A comparative study to evaluate the effectiveness of lateral cephalogram and study cast to measure anteroposterior anchorage loss with preadjusted edgewise appliance

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Abstract

Objective: Measurement of anchorage loss is an essential part of assessing the progress of orthodontic treatment. It can be assessed on the lateral cephalogram or on study models. The purpose of the present study is to compare the mean horizontal molar movement or anchorage loss relative to the palatal rugae landmarks on study models with that of cephalometric superimpositions in maximum anchorage cases and to concur whether only one record (study casts or cephalogram) could suffice for the evaluation of anchorage loss.

Materials and Methods: A power analysis was performed to determine the sample size needed to detect a 1.0-mm difference in tooth movement with the effect size of 0.5 at a confidence level of 90%, to consider the dropouts thirty maximum anchorage patients requiring first premolar extraction as part of their treatment plan were selected by consecutive sampling. Mean horizontal movement of molars was calculated on lateral cephalogram and study cast records after alignment and leveling.

Statistical Analysis: Paired t-test was performed to compare the mean values of anchorage loss measured on lateral cephalogram and study model.

Results: The results showed that there was no statistically significant difference in measurement of anteroposterior anchorage loss with either lateral cephalogram or study cast (p – value 0.554). The mean horizontal molar movement measured on lateral cephalogram was 2.32 with SD of 1.77 and mean horizontal molar movement measured on study cast was 2.09 with SD of 1.22.

Conclusion: The present study shows that the measurement of anchorage loss on study models is equally reliable as that on the lateral cephalogram. Thus, study models presents as an alternative method to the measurement of anteroposterior anchorage loss.

Keywords: Lateral cephalogram, study cast, Anchorage loss, Preadjusted edgewise.

Introduction

Anchorage planning in orthodontics is the most vital part of treatment planning and considered before beginning the orthodontic therapy. The success of orthodontic treatment would be obstructed in case of any undesirable forward movement of anchor teeth resulting in the loss of extraction space.[1] In maximum anchorage cases adjunct appliances, such as mini-screws, Nance holding arch, transpalatal bar, involvement of second molar and extraoral traction, are often used to increase the molar anchorage.[2-5]

In such maximum anchorage cases, anchorage control is crucial and plays a pivotal role.[6-7] Measurement of anchorage loss at every stage of treatment can help the clinician to achieve the planned treatment objectives. Measurement of anchorage loss have been traditionally done on cephalometric superimposition which has been considered the only reliable method to determine the movement of teeth with respect to stable reference points.[8] However, the process of tracing, analysis and superimposition of cephalometric radiographs is time consuming, technique sensitive with requiring all the serial radiographs of the same magnification and requiring radiation exposure which prevents many clinicians from routinely using these records.[9]

Another method of calculating the anchorage loss is by comparing the serial study model cast taking the palatal rugae as a stable reference landmark for the measurement of linear values.[9,10]

However, there is no literature comparing the accuracy in the measurement of the anchorage loss measured on the study model cast with that measured with cephalometric superimposition. Thus, the present study aims to compare the mean horizontal molar movement relative to the palatal rugae landmark on the study model casts with that on Lateral Cephalogram in maximum anchorage cases after initial alignment and leveling.

Materials and Methods

A power analysis was performed to determine the sample size needed to detect a 1.0-mm difference in tooth movement with the effect size of 0.5 at a confidence level of 90%. At an alpha of .05, a beta of .10, and standard deviation of change as 0.8 in a population the sample size for the study was calculated as 27 subjects. To consider dropouts sample for the study consisted of 30 maximum anchorage patients (16 females and 14 males) from the age of 12 years or above reporting to the Department of Orthodontics for orthodontic treatment. Ethical approval was obtained from the institutional ethical committee.

The patients were recruited with consecutive sampling technique. The patients were selected according to the following criteria-

Inclusion Criteria:

1. Treatment plan requiring first premolar extraction.
2. Maximum anchorage case.
3. Complete eruption of first and second maxillary molar.
4. Age 12 years or above

Exclusion Criteria:

1. No history of orthodontic treatment
2. No history of orthognathic surgery
3. Craniofacial anomaly
4. Patient with missing teeth.
5. Patients with systemic diseases.

