COMPARATIVE EVALUATION OF THE CONVENTIONAL ANCHORING DEVICES FOR MEASURING ANCHOR LOSS

Sudhir Munjal[1], Eknoor Kaur[2], Satnam Singh[3], Harmeet Singh[4], Rahul Khullar[5], Sonali Batta[6]

[1] Professor & Head, [2,5,6] Post Graduate Student (Final year), [3]Professor, [4] Associate Professor, Department of Orthodontics & Dentofacial Orthopaedics, Dasmesh Institute of Research & Dental Sciences, Faridkot (Punjab), India

Corresponding author : Sudhir Munjal, Professor & Head, Department of Orthodontics & Dentofacial Orthopaedics, Dasmesh Institute of Research & Dental Sciences, Faridkot (Punjab), India, Mob no. 9814057485

Abstract: The multifaceted nature of temporary anchorage devices has made them extremely useful auxiliaries to prevent the unwanted tooth movement during fixed mechanotherapy. A proper planning of the anchor control is required beforehand in order to expel the untoward effects resulting in inefficacious treatment**. OBJECTIVE**: The purpose of this study was to determine anchor loss during en masse retraction of the anterior segment into the premolar extraction space when Transpalatal arch and Nance palatal arch were used as an anchorage device and to concur whether only one record either study casts or cephalogram could suffice for the evaluation of anchorage loss. **MATERIAL AND METHOD**: Pre-treatment, mid-treatment and posttreatment study models and lateral cephalograms of forty patients were taken and divided into two groups: Group I: Cases with anchorage reinforcement via Transpalatal Arch; Group II : Cases with anchorage reinforcement via Nance Palatal Arch. The mesial migration of maxillary first molar was determined. Data was then statistically analysed using Independent ‘t’ test **RESULTS:** Results revealed that both the anchorage regimes were effective in reinforcing anchorage. The anchorage loss was significantly lower in the Nance appliance as compared to the TPA mainly during initial leveling and alignment, space closure and finishing and detailing. **CONCLUSION:** TPA-Nance might be a suitable alternative method in reinforcing anchorage when taking into consideration the cost, and amount of anchorage loss.

KEYWORDS: Anchor loss, Anchorage, En masse retraction, Transpalatal arch, Nance palatal button, Study models, Lateral cephalogram.

INTRODUCTION

Newton's third law of motion states that action and reaction forces come in pairs. This concept can be applied in orthodontics when retracting the anterior teeth using the posterior teeth as an anchor. Anchorage, as defined by Graber, refers to the resistance to movement provided by a particular anatomical unit during the process of affecting tooth movement. It is crucial to have a well-planned and accurately diagnosed treatment to achieve a successful outcome in orthodontics, as any undesired movement of teeth may result in treatment failure, which is a significant setback for the orthodontist. Additionally, tracking anchor loss at different stages of the treatment can be helpful in achieving the desired results.[1,2]

In 1728, Fauchard, a French dental innovator, proposed that proper tooth anchorage was necessary when applying mechanical forces during dental treatment. Today, anchorage is considered essential for modern orthodontic practice, and managing it is a primary consideration when formulating a treatment plan. Orthodontists have developed various intraoral and extraoral devices, including the Nance palatal arch, lingual arch, transpalatal arch, headgear, and temporary anchorage devices, to enhance anchorage and prevent unwanted tooth movement.[3]

Numerous techniques have been utilized to investigate anchor loss, but there is a lack of literature regarding the dependability of study models and the concurrent evaluation of the efficacy of transpalatal and Nance palatal arches in preserving molar position throughout the mid-treatment and post-treatment phases. Consequently, there is a requirement for research in this area.

