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Comparison of Mini Implants and Nance Palatal Arch Mediated Anchorage Reinforcement during En-Masse Retraction in Maxillary Dentoalveolar Protrusion-A Cephalometric Study

[1]Dr. Aivin K Cleetus, Junior resident, Department of Orthodontics and Dentofacial Orthopaedics, Govt Dental College Trivandrum, Kerala, India

[2]Dr.Sreejith Kumar, Professor, Department of Orthodontics and Dentofacial Orthopaedics, Govt Dental College Trivandrum, Kerala, India

[3]Dr.Babukuttan Pillai , Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Govt Dental College Trivandrum, Kerala, India

[4]Dr.Manjit Rajan, Assistant Professor, Department of Orthodontics and Dentofacial Orthopaedics, Govt Dental College Trivandrum, Kerala, India

[5]Dr.Anand Krishnan, Assistant Professor, Department of Orthodontics and Dentofacial Orthopaedics, Govt Dental College Trivandrum, Kerala, India

Corresponding author: Dr. Aivin K Cleetus, Junior resident, Department of Orthodontics and Dentofacial Orthopaedics, Govt Dental College Trivandrum, Kerala, India

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Abstract

Background and objectives: Anchorage control is one of the most important keys for achievement of successful treatment outcome in clinical orthodontics. The present study was done to compare the anchorage potential of mini implants (TAD) and Nance palatal arch (NPA) for en masse retraction in maxillary dent alveolar protrusion.

Methods: Patients were randomly divided into two groups: Mini implant (TAD) (group A; n=15) and Nance palatal arch (NPA) (group B; n=15). In group A, Titanium miniscrew implants and in group B, Nance palatal arch was used to assess anchorage in en masse retraction of anterior teeth. Lateral cephalometric radiographs were taken twice, once before retraction and another following closure of extraction spaces and, comparison of cephalometric parameters were done.

Results: Comparison of anchorage loss between two groups (mini implants and Nance button) was done. In the Nance palatal arch (NPA) group, net mesial movement of molar (0.703 ± 0.357mm) was noted suggesting anchorage loss which was statistically significant [t (14) =7.610, p<0.05] whereas in the mini implant (TAD) group, net distal movement of molar (1.005±0.663mm) was obtained which was statistically significant [t(12)5.463,p<0.05].

Conclusion: The en masse retraction using mini implants anchorage gave superior results compared to conventional anchorage in terms of anchorage loss.

Keywords: Anchorage, Anchorage loss, Nance palatal arch, TAD, mini implants.

Introduction

Anchorage control plays a pivotal role in the effective management of orthodontic patients for obtaining both structural balance and facial aesthetics. Anchorage is defined as the resistance to unwanted tooth movement. Obtaining maximum or absolute anchorage has always been an arduous goal in clinical practice[1]. There exists a vast array of armamentarium to control anchorage and achieve required tooth movement .Anchorage planning and preparation during orthodontic treatment is essential to prevent untoward tooth movements and not to compromise the result[2]. Both extraoral traction such as headgear and intraoral methods like Nance palatal arches(NPA) and transpalatal arches (TPA) have been proposed to achieve sufficient anchorage[3].

More commonly, palatal arches are used to reinforce anchorage and prevent mesial movement of the upper first permanent molars during treatment. The anchorage value is increased by maintaining a fixed intermolar width across the arch, so that as the molars loose anchorage by drifting forwards, their roots engage the buccal cortex, which theoretically will prevent further forward drift[4]. However, all these methods have inherent disadvantages, such as complicated designs, need for exceptional patient cooperation, and elaborate wire bending[5].

With the introduction of dental implants, miniplates and microscrews as anchorage units, it is now possible to obtain absolute anchorage of the posterior teeth and close the extraction spaces completely by anterior tooth retraction[6]. Orthodontic mini-implants (OMIs), known as temporary anchorage devices, were introduced in clinical orthodontics to prevent loss of anchorage[7]. OMIs can provide stable bony anchorage and overcome problems of anchorage loss during extraction space closure, which usually occurs with traditional methods of anchorage preparation[5].

