 15-25 years were selected who had a treatment protocol for extraction of first upper and lower premolars and had maximum anchorage requirement. The mini-implant of 1.3 mm in diameter and 8 mm in length were placed in the interdental region in the buccal alveolus between the second premolar and the first molar in each quadrant of maxilla and mandible, and were loaded with Ni-Ti coil spring. Primary and secondary outcomes of implants placement was checked.

Results: The success rate of the immediately loaded OMIs in the study was 83.33%with a higher success rate on left side. Pain and peri-implantitis was the only complication observed. Avoidance of the headgear during the treatment was one of the most important motivating factor for patients to opt for OMIs during the study.

Conclusion: Orthodontic mini-implants can be used as an excellent source of anchorage. OMIs were very well accepted by the patient as an alternative to headgear for anchorage augmentation.

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INTRODUCTION

During orthodontic treatment, achieving maximum or absolute anchorage with traditional approaches can be a biomechanical challenge. Attempts at overcoming this challenge have led to extensive investments of both clinical and academic resources. The search for an ideal anchorage unit has resulted in bone-borne, or skeletal, anchorage devices that do not rely on patient compliance, soft tissues, or the dentition (Upadhyay *et al.,* 2008). Osseo integrated implants are considered reliable source of anchorage for orthodontist however the larger size of the implants limits their uses. To overcome this problem many implants were developed. Their advantage in addition to size, include minimal anatomic limitation, minor surgery, increased patient comfort, immediate loading and lower cost. Fear of pain is a problem because it contributes to patients' avoidance of orthodontic treatment. Most patient report pain and discomfort during orthodontic treatment.

****Corresponding author: Abhishek Ranjan,***
Post Graduate Student, Dept. of Orthodontics and Dentofacial Orthopaedics, JSS University, Mysore, India.

Because of the surgical procedure, many patients are also concerned about pain and discomfort after implantation (Upadhyay *et al.,* 2008). Therefore the need of this study is to evaluate the clinical usefulness of mini screws as orthodontic anchorage. The growing demand for minimum compliance and maximum curative effects has made the temporary anchorage devices more promising as an excellent alternative to traditional orthodontic anchorage.

Endosseous dental implants have served successfully as anchorage structures for orthodontic appliances, especially in patients whose dental elements lack quantity and quality. To no longer depend on patients' compliance, several devices and techniques have been introduced as alternative means of skeletal anchorage: conventional dental implants, special intraoral implants, onplants, zygoma wire, intentionally ankylosed teeth, miniscrews, miniplates (Moyers, 1973; Gianelly, 1971).

MATERIALS AND METHODS

In this study, a signed informed consent (Annexure A) was obtained, from the selected patients for the placement of orthodontic mini-implant. All the patients were made to rinse with 0.02% Chlorhexidine mouth rinse before the implant placement procedure. Local anesthesia was administered with 2% lignocaine. The site for placement of the implant was decided by a guide made with a 0.014 round SS wire. A pilot hole was drilled through the cortical bone using a coolant spray with a contra angle hand piece. A round bur was first used to make indentation on the soft tissue to make a smooth path for the drill bit. The pilot drill is usually 0.2-0.3mm smaller than the desired implant size and the pilot drill of 1.1 mm was selected to be drilled at a slow speed. The mini-implants 1.2 mm in diameter and 8 mm in length was inserted. The orthodontic mini-implants was placed in the interdental region in the buccal alveolus between the second premolar and the first molar in each quadrant of maxilla and mandible. The position of the implant was checked by a post insertion intraoral periapical radiograph. The mini-implants were checked for the stability and were loaded immediately with Ni-ti coil spring with 150 grams of force on individual implants. Primary outcome determines the success or failure of mini-implants as anchorage devices during orthodontic tooth movement. Primary outcomes are measured by Immobility of implant, mobility and displacement of implant, failure of the implant and anchorage effectiveness by Cephalometric evaluation.

Score 0: Success without mobility
Score 1: Success with mobility and displacement
Score 2: Failure of implants.

Cephalometric Evaluation

Lateral cephalometric radiographs of all the patients were taken before and after retraction and dental skeletal, soft tissue and hard tissue parameters were compared.

Secondary Outcomes were divided into 3 categories:

Biologic Damage

Score 0**:** No biologic damage.
Score 1: Reversible biological damage
Score 2: Irreversible biologic damage

Inflammation: It was measured from the first month of implant placement. It was measured on visual inspection by seeing any signs of inflammation.
Score 0: No inflammation
Score 1: Temporary inflammation
Score 2: Continuing inflammation

Pain and Discomfort

SCORE 0: No pain or discomfort during the entire treatment period with mini-implants.
SCORE 1: Moderate pain or discomfort in the first 2 weeks.
SCORE 2: Severe pain and discomfort for more than 2 weeks.