MATERIAL AND METHODS

A retrospective study was nested at Department of Orthodontics & Dentofacial Orthopedics, Dasmesh Institute of Research & Dental Sciences, Faridkot to assess the effectiveness of TPA and Nance palatal arch in controlling anchorage. Lateral cephalograms and study models of 40 patients were taken in standardized manner using Allengers-Alldent HF X-ray machine manufactured by Allengers, Medical System Ltd. For standardized positioning, a cephalostat was used to maintain the subjects head in a constant relationship to the film. This in turn, standardized the distance of the subject to the film, the X-ray exposure as well as the magnification exposure. The digital copy of cephalogram was obtained from Fujifilms FCR Prime console (CR-IR391CL) software. All the patients were recruited from the regular pool reporting to the department and were divided into two groups:

Group I : Cases with anchorage reinforcement via Transpalatal Arch (TPA)

Group II : Cases with anchorage reinforcement via Nance Palatal Arch

Once the inclusion criteria were fulfilled, it was discussed with the patient and their participation was solicited.

INCLUSION CRITERIA

1. Patients having complete permanent dentition from the right first molar to the left first molar
2. The patients should have undergone first premolar extractions bilaterally as a part of their comprehensive treatment plan
3. Transpalatal and Nance palatal arch were used to reinforce anchorage
4. No previous history of orthodontic treatment and orthognathic surgery

EXCLUSION CRITERIA

1. Patients having expansion appliance as a part of their therapy
2. Patients treated with any other anchorage devices
3. Patients with RCT treated first and second molars
4. Syndromic patients

Pre-treatment cephalograms & study models were taken as diagnostic records for all subjects in both the groups. Bilateral extraction of first premolar was carried out. Initial leveling and alignment of the orthodontic mechanotherapy was done with Nickel-Titanium 0.016" round arch wire & 0.016" × 0.022" Nickel-Titanium rectangular arch wires for a period of few weeks in both the groups. After leveling and alignment the arch wires were removed and a second set of lateral cephalograms and study models were taken. Space closure, finishing and detailing was done with 0.017” × 0.025" stainless steel & 0.019" × 0.025" Stainless Steel arch wires in 0.022" bracket slot respectively. Sagittal and vertical dental changes which occurred during the examination period in either groups were analysed cephalometrically before the start of the treatment (pre-treatment), after the leveling and alignment phase (mid-treatment) and post treatment that is after finishing and detailing phase of orthodontic mechanotherapy.

Analysis of Lateral Cephalograms : The measurements taken from Pre-treatment, Mid-treatment and Post-treatment lateral cephalograms were traced using tracing sheet made of lead acetate 0.05mm thickness. Considering Sella Nasion (SN) plane as stable line, it was used as a plane for superimposition at Sella. A True Horizontal Line (THL) was drawn at 7° to SN plane as done in COGS analysis and a perpendicular to True Horizontal Line (THL) was drawn which was considered as True Vertical Line (TVL). Perpendiculars from True Vertical Line (TVL) to the most prominent mesial tooth surface and the mesial root tip of upper first molar (lines A and B respectively) were drawn and the linear values of both the lines (lines A and B) were measured. Similar procedure was followed for the Mid-treatment (lines A' and B') and Post-treatment linear values measurement on lateral cephalogram (lines A" and B"). The difference between (A' & A) and (B' & B) was the anchor loss in the initial stages of treatment (mid treatment), the difference between (A" & A') and (B" & B') was the anchor loss after space closure (post treatment) and the difference between (A" & A) and (B" & B) was the total anchor loss achieved. Then a line was drawn joining the mesial and distal cusp tips of upper first molar (MD) and a perpendicular bisector (MDP) to the line MD extending to the true horizontal followed by measuring the distal angle i.e. alpha angle (α) for pre-treatment cephalograms. Similar procedure was followed for the mid-treatment and post-treatment lateral cephalograms and the angles were denoted as α' and α" respectively. The difference between (α' and α) be the tipping produced in the initial stages of treatment (mid treatment), the difference between (α" and α') was the tipping produced after space closure (post treatment) and the difference between the alpha angles (α” and α) gave the total amount of tipping produced. [2] (Figure 1)