The mini-screws and mini-plates utilise bone anchorage by taking sites such as interdental area between posterior teeth, retromolar pad, hard palate, maxillary tuberosity etc. For en masse retraction of anterior teeth interdental area between posterior teeth are considered as best sites both for the operator and the patient[8]. The use of a stable anchorage eliminates undesirable movements upon anchoring teeth and replaces traditional procedures that allows for continuous force application leading to a shorter treatment time[9]. Further, the patient compliance required was minimal which adds to its advantage over other conventional means of anchorage.

The use of Nance palatal arches and mini implants have been described in the literature as providing reinforcement of anchorage in treating maxillary dentoalveolar protrusion, but no comparison of the effectiveness of these two types have been scientifically evaluated. Therefore, the aim of the study was to compare the anchorage potential of mini implants and nance palatal arch for en-masse retraction in maxillary dentoalveolar protrusion using lateral cephalograms.

Materials And Methods

This prospective observational study was done in the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College, Thiruvananthapuram which was of 1 year duration.

Inclusion criteria

1. Patients with proclination of upper anterior teeth with age 13 years and above
2. Patients with SNA>82º
3. Maxillary arch with well aligned teeth or with crowding.
4. Patients with full set of teeth in maxillary arch.
5. Patient without upper midline shift.

Exclusion criteria

1. Patients with craniofacial deformity and systemic diseases.
2. Patients having malocclusion requiring extractions other than first premolar.
3. Periodontitis with poor oral hygiene.
4. History of previous orthodontic treatment.

30 patients were selected on the basis of above criteria and the patients were randomly divided in two groups-

Group 1 (Miniimplant group): Consisted of 15 patients(n=15; pretreatment age>13years) who were retracted with Miniimplants.

Group 2 (Nance palatal arch group): Consisted of 15 patients(n = 15; pretreatment age>13years) who were retracted from the hooks of maxillary first molar and the molars where reinforced with Nance palatal arch.

Fixed appliance therapy with MBT 0.022"x 0.028" prescription was used in the study to evaluate the amount of anchorage loss and amount of incisor retraction in this study. The maxillary first molars will be banded while the other teeth, mesial to the first molars will be bonded. After initial levelling and alignment, a 0.019" x0.025" stainless steel arch wire will be placed with crimpable hooks between lateral and canine for en-masse retraction of anterior teeth.

In group A ,Titanium miniscrew implants measuring 1.5mm in diameter and 8mm in length will be used for en-masse retraction of anterior teeth[Fig:1] and in group B Nance palatal arch will be used for anchorage in en masse retraction of anterior teeth[Fig:2]. Patients' informed consent will be taken for placement of miniscrew implants after explaining the details and complications of the procedure. IOPA radiographs in the region of maxillary first molar and second premolar will be taken before implant placement. They will be placed in the alveolar bone between the maxillary first molar and second premolar in the attached gingiva after administration of local anaesthesia according to the recommended protocol.

In group A, retraction force of 150-200g per side will be applied with the use of nickel-titanium coil spring extending from the implant to the crimpable hook placed between maxillary lateral incisor and canine on the archwire and in group B same retraction force will be delivered using nickel-titanium coil spring extending from maxillary first molar hook to the crimpable hook placed between between maxillary lateral incisor and canine on the arch wire. Lateral cephalometric radiographs will be taken twice, once before retraction and the other following closure of extraction spaces. The comparison of cephalometric parameters will be done before and after retraction of maxillary anterior teeth. The parameters considered in this study will be as follows:

The cephalometric radiographs obtained before(T1) and after en-masse retraction(T2) in two groups will be traced manually and all measurements will be taken using digital vernier calliper by the observer.

