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A Cephalometric Appraisal of Dento-Facial Changes During and Following Treatment In Class I Bimaxillary Dento-Alveolar Protrusion Cases

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ABSTRACT

Aim: The aim was to evaluate the dentofacial changes during and following treatment in Class I bimaxillary dento-alveolar protrusion cases treated with four bicuspid extraction and Begg light wire appliance.

Materials and Methods: The data for the study was obtained from lateral cephalograms of ten female patients taken before treatment, at the end of active treatment and six months to one year in retention. Angular and linear measurements were subjected to statistical evaluation to find out whether the changes in the dentofacial complex were significant or not and to determine the stability of the results.

Results: Overbite corrected during treatment generally tended to partially relapse in the post-treatment period. Significant changes were obtained for overjet, U1-palatal plane, Point A, L1-mandibular plane and inter-incisal angle during treatment and they were relatively stable in the post-treatment retention period. The occlusal plane to SN and Y-axis angle increased during treatment. This tended to revert to the pre-treatment value during the post-treatment period. The U1-SN was significantly reduced during the treatment period, but the post-treatment period showed a slight proclination of the maxillary incisors. The incisor mandibular plane angle was significantly reduced during the treatment period. There was a slight increase in retroclination in the post-treatment period.

Conclusion: In the present study, judicious use of mechanics and orthodontic forces gave good clinical results. Some parameters like overbite, occlusal plane-SN, Y-axis, U1-SN and IMPA showed some changes in the retention period. This has to be kept in mind prior to debonding the patient. Further studies with a larger sample size to assess the dento-skeletal and soft tissue changes during the retention period would be useful so that the nature and extent of changes could be standardized for the Kerala population.

Keywords: Bimaxillary dento-alveolar protrusion, cephalometric appraisal, post-treatment relapse.

INTRODUCTION

Bimaxillary dento-alveolar proclination is the most prevalent malocclusion found in the Kerala population. It has a profound effect on the esthetic as well as psychological wellbeing of the affected individual. First premolar extraction followed by orthodontic retraction seems to be the most favourable orthodontic solution to this malocclusion. The study is aimed at evaluating the dentofacial changes during and following treatment in Angle's Class I bimaxillary dento-alveolar

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protrusion cases treated with four bicuspid extraction and Begg light wire appliance. Linear and angular measurements are made from lateral cephalograms of ten female patients to evaluate the changes in the dentofacial complex and to determine the stability of the results obtained.

The investigation has the following objectives:

1. The quantitative analysis of changes during and following orthodontic treatment of the following variables:

(a) Overjet
(b) Overbite
(c) Vertical changes in the maxillary incisors in relation to maxilla
(d) Vertical changes in the mandibular incisors in relation to mandible
(e) Cant of occlusal plane
(f) Mandibular plane angle
(g) Y-axis
(h) Incisor mandibular plane angle
(i) Inter-incisal angle
(j) Axial inclination of upper incisors
(k) Apical base discrepancy

2. To find out the changes in the maxilla and the mandible produced by Class II elastic force by analysing:

(a) Maxillary unit length
(b) Mandibular unit length, during and following treatment.

MATERIALS AND METHODS

The data for this study was obtained from lateral cephalometric radiographs of ten patients, taken before treatment, at the end of active treatment and six months to one year in retention, treated in the postgraduate clinic of the Department of Orthodontics, Dental College, Trivandrum. The group consisted of females in the age group of 14-20 years with a mean age of 16.6 years. This was done to form a homogeneous group to avoid the differences if any in response to treatment between male and female patients. The time taken for treatment was 16-23 months with a mean of 18.6 months. The malocclusion was classified as Angle's Class I bimaxillary dento-alveolar protrusion. All cases had full complement of teeth upto second molars.

In all the patients, the first premolars in both quadrants of the maxillary and mandibular arches were extracted. They were then treated with Begg light wire appliance. The treatment result at the time of removal of active appliance was judged to be satisfactory. All cases were given wrap-round retainers after the removal of fixed attachments.

Cephalometric radiographs were taken using Panex E.C. Cephalostat by J. Morita Corporation set at 90 KVP, 10 mA and 2 seconds exposure time. Each radiograph was manually traced by the same operator (Fig.1 A,B,C). All angular measurements were made to the nearest 0.5^0 and linear measurements to 0.5 mm. To identify any intra-examiner error, 10 radiographs were randomly picked up and retraced by the same investigator after an interval of two weeks. The intraclass correlation coefficient was used to evaluate the level of agreement and showed good agreement.