0.022” MBT was chosen as the prescription of choice. Maxillary second molars were banded and included to increase the posterior anchorage.[11] Consequently, the arches were aligned and leveled upto 0.019” x 0.025” Stainless Steel wire.

Alignment was considered to be complete and recorded when a 0.019" x 0.025" Stainless Steel wire was engaged for a period of 6 weeks without any active force. Post-alignment records (Lateral Cephalogram and Study cast) were taken at this stage. The approximate time taken to achieve this stage was approximately seven months.

Analysis of Records

Pretreatment and post alignment records were analysed and amount of Anteroposterior anchorage loss was measured on the lateral cephalogram and study models respectively.

Analysis of Study Cast

Fabrication of jig for measurement of horizontal molar movement on cast - [Fig. 1,2]

For every patient to calculate the amount of horizontal anchorage loss an acrylic palatal jig was fabricated on the pretreatment study model according to the method recommended by Lotzof.[12]

The anterior palatal vault (rugae area) was used as a stable reference point for the placement for the jig.[12] An acrylic jig was fabricated with reference wires (0.045 stainless steel) embedded that extended to the central fossa of first molars. The acrylic jig was constructed for every patient using the pre-treatment model.

The pre treatment model was used to fabricate the jig which was then fitted on the stable reference point i.e. palatal rugae on the final model on completion of alignment. The distance between the initial positions of the wire to the final position was measured at the molar region with the help of Vernier calipers to calculate the molar anchorage loss in each subject. [Fig. 3]

Fig. 1 : Acrylic jig on the pre treatment cast stabilized on the palatal rugae with the wires extending to the central fossa of first molars

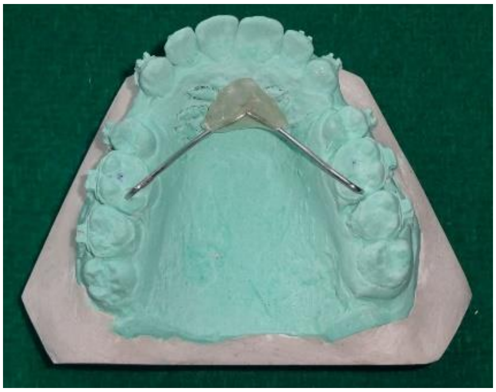

Fig. 2: Acrylic jig on the post treatment cast stabilized on the palatal rugae

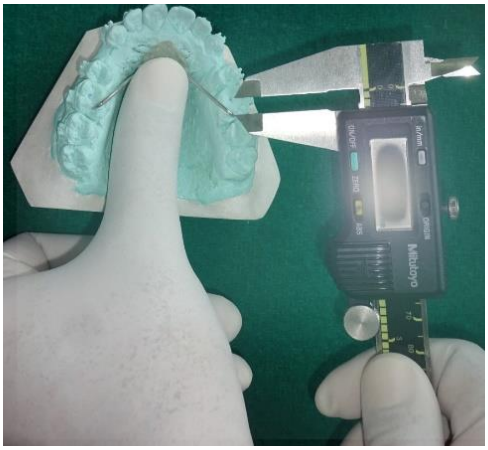

Fig. 3: Measurement of horizontal molar movement by measuring the distance between the initial and final position of the wire

Analysis of Lateral Cephalogram

The pretreatment and post-alignment digital lateral cephalogram with adjusted magnification were superimposed as per the study carried out by Lissa et al. Anterior and posterior images of the zygomatic process of the maxilla, palate, maxillary central incisor and maxillary first permanent molar were traced. The maxillary superimposition was performed “blind” with a maxillary tracing which had no teeth using the best fit method. The teeth were added to the tracing once the maxillae were superimposed. The two fiducial points from the pre-treatment tracing were then transferred to the post alignment tracing. [13]

The following landmarks were marked- [Fig. 4]

Anterior Fiduciary Point (AFP): Located approximately 5 mm anterior to anterior nasal spine.

Posterior Fiduciary Point (PFP): Located approximately 5 mm posterior-to-posterior nasal spine. PFP combined with AFP are representative of the palatal plane.

Mesial Molar Point (MMP): The most anterior point of the mesial outline of the maxillary first molar crown.

Horizontal maxillary first molar movements was recorded as maxillary first molar horizontal movement (U6 HOR) distance between PFP perpendicular (perpendicular dropped from PFP) and MMP.