For the maxillary measurements, the lateral cephalometric tracings will be superimposed along the palatal plane registered at ANS. The horizontal distance from the

pterygoid vertical to the distal surface of the maxillary first molar will be calculated to measure anchorage loss and horizontal distance from pterygoid vertical to the incisal edge of maxillary central incisor is measured to calculate the amount of anterior teeth retraction.

Standardization of cephalometric technique

Standardized 8X10" Kodak lateral radiographic films were used for each subject on NewtomGianoCeph Machine[Fig: 3]. The X- ray source to subject distance was kept at a constant distance of 5 feet; the film was kept at a constant distance of 16 centimeter away from the midsagittal plane. Exposure parameters were at 71 kVp at 10 milliampere for 0.08 seconds. Each radiograph was taken with teeth in maximum intercuspation, lips relaxed and subjects oriented in Natural Head Position. Natural Head Position was obtained by asking the subject to look straight into his eyes in mirror which was hung on the wall facing the cephalostat. The Xrays T1 (pre retraction) and T2 (post retraction) were obtained in both groups.

Tracing technique

All the lateral cephalometric films were traced on 36 micron citizen acetate tracing sheets using 4H lead pencil. Similar condition of light box and general illumination were maintained during tracing. All the tracings were done by the same operator. Wherever the bilateral structures casted double shadows on the film, the average of the two images was taken.Cephalograms were traced to evaluate the anchorage loss and amount of incisor retraction in millimetres among T1 and T2 stages.

Materials Used In the Study

- Standardized Lateral cephalograms.
- 0.36 mm matte acetate tracing paper.
- View Box.
- Geometry box (scale, protractor, 4H lead pencil, set squares, and eraser)[Fig.4]
- Scotch tapes.
- Tracing board.
- Scissors.
- Calculator.
- Miniimplant(TAD)[Fig:5]
- Nance Palatal Arch(NPA)[Fig:6]
- Digital vernier caliper[Fig:7]

Cephalometric landmarks to be used

1. **Point A (subspinale):** The point at the deepest midline concavity on the maxilla between the anterior nasal spine and prosthion.
2. **ANS (Anterior nasal spine)**: The most anterior point of the nasal floor; spinous process of the premaxilla on midsagittal plane.
3. **PNS (Posterior nasal spine):** The spinous process formed by the most posterior projection in the sagittal plane of the bony hard palate.
4. **Pterygomaxillary fissure**: It is a triangular shaped lateral opening of pterygopalatinefossa.
5. **Maxillary first molar (U6):** Distal surface of maxillary first molar.
6. **Maxillary incisor (U1):**Incisal edge of maxillary central incisor.

Cephalometric planes to be used:

1) **Palatal plane (PP)**: A line connecting anterior nasal spine and posterior nasal spine.
2) **Pterygoid vertical (PTV):** A vertical line drawn through the distal radiographic outline of the pterygomaxillary fissure and perpendicular to FH plane.
3) **Frankfort Horizontal Plane (FH):**Horizontal plane passing through the inferior margin of the orbit and the upper margin of external auditory meatus.

Statistical Analysis: The software employed for statistical analysis of the data wereStatistical Package for Social Sciences (SPSS version 16).The Paired student-t test was used to compare between two groups.