FIGURE 1: Illustration of Cephalometric measurements

Analysis of Study Models: A line was drawn through anterior and posterior raphe points (MRL) followed by a perpendicular constructed from mesial contact point of right and left Upper Molars to the Median Reference Line (URM-MRL) and (ULM-MRL) respectively. Considering medial rugae as the most stable landmark, linear distance from the mid-point of the third rugae to the perpendicular drawn to the mesial contact points of Upper Right (URM) and left (ULM) first molars were summed up for pre, mid and post study models and denoted as dR & dL, dR' & dL' and dR" & dL" respectively. The difference between the values of mid-treatment and pre-treatment was the amount of anchor loss in the initial stages of treatment. The values of pre-treatment were subtracted from post-treatment for both right and left sides and mean anchor loss was calculated for the whole upper arch. [4] (Figure 2)

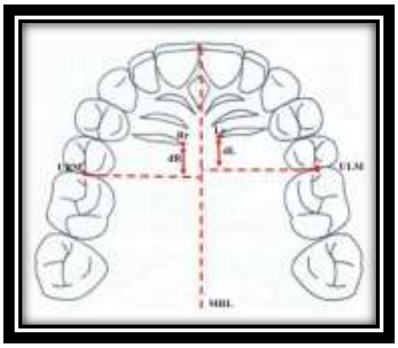


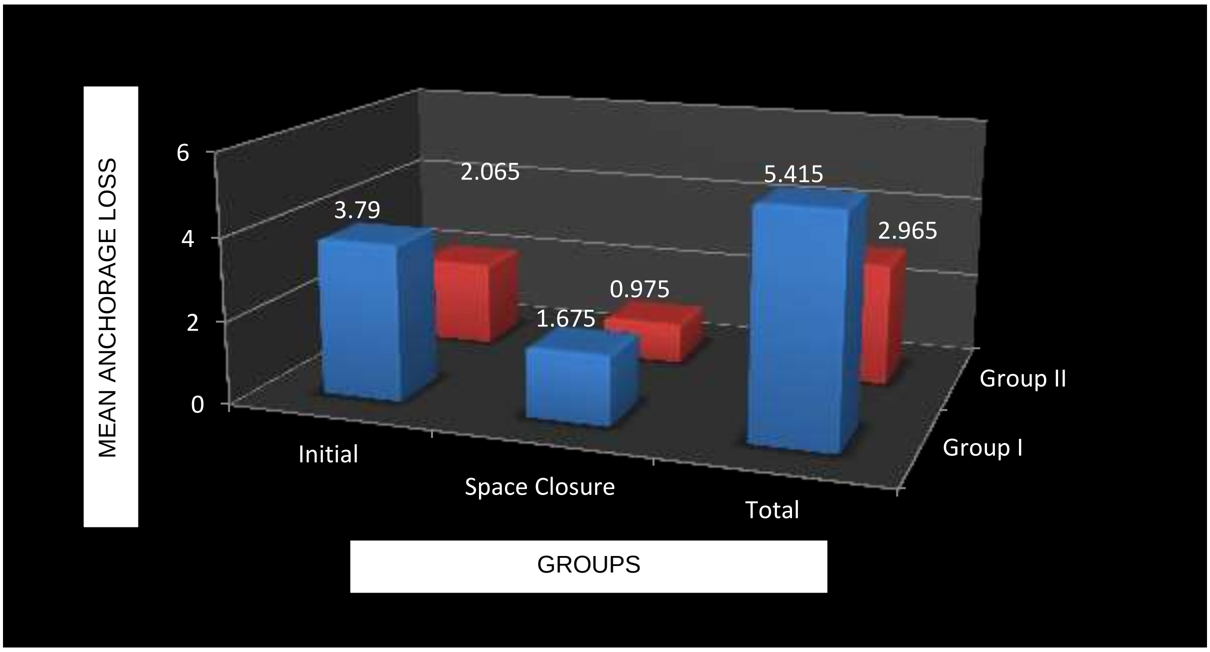
FIGURE 2: Linear Parameters for study model evaluation

RESULTS

The result of the anchorage loss for both the groups using cephatometric analysis at point A, point B and angle α and model analysis along with their interpretation are presented in Table 1 and Graph 1, Table 2 and Graph 2, Table 3 and Graph 3, Table 4 and Graph 4 respectively. Descriptive statistics like mean and standard deviation were calculated for every group. Independent 't' test was used for multiple comparisons to find difference in all groups for statistical analysis, 'P' value of <0.005 was considered significant.