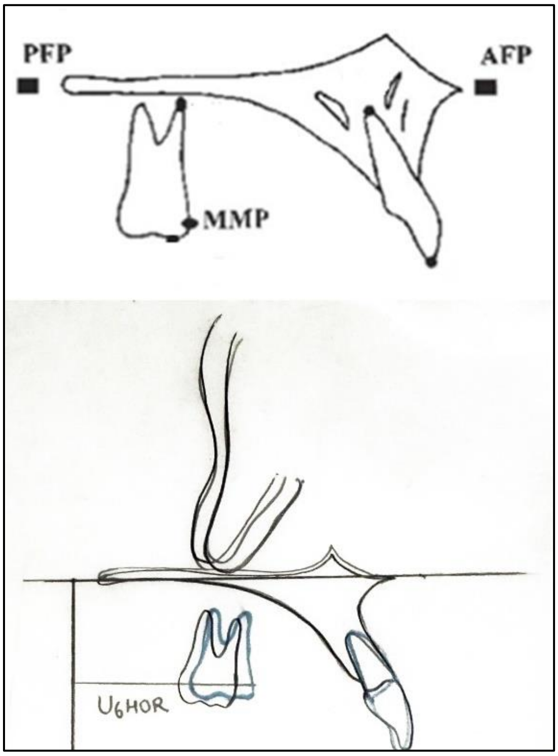

Fig. 4: Measurement of horizontal molar movement on cephalometric superimposition

The pretreatment and post alignment observations obtained from study model cast and lateral cephalogram were tabulated and subjected to statistical analysis.

Statistical Analysis

Statistical analysis was done with R – Programming software. The pretreatment and post alignment values of lateral cephalogram and study cast were evaluated using paired *t*-test. Mean and standard deviation were calculated. Significance was predetermined at 0.05 levels. The intraclass correlation coefficient was used for assessment of reliability of measurements. To overcome the bias interobserver reliability was measured by randomly selecting records of 10 samples and a second observer calculated anchorage loss.

Results

In the present study, we observed that the amount of anchorage loss i.e. horizontal movement of maxillary first molar measured on the lateral cephalogram was equivalent to the horizontal movement seen on the study model cast.

Table 1: The horizontal maxillary first molar movements using cephalometric superimpositions

	Mean	SD	SE
U6 HOR	2.32	1.77	0.323

According to Table 1 the mean horizontal maxillary first molar movement using cephalometric superimpositions was 2.32 with standard deviation of 1.77.

Table 2: The horizontal molar movements using study cast

	Mean	SD	SE
U6 HOR	2.097	1.227	0.224

According to Table 2 the mean horizontal maxillary first molar movement using study cast was 2.09 with standard deviation of 1.22.

Table 3: Paired t-test for comparison of lateral cephalogram and study cast

		Mean Difference	t	Df	p-value
Pair	LCU6 - DCU6	0.220	0.598	29	0.554

The comparison of mean horizontal movement of the maxillary first molars on the lateral cephalogram and study cast was done to measure the anchorage loss in anteroposterior plane. [Table 3]

No statistical differences was found between the upper first molar movement assessed on lateral cephalogram and on the dental cast (p - 0.554). It indicates measurement of mean molar movement in anteroposterior plane on study model cast is equally reliable as measured on the Lateral cephalogram.

Table 4: Intraclass correlation coefficient – study model

	Intraclass Correlation[a]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.850[b]	0.508	0.961	12.350	9	9	0.000
Average Measures	0.919[c]	0.674	0.980	12.350	9	9	0.000

Table 5: Intraclass correlation coefficient – lateral cephalogram

	Intraclass Correlation[a]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.947[b]	0.803	0.987	36.801	9	9	0.000
Average Measures	0.973[c]	0.891	0.993	36.801	9	9	0.000

The correlation coefficient for interobserver reliability was 91.9%for study models and 97.3% for lateral cephalogram with the difference been statistically non-significant. [Table 4, 5]

Discussion

The present observational study was carried out with the aim of comparing lateral cephalogram and study model cast as a reliable diagnostic aid to measure anteroposterior anchorage loss after alignment and leveling in maximum anchorage cases.