Results

Anchorage loss was assessed by change in horizontal distance in millimeters from the pterygoid vertical to the distal surface of the maxillary first molar and amount of incisor retraction was assessed by the change in the horizontal distance in millimeters from pterygoid vertical to the incisal edge of maxillary central incisors using lateral cephalograms. The Pre and post lateral cephalometric values were measured to assess the molar movement difference(anchorage loss) and incisor retraction difference.Among the 15 patients assessed in the NPA group, the mean incisor retraction difference was 5.57 ± .425mm with maximum value of 6.25mm and minimum value of 4.98mm.The mean of Molar movement difference depicting anchorage loss was assessed to be .703 ± .357mm with maximum value of .26mm and minimum value of 1.73mm.(Table 1) Among the 15 patients assessed in the TAD group, the mean incisor retraction difference was 4.89 ± .743mm with maximum value of 7.45mm and minimum value of 4.38mm.The mean of Molar movement difference depicting distal movement was assessed to be 1.028 ± .617mm with maximum value of .08mm and minimum value of 1.96mm.(Table 2) The molar movement difference depicting the anchorage loss in NPA and TAD group is given in the above bar graph (graph 1). It was noted that in the NPA group all the cases had anchorage loss whereas in TAD group only 3 cases showed slight anchorage loss. Paired t test was used to assess significance of anchorage loss and incisor retraction in NPA and TAD groups.In the NPA group, net mesial movement of molar (0.703 ± 0.357mm) was noted suggesting anchorage loss which was statistically significant [$t(14)=7.610, p<0.05$]. The mean incisor retraction was (5.572±.425) which was statistically significant [$t(14)=50.692, p<0.05$](Table:3).In the TAD group ,net distal movement of molar (1.028± .617mm) which was statistically significant [$t(14)6.449, p<0.05$].The mean incisor retraction was(4.808± .829mm) which was statistically significant[$t(14)=22.449, p<0.05$](Table: 4).Further ,the comparison of anchorage loss between NPA and TAD groups was statistically significant($p<0.05$) ,suggesting that TAD is superior in providing anchorage reinforcement.(Table: 5)

Discussion

Anchorage loss (AL) is a reciprocal reaction that could obstruct the success of orthodontic treatment by complicating the anteroposterior correction of the malocclusion and possibly detracting from facial esthetics. A major concern when correcting severe crowding, excessive overjet, and bimaxillary protrusion is control of AL. Therefore, adjunct appliances, such as the Nance holding arch, transpalatal bar, and extraoral traction, are often used to augment molar anchorage. The use of multiple teeth at the anchorage segment to form a large counterbalancing unit and the application of differential moments have also been described as methods to stabilize molar position.[10] Although several traditional methods of anchorage reinforcement have been used they were unable to provide absolute anchorage leading to anchorage loss and unesthetic result.

Absolute or infinite anchorage is defined as no movement of the anchorage unit (zero anchorage loss) as a consequence to the reaction forces applied to move teeth.Such an anchorage can only be obtained by using ankylosed teeth or dental implants as anchors, both relying on bone to inhibit movement. It can provided by devices, such as implants or miniscrew implants fixed to bone, may be obtained by enhancing the support to the reactive unit (indirect anchorage) or by fixing the anchor units (direct anchorage), thus facilitating skeletalanchorage.[11]

The use of implants for orthodontic anchorage is a rapidly developing field .Mini-screw implants are temporary

anchorage devices that provide anchorage reinforcement combination of mechanical retention immediately after insertion (primary stability) and a degree of osseointegration. Miniscrew implants can function as viable alternative to conventional molar anchorage. They are simple and efficient anchors for canine retraction, especially in moderate to maximum anchorage situations.[12]

In this study for Group A, mini-implants were inserted between the roots of permanent upper second pre-molars and first molar. In Group B Nance button was employed as an anchorage system. Among the 15 patients assessed in the NPA group, the mean incisor retraction difference was 5.57 ± .425mm with maximum value of 6.25mm and minimum value of 4.98mm.The mean of Molar movement difference depicting anchorage loss was assessed to be .703 ± .357mm with maximum value of .26mm and minimum value of 1.73mm. Among the 15 patients assessed in the TAD group, the mean incisor retraction difference was 4.89 ± .743mm with maximum value of 7.45mm and minimum value of 4.38mm.The mean of Molar movement difference depicting anchorage loss was assessed to be 1.028 ± .617mm with maximum value of 1.96mm and minimum value of .08 mm(distal movement).

Similar results were obtained by Arantes et al(2012)[9] showing an average anchorage loss of 2.85 ±2.41mm on the right side and 2.73 ±5.19mm on the left side for the group with Nance button. In the Mini-implant group, average anchorage loss of 2.65±4.73mm on right side and 1.90±5.29mm on the left side depicting that anchorage loss is minimal in mini-implant group.