	Groups	Mean	Std. Deviation	Std. Error Mean	'P' value	Significance
Initial	Group I	3.790	2.199	0.491	0.005	Significant
	Group II	2.065	1.380	0.308		
Space Closure	Group I	1.675	1.248	0.279	0.054	Non-Significant
	Group II	0.975	0.962	0.215		
Total	Group I	5.415	2.712	0.606	0.001	Significant
	Group II	2.965	1.768	0.395		

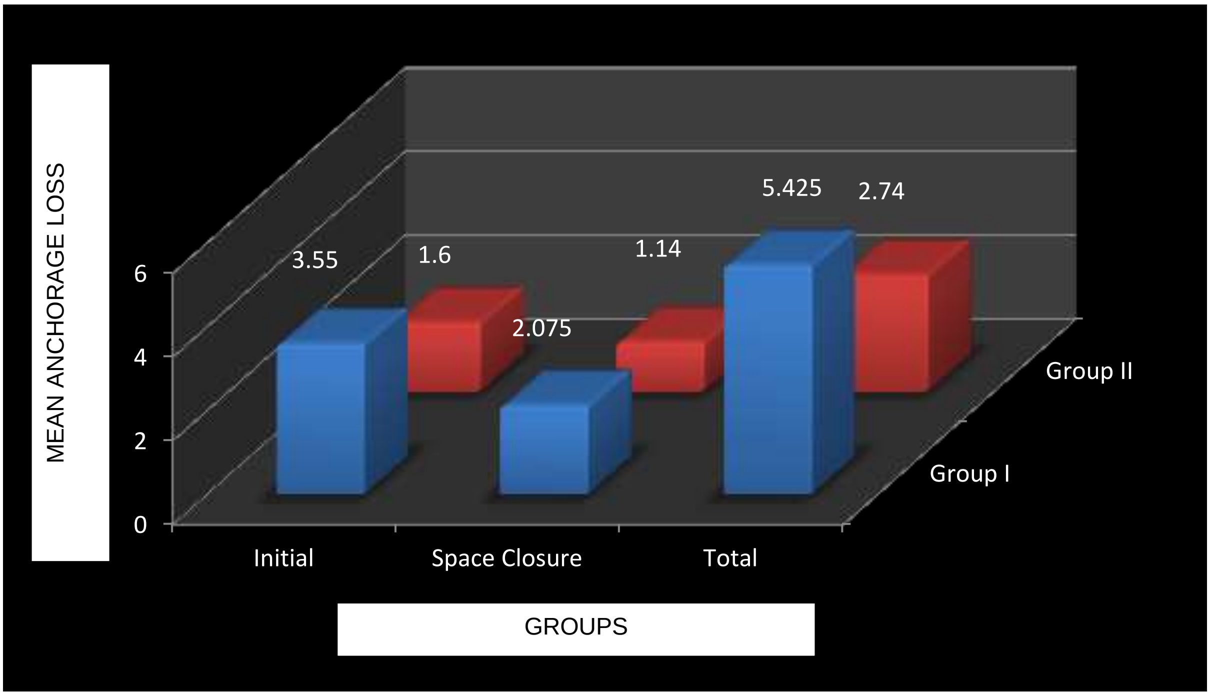
TABLE 1: Intergroup comparison of anchorage loss during initial leveling and alignment, space *closure* and finishing and detailing using Transpalatal arch and Nance palatal arch at Point A