One of the most difficult aspect of any appliance and mechanics is anchorage control, thus anchorage planning is the foremost requirement of any orthodontic treatment plan. Inspite of different methods to control anchorage, loss of anchorage is a potential side effect that would halt the favourable outcome of orthodontic treatment.

Loss of anchorage is a multifactorial response in which crowding and mechanics are the primary factors.[14] Evaluation of anchorage loss is done in every stage of treatment. So, it is imperative to evaluate anchorage loss after initial alignment and leveling.[15] In the present study anchorage loss was measured after initial alignment and leveling in maximum anchorage cases.

In the past, cephalometric measurement was the only reliable method to measure tooth movement. Bjork has stated that the anterior portion of zygomatic process of maxilla is the area of greatest reliability for maxillary superimposition.[16] Similarly, Doppel et al found that anterior and posterior zygomatic process of maxilla match closely with that of implant superimposition.[8] Thus, horizontal movement of the maxillary first molar in the anteroposterior plane can be calculated after superimposing the maxillary bone.

But the disadvantages and limitation of this method includes radiation exposure, technique sensitive i.e. serial Lateral cephalogram of the same magnification, inability to evaluate tooth movement in transverse direction with the process of tracing and superimposition been time consuming.[9]

An alternative method for assessment of dental changes includes the dental study model casts. Dental casts which are collected as a part of routine progress records provide a three dimensional view. Lotzoff et al suggested that the measurement on dental study cast is easy and accurate and in the maxilla anterior palatal vault could be used as a stable reference point.[12] Various methods for measurement of tooth movement on study cast have been evaluated in orthodontic literature. Van der Linden used the Optocom to record 3-dimensional information about the dental casts.[17] Peavy and Kendrick and Lebret used the symmetrograph of Korkhaus to measure tooth movement on study models.[18-20] Brent R Hoggan and Cyril Sadowsky compared the lateral cephalometric superimposition and the scanned copy of dental cast taking the palatal rugae as the stable reference mark. It was concluded that the two methods are equally reliable.[9] Scanned images require adjustment for magnification and like radiograph it is also a 2-D representation of a 3-D object. So in this study acrylic jig was fabricated on the cast with the palatal rugae taken as a stable reference point.

The present study measured and compared the anchorage loss calculated on lateral cephalogram and study cast after initial alignment and leveling. Lateral cephalometric superimpositions were compared to the measurements made on study model cast with the help of an acrylic jig stabilized on palatal rugae according to the method suggested by Lotzoff et al. The jig was transferred from pretreatment maxillary cast to post alignment maxillary cast to measure the amount of anchorage loss in the maxillary first molars.[10]

The mean horizontal movement of maxillary first molar on lateral cephalogram was calculated to be 2.31mm with SD of 1.76mm and the mean movement of maxillary first molar on dental study cast was observed to be 2.09mm with SD of 1.22mm. Thus, there was no significant difference between lateral cephalogram and study model in the measure of anteroposterior movement of maxillary first molar.

With the amount of anchorage loss measured on the Lateral cephalogram and study model casts been similar, either of the method can be used to measure anteroposterior tooth movement looking at the advantages and disadvantages.

The study model casts serve as a suitable alternative to assess the amount of anchorage loss for maxillary first molars in the anteroposterior plane and lateral cephalogram can be avoided and preventing the patient from additional radiographic exposure.[21] Also, lateral cephalometry suffer from the inheritant limitation of superimposition of the bilateral structures. Thus, it becomes inevitable to take special measures to differentiate between the bilateral molar teeth.[22] Whereas, no such limitation is encountered in the measurement of anchorage loss on study model casts.

The study however suffered from a limitation that it assesses the anteroposterior anchorage loss in the maxillary arch only. In the mandibular arch, the same procedure would not be viable due to lack of stable reference point for the study model cast. Inspite of a dental cast providing a 3-dimentional structure, evaluation of anchorage loss in the vertical dimension is difficult and is also a major limitation of this method. However with the onset of recent 3-Dimensional superimposition technique this limitation can be vanquished.

Conclusion

The present study shows that the measurement of anchorage loss on study model and lateral cephalogram are equally reliable. Thus, study model cast provide an alternative method in measurement of anteroposterior anchorage loss of maxillary molars during treatment with the preadjusted edgewise appliance.

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