Patient evaluation of orthodontic mini implants was done by following questionnaires

Pretreatment patient questionnaire

To avoid using headgears Yes ☐ No ☐
Potential for faster treatment Yes ☐ No ☐
Potential for better treatment Yes ☐ No ☐
Opportunity to try something new Yes ☐ No ☐
Opportunity to contribute to the science Yes ☐ No ☐

During treatment patient questionnaire

Do you think the OMIs are working well? Yes ☐ No ☐
Did it hurt to have the OMIs placed? Yes ☐ No ☐
Is it more difficult to clean around OMIs versus braces? Yes ☐ No ☐
Do the OMIs hurt during treatment? Yes ☐ No ☐
Do the OMIs bother you? Yes ☐ No ☐

After treatment questionnaire

Do you think the OMIs worked well? Yes ☐ No ☐
Are you glad to get the OMIs? Yes ☐ No ☐
Did you enjoy participating in the study? Yes ☐ No ☐
Did removing the OMIs hurt you? Yes ☐ No ☐
Do you recommend OMIs to your friends/colleagues? Yes ☐ No ☐

RESULTS

The study comprised of 15 patients, in which 8 were females with a mean age of 16.24 years (SD±2.24), and 7 male patient with a mean age of 17.24 year (SD±1.93). The overall success rate of the orthodontic mini-implants in the study was 83.3%. The implants placed on the right side had a success rate of 56% of the overall success rate and 20% of the overall failure rate. The implant placed on the left side had 44% of the overall success rate and 80% of the overall failure rate. The failure rate of the implant was more seen on left side of the patient and the value was statistically significant ($p<0.038$). 76.7% of the implants did not show any signs of inflammation and was well tolerated whereas 23.3 % of the implants showed inflammation upto 2 weeks. 86.7% of the patient complained of pain during placement of the implant whereas 13.3 % of the patient complained of pain and discomfort in the first two weeks of the placement of implants. Peri-implantitis and pain were the only complications encountered during the treatment. Orthodontic mini-implant was considered as an excellent alternative in place of headgear for anchorage augmentation and the value was statistically significant. Paired-t test was done to check for the molar position cephalometrically after treatment and no significant difference was found.

DISCUSSION

Anchorage has been the most important factor of consideration which determines the treatment and result of orthodontic treatment. Anchorage loss has also been an 'Achillies heel' during orthodontic treatment. In the present study the primary and secondary outcomes of implant placement was measured.

Table 1. Success rate of implants between right and left side

			Success		Total
			Success	Failure	
Side	Right	Count	28	2	30
		% within success	56.0%	20.0%	50.0%
	Left	Count	22	8	30
		% within success	44.0%	80.0%	50.0%
Total		Count	50	10	60
		% within success	100.0%	100.0%	100.0%

Table 2. Success rate of implant per quadrant

			QUADRANT				Total
			1	2	3	4	
IMPLANT	Success without mobility	Count	12	9	11	13	45
		% of QUAD	80.0%	60.0%	73.3%	86.7%	75.0%
	Success with mobility	Count	1	2	1	1	5
		% of QUAD	6.7%	13.3%	6.7%	6.7%	8.3%
	Failure of implants	Count	2	4	3	1	10
		% of QUAD	13.3%	26.7%	20.0%	6.7%	16.7%
Total		Count	15	15	15	15	60
		% of QUAD	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3. Skeletal parameters

		Paired Differences					t	df	Sig (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	SNA_PRE - SNA_POST ...	0.47	0.52	0.13	0.18	0.75	3.50	14	.004
Pair 2	SNB_PRE - SNB_POST ...	0.27	1.03	0.27	-0.31	0.84	1.00	14	.334
Pair 3	GOGN_PRE - GOGN_POS .	-0.40	0.51	0.13	-0.68	-0.12	-3.06	14	.009
Pair 4	ANB_PRE - ANB_POST ...	0.47	0.52	0.13	0.18	0.75	3.50	14	.004

Table 4. Hard tissue parameters

		Paired Differences					t	df	Sig (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 5	U1SN_PRE - U1SN_POS ...	24.80	3.61	0.93	22.80	26.80	26.61	14	.000
Pair 6	IMPA_PRE - IMPA_POS ...	8.00	9.91	2.56	2.51	13.49	3.13	14	.007
Pair 7	II_PRE - II_POS ...	-29.47	10.39	2.68	-35.22	-23.71	-10.98	14	.000
Pair 8	U6PP_PRE - U6PP_POS ...	-0.03	0.13	0.03	-0.10	0.04	-1.00	14	.334
Pair 9	U6SV_PRE - U6SV_POS ...	-0.13	0.35	0.09	-0.33	0.06	-1.47	14	.164
Pair 10	L6MP_PRE - L6MP_POS ...	-0.17	0.36	0.09	-0.37	0.03	-1.78	14	.096
Pair 11	L6SV_PRE - L6SV_POS ...	-0.07	0.18	0.05	-0.16	0.03	-1.47	14	.164
Pair 11	U1SV_PRE - U1SV_POS ...	5.93	0.80	0.21	5.49	6.38	28.77	14	.000