GRAPH 1: Intergroup comparison of anchorage loss during initial leveling and alignment, space closure and finishing and detailing using Transpalatal arch (Group I) and Nance palatal arch (Group II) at Point A

	Groups	Mean	Std. Deviation	Std. Error Mean	'P' value	Significance
Initial	Group I	3.550	2.083	0.465	0.001	Significant
	Group II	1.600	1.071	0.239		
Space Closure	Group I	2.075	1.928	0.431	0.078	Non-Significant
	Group II	1.140	1.232	0.275		
Total	Group I	5.425	2.596	0.580	0.001	Significant
	Group II	2.740	1.739	0.388		

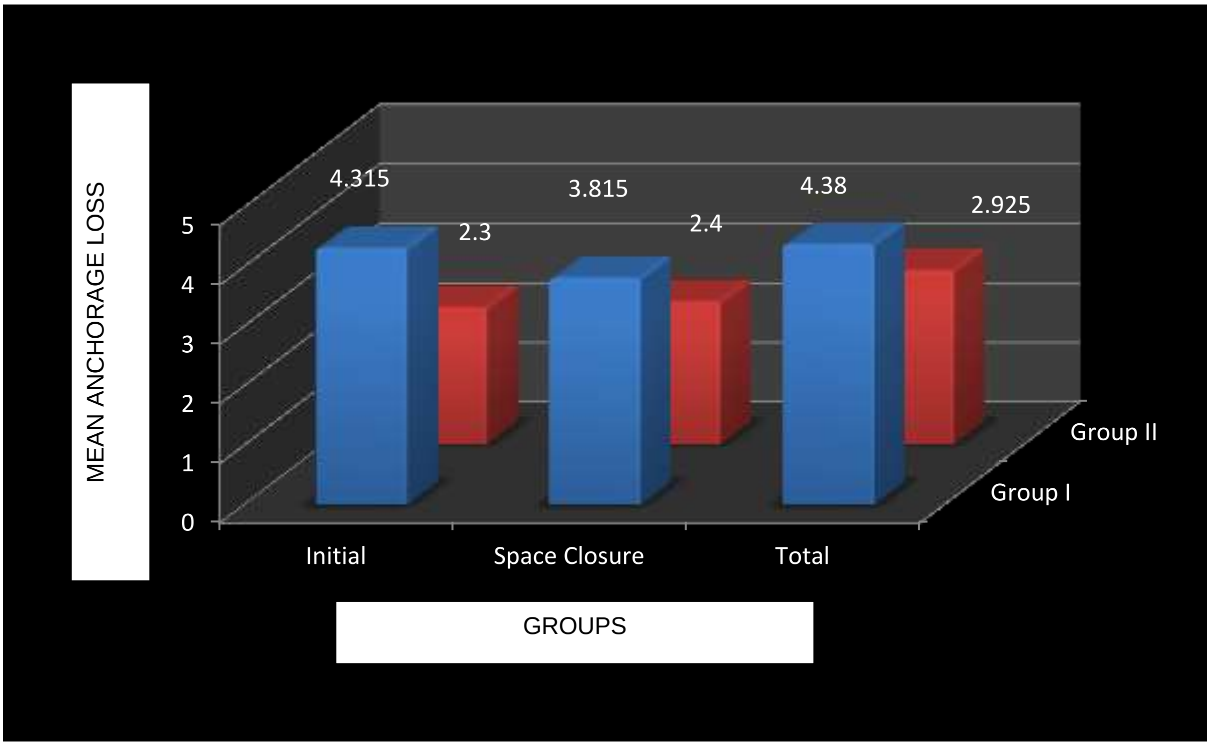
TABLE 2: Intergroup comparison of anchorage loss during initial leveling and alignment, space closure and finishing and detailing using Transpalatal arch and Nance palatal arch at Point B



GRAPH 2: Intergroup comparison of anchorage loss during initial leveling and alignement, space closure and finishing and detailing using Transpalatal arch (Group I) and Nancepalatal arch (Group II) at Point B