Antonarakis and Kiliaridis[13] in their systematic review found that tooth-borne distalizers could move maxillary molars distally on average 2.9 mm; however, it was associated with undesirable incisor mesial movement of 1.8 mm.Goyal et al[14] suggested minimplants to distalise molars and preserve anterior anchorage.The Intraoral distalizing appliances cause an adverse, reciprocal mesial movement of the anterior teeth and premolars during distal movement of the molars. On the other hand, distal movement using mini-implants causes a group movement of buccal segment teeth. Hence, there is no forward movement of the anterior teeth in mini-implant-aided mechanics. And so, the use of miniimplnats did not produce any adverse side effect on the anterior teeth.

In a study by Upadhyay et al[1] to determine the efficiency of mini-implants as intraoral anchorage units for en-masse retraction of anterior teeth. Minimplants and conventional methods of anchorage reinforcement were compared. The maxillary first molars in the mini-implant group showed net distal movement of 0.55 mm, and mesial movement of 1.95 mm was found in conventional group which is in support of our present study.

In our study when anchorage potential and maxillary anterior teeth retraction was assessed with mini implants(TAD) and NPA for en-masse retraction in maxillary dentoalveolar protrusion .It was found that in NPA group net mesial movement of molar (0.703 ± 0.357mm) was noted suggesting anchorage loss which was statistically significant [$t(14)=7.610, p<0.05$]. The mean incisor retraction was (5.572±.425mm) which was also statistically significant [$t(14)=50.692, p<0.05$]. In TAD group a net distal movement of molar(1.028±.617mm) was obtained which was also statistically significant [$t(14)=6.449$, $p<0.05$]. The mean incisor retraction was(4.808±.829mm) which was statistically significant[$t(14)=22.449$,$p<0.05$].

One of the reasons for which there was no or slight anchorage loss in Mini implant group was that there is no reactionary forces acting on the anchor teeth as the retraction force is attached directly to the implant whereas

there is a reciprocal force acting on the anchor teeth in the Nance palatal arch group. Also mini implants are skeletal anchors which derive support from the cortical bone into which they are engaged whereas in Nance palatal arch the anchorage is dentoalveolar with reciprocal forces acting on the anchor unit. The Nance palatal arch takes support from the anterior palate which hinders the amount of anterior teeth retraction and thus could be a possible reason for the less amount of incisor retraction obtained in the Nance palatal arch (NPA) group in our study. The forces acting on the tooth such as masticatory forces could be another contributing factor to the movement of the anchor unit and the Nance palatal arch which could decrease the resistance of the anchor unit and thus leading to anchorage loss. Thus mini-implants are efficient for intraoral anchorage reinforcement for en-masse retraction of maxillary anterior teeth. The results of this study are in accordance with[1,15,16] .Further, Upadhyay et al[17] explained that the application of light force (eg. NiTi closed coil spring) after the extraction space has been closed would cause a transmission of force to the posterior segments through the interdental contacts producing a distal and intrusive force on the posterior teeth and thereby resulting in molar distalisation which was observed in our study.

Some limitations of the present study are to be considered when interpreting the results. Firstly, the small sample size of the study is a major drawback. Most of the studies which states that efficacy of mini implants is based on clinical case reports, and at least randomized controlled trials are required to provide clear recommendations. Secondly the use of lateral cephalometric variables may produce errors in interpretation due to overlapping as it is a 2-D representation of a 3-D object. Superimposition of contralateral molars on a cephalogram may induce measurement errors when assessing anchorage loss. Within the limits of the present study, it was concluded that mini implants can be used as an effective anchorage reinforcement method for en masse retraction in maxillary dentoalveolar protrusion. Further high quality prospective, randomized clinical trials are needed to investigate the anchorage efficacy of orthodontic mini implants in comparison to conventional techniques.