The overall success rate in this study of the OMIs was 83%. It was considerably higher than 37% reported by (Kim and Choi, 2005) 70% reported by Fritz *et al.,* 2004 70.73% reported by Garfinkle *et al.,* 2009. It is similar to success rate of 83.9-85% reported by Miyawaki *et al.,* 2007 and 85% reported by Moon *et al.,* 2008 However it was lower than 93.6% reported by Park *et al.,* 2004 and 85.7%-90.2% by Chen *et al.,* 2009 All the OMIs failed within 3 weeks of placement. This is shorter than 1.65 months of Moon *et al.,* 2008 and 3.40 month of Park *et al.,* 2004. In our study 6 of the 10 implants that failed were from the initial patients, which indicated a learning curve associated with the placement of TADs and the success rates tends to increase gradually. Females had a slightly higher success rates than males though it was not statistically significant and it can be attributed to a better oral hygiene maintained by the females than males. This was similar to studies done by Moon *et al.,* 2008 Park *et al.,* 2004 and Miyawaki *et al.,* 2007 who have also mentioned that gender is not related with success and failure of the implants. The success rate of OMIs for the left side was lower than the right side of the patient in the present study. Though studies done by Moon *et al.,* 2008 have found no significant difference in the success rate on either side of the jaw. Studies done by Park *et al.,* 2004 have found that left side of the patient had a significantly higher success rates than the right side. It can be attributed to the right handed clinician being more comfortable in placing OMIs in the first and the fourth quadrant. Since all the participants in the study were right handed so failure of the implants can be associated with the brushing habits of the patient. There was no significant difference between the success rates of implant placed in maxilla or mandible. Placement and removal of the implants were done under the effect of local anesthetic. None of the patients reported the use of analgesics post the effect of local anesthetic subsided. This

indicates that the OMIs were well tolerated by the patients. Avoidance of the headgear was the most important motivating factor to opt for the OMIs. This result was similar to the study done by Garfunkle *et al.,* 2008 and was statistically significant ($p<0.05$). The OMIs provided an excellent alternative to extraoral anchorage devices. The reason behind it being more socially and esthetically acceptable with a better patient compliance. All the mini-implants which failed during the procedure were due to peri-implantitis, though antibacterial mouthrinse was prescribed and oral hygiene instructions was given to the patients after the placement of OMIs. All the patients were kept on three days antibiotic protocol after the placement of implants. Liou *et al.,* 2004 have prescribed one week of antibiotic protocol after placement of implants whereas Hedayati *et al.,* 2007 have prescribed the use of antibiotics before placement of implants. The size of the implant used in the study was 1.3 mm in diameter and 8 mm in length and the pilot hole drilled was 1.1 mm. The implant replaced at the site of failure was also of the same diameter. 2 mm diameter implant with 1.5mm pilot drill was used by Costa *et al.,* 1998 and Park *et al.,* 2004 and showed a survival rate of 85%-100%. Freudenthaler *et al.,* 2001 used a 2 mm diameter twist drill for 2 mm diameter implants with immediate loading. Park *et al.,* 2004 and Park, 2003 used a 0.9 mm diameter drill for 1.2 mm mini-implants, for an overall success rate of 90%. Kuroda *et al.,* 2007 made screw holes with a 1.6 mm twist drill for 2-2.3 mm diameter implants and 1.0 mm twist drill for 1.3 mm diameter implants. Self drilling method is a new technique used nowadays. Since their placement torque is high they are not recommended in the posterior and inferior aspect of the mandible. Loading of the implants was done immediately with 150 grams of force with Ni-Ti coil spring. Studies by Chen *et al.,* 2009 have showed that immediate loading of the threaded implant does not necessarily lead to fibrous tissue healing. In our study the amount of force applied on immediate loading of the implants was 150 grams with Ni-Ti coil spring. Force levels for loading the orthodontic mini-implant have shown to vary from 50-400 grams on loading, but most of the recent studies indicate use of forces of 200 grams or less than that. The excessive strain applied on the screw in the earlier stages of the loading can cause screw loosening in the areas having thin cortical bone and low density trabecular bone. The skeletal parameters in our study showed statistically significant changes between the pretreatment and post treatment results. Headgear had been the most preferred appliance for extraoral anchorage, however it depends entirely on patient cooperation. Another disadvantage with the use of headgear is the intermittent force delivery, whereas OMIs have an advantage of continuous force application. Patient compliance with the headgear is usually decreased due to esthetic concern and the risk of injury.

Conclusion

Orthodontic mini-implants can be used as an excellent alternative to conventional anchorage augmentation technique. The overall success rate of the orthodontic mini-implant was 83.3% which is comparable to conventional implants and mini-plates. The right side of the patient had more success rate of implants in compared to left side and it was statistically significant. Peri-implantitis and pain were the only significant complications encountered during the procedure apart from biological damage and inflammation. The patient acceptance and compliance was more with orthodontic mini-implants when compared to headgear.

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