	Groups	Mean	Std. Deviation	Std. Error Mean	'P' value	Significance
Initial	Group I	4.315	2.607	0.583	0.001	Significant
	Group II	2.300	1.481	0.331		
Space Closure	Group I	3.815	2.523	0.564	0.056	Non-Significant
	Group II	2.400	1.832	0.409		
Total	Group I	4.380	4.341	0.970	0.018	Significant
	Group II	2.925	1.893	0.423		

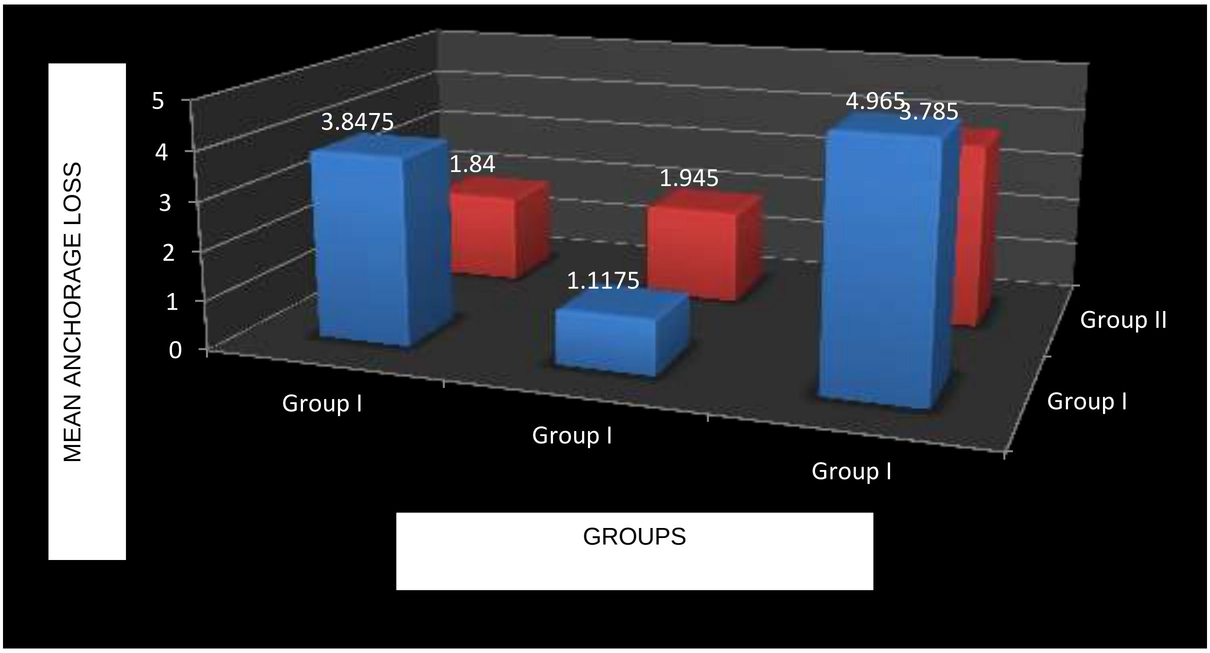
TABLE 3: Intergroup comparison of anchorage loss during initial leveling and alignment, space closure and finishing and detailing using Transpalatal arch and Nance palatal arch at α angle



GRAPH 3: Intergroup comparison of anchorage loss during initial leveling and alignment, space closure and finishing and detailing using Transpalatal arch (Group I) and Nance palatal arch (Group II) at α angle

	Groups	Mean	Std. Deviation	Std. Error Mean	'P' value	Significance
Initial	Group I	3.847	2.136	0.477	0.001	Significant
	Group II	1.840	0.824	0.184		
Space Closure	Group I	1.117	1.044	0.233	0.079	Non-Significant
	Group II	1.945	1.767	0.395		
Total	Group I	4.965	2.366	0.529	0.106	Non-Significant
	Group II	3.785	2.100	0.469		