Legends Figures and Tables

Figure1: Retraction in Miniimplant(TAD)group

Figure 2: Retraction in NancePalatalArch(NPA)group

Figure 3: Newtom Giano Ceph Machine

Figure 4: Geometry box

Figure5: Miniimplant(TAD)

Figure 6: Nance Palatal Arch

Figure 7: Digital Vernier Caliper

Table 1: Distribution of average, standard deviation between before and after measurements obtained from the Nance palatal group

	N	Mean±SD	Minimum	Maximum
Incisor retraction difference	15	5.57 ± .425	4.98	6.25
Molar movement difference	15	-.703 ± .357	-1.73	- .26

Table 2: Distribution of average, standard deviation between before and after measurements obtained from the TAD group

	N	Mean±SD	Minimum	Maximum
Incisor retraction difference	15	4.89 ± .74327	4.38	7.45
Molar movement difference	15	1.028 ± .617	-.08	1.96

Graph 1: Bar graph depicting the anchorage loss between NPA and TAD group

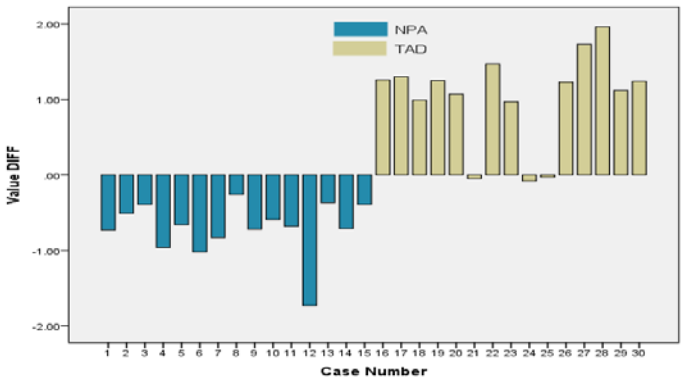

Table: 3 Paired t test of NPA group

		Mean	N	SD	Std. Error Mean
Pair 1	Molar movement PRE	19.5707	15	3.95393	1.02090
	Molar movement POST	20.2740	15	3.89088	1.00462
Pair 2	Incisal retraction PRE	59.5327	15	4.20667	1.08616
	Incisal retraction POST	53.9607	15	4.06229	1.04888

Paired Samples Statistics

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MMPRE – MMPOST	-.70333	.35796	.09243	-.90157	-.50510	-7.610	14	.000
Pair 2	IRPRE - IRPOST	5.57200	.42571	.10992	5.33625	5.80775	50.692	14	.000

Table 4: Paired t test of TAD group Paired Samples Statistics

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MMPRE – MMPOST	1.02867	.61782	.15952	.68653	1.37080	6.449	14	.000
Pair 2	IRPRE - IRPOST	4.80800	.82951	.21418	4.34863	5.26737	22.449	14	.000

Table 5: Comparison of anchorage loss between NPA and TAD groups

Molar movement difference	NPA	TAD	Test used	p value
Mean±SD	-.703±0.357	1.028±.617	Independent sample Mann-Whitney U test	0.000

Conclusion

The present observational study compared the anchorage potential of mini implants and Nance palatal arches by lateral cephalometric assessment and the following conclusions are drawn.

1. Mini-implants and Nance palatal arches provide statistically significant anchorage control for orthodontic retraction of anterior tooth.
2. On comparison of anchorage loss between two systems, In the NPA group, net mesial movement of molar was noted suggesting anchorage loss which was statistically significant whereas in the TAD group, net distal movement of molar was obtained which was statistically significant.
3. Comparison of anchorage loss between NPA and TAD groups was statistically significant, suggesting that TAD is superior in providing anchorage reinforcement.
4. There was no anchorage loss with mini-implants except for three cases when compared with Nance palatal arch.
5. Hence when retracting upper anterior teeth in patients with moderate to severe protrusion, the en-masse retraction with mini-implants anchorage provide superior results compared to conventional anchorage in terms of anchorage loss. More studies with larger samples are required to further evaluate this approach of treatment.

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