TABLE 4: Intergroup comparison of anchorage loss during initial leveling and alignment, space closure and finishing and detailing using Transpalatal arch (Group I) and Nance palatal arch (Group II) in model analysis



GRAPH 4: Intergroup comparison of anchorage loss during Initial leveling and alignment, space closure and finishing and detailing using Transpalatal arch and Nance palatal arch for model analysis

<u>DISCUSSION</u>

DISCUSSION

The objective of orthodontic treatment is to achieve the six keys of occlusion outlined by Andrews. In extraction cases, the orthodontist should comprehend the interconnected relationship between anchorage balance, extraction pattern, and treatment mechanics, including canine retraction and space closure,[5] to attain these objectives. Previous comparative investigations have demonstrated the effectiveness of the Nance palatal arch and the Goshgarian appliance in averting mesial drift, distal tipping, and mesio-palatal rotation of the upper first permanent molars while providing patient comfort and ease of removal. Although the Goshgarian palatal arch produced slightly more disto-palatal rotation than the Nance arch, it was not considered to be clinically significant.[6] However, the literature has extensively reported high anchorage loss in terms of transpalatal arch. [7]

In the current research, the mean anchorage loss utilizing the Nance appliance was 2.96mm and 2.74mm at Point A and Point B, respectively. Several authors have corroborated the notion that the Nance appliance induces minimal anchorage loss. The Nance appliance's reduced anchorage loss compared to the transpalatal arch in this study can be attributed to the appliance's palatal acrylic button, which minimizes anchorage loss during fixed appliance therapy. This button aids in preventing the mesial rotation of the upper molars' roots as they move forward and positions the buccal roots in contact with cortical bone, which provides additional anchorage by resisting remodeling (i.e., cortical anchorage).[8,9]

The degree of anchorage loss demonstrated in the model analysis was nearly identical to that observed in the cephalograms. This finding is backed by a study that examined the similarity between mean horizontal molar movement or anchorage loss measured on study models relative to palatal rugae landmarks and those obtained from cephalometric superimpositions in cases with maximum anchorage. The study discovered no statistically significant variation in measuring anteroposterior anchorage loss using either lateral cephalograms or study casts.

The limitations of the present study are:

1. While the study revealed substantial distinctions in the clinical performance of the Nance palatal arch and TPA, it had a limitation in that it did not include a control group without a palatal arch. Comparing each palatal arch group to the control group would have provided a clearer understanding of the actual anchorage loss associated with each appliance.

2. The retrospective nature of the present study implies that it may have certain limitations due to its design. As the study relies on the analysis of data that was not initially intended to be used for research purposes, some data may be incomplete or unavailable. Furthermore, variances in treatment provided by various clinicians and instances of missed appointments may not be accurately determined, potentially leading to bias.

3.Digital analysis could have provided more accurate results.

CONCLUSION

Since the beginning of orthodontics, anchorage problems have been a major challenge in the clinical routine. There are many methods to obtain anchorage like Transpalatal arch, Nance palatal arch, Extraoral devices and Mini-implants. However, the most commonly used anchorage devices in routine practice are Transpalatal arch and Nancepalatal arch. The results revealed that Nance palatal arch provided clinically significant anchorage control than Transpalatal arch especially during initial leveling and alignment, space closure and finishing and detailing. Both the anchorage devices were effective in reinforcing anchorage. Also TPA-Nance could be a better alternative in terms of effectiveness and cost. Amongst both the evaluation tools, study model and cephalogram analysis showed similar results and therefore could suffice to measure anchorage loss individually. However, newer techniques like Temporary Anchorage Devices (TADs) provides absolute anchorage and has been widely incorporated into orthodontic treatment for expanding the boundary of tooth movement without patient compliance. TAD skeletal anchorage is especially useful for treating malocclusion with vertical problems such as open bite and over eruption of teeth due to loss of antagonists. The major drawback with TADs is that it is invasive and is not cost effective.

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