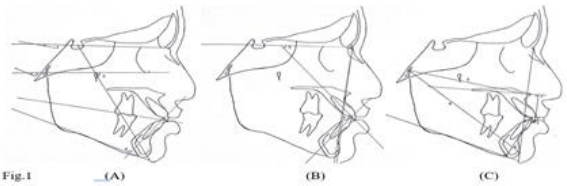

Fig 1(A)and (B): **Angular measurements**

1. *Occlusal plane-SN* **2.***FMA* **3.***Y-axis angle* **4.***IMPA* **5.***U1-SN* **6.***U1-L1* **7.***SNA* **8.***SNB* **9.***ANB*

Fig 1(C) : **Linear measurements**

1.*Overbite* **2.***Overjet* **3.***U1-Palatal plane* **4.***L1-Mandibular plane* **5.***Maxillary unit length* **6.***Mandibular unit length*

RESULTS

For each parameter, the range, mean and standard deviation were calculated. The differences between the means were calculated using the Student's paired t-test and correlation among various parameters was calculated by using Carl Pearson Correlation Coefficient. The level of significance was set at $P < 0.05$.

Table 1 describes the angular and linear cephalometric parameters

Table 2 describes the range, mean and standard deviation of four linear and nine angular parameters.

Table 3 describes the net changes of four linear and nine angular parameters from a)Pre-treatment to end of treatment and b)Post-treatment to end of treatment.

Table 4 shows the 't' value for the net changes for maxillary and mandibular unit length from a)Pre-treatment to End of treatment and b)Post-treatment to End of treatment.

Table 1: Cephalometric parameters used in the study.

Angular measurements

No	Parameters	Description
1	Occlusal Plane to SN	Angle between the SN plane and the occlusal plane
2	FMA	Angle between the Frankfort horizontal plane and mandibular plane
3	Y-axis angle	Antero-inferior angle where Y-axis intersects the Frankfort horizontal plane
4	IMPA	Angle between the long axis of L1 to Go-Gn plane
5	U1-SN	Angle between the long axis of U1 to S-N plane
6	U1-L1	Angle between the long axes of U1 and L1
7	SNA	Angle between the SN plane and NA line
8	SNB	Angle between the SN plane and NB line
9	ANB	The difference between the angles SNA and SNB

Linear measurements

No	Parameters	Description
1	Overbite	The vertical difference between the lines tangent to the upper and lower incisal edges
2	Overjet	The horizontal difference between the above lines
3	U1-Palatal plane	The length of the perpendicular drawn from the palatal plane to the maxillary incisal edge
4	L1-Mandibular plane	The length of the perpendicular drawn from the mandibular plane to the mandibular incisal edge

Table 2: Table showing the Mean, Standard Deviation and Range of the linear and angular measurements in the (a) Pre Treatment (b) End of Treatment and (c) Post Treatment Period (6 – 12 months in retention)

	Overbite (mm)	Overjet (mm)	U1 to palatal plane (mm)	L1 to mandibular plane (mm)	Occlusal plane to SN (Deg.)	FMA (Deg.)	Y-axis (Deg.)	IMPA (Deg.)	U1 To SN (Deg.)	U1 To L1 (Deg.)	SNA (Deg.)	SNB (Deg.)	ANB (Deg.)
Pre-treatment Range Mean S.D.	2-4 2.95 0.7976	3-8 4.85 1.3754	25-30 28.5 1.5811	41.5-49 44.75 2.5954	10-20 15.4 3.6803	28-40 33.5 3.5668	61-69 665.3 2.3118	94-107 100.7 4.5228	108-125 117.5 5.0827	100-117 107.2 6.0148	80-88 83.65 2.7290	75-83 79 2.4495	-0.5-8 4.65 2.4387
End of treatment Range Mean S.D.	0-2 1.45 0.8317	1.5-4 2.35 0.7091	25-37 30.25 3.3932	40-48 43.45 2.6506	10.5-22 17 3.0641	26-43 33.5 4.9721	61-71 66.1 3.2472	85-98.5 93.25 4.0363	96-123 103.15 7.5794	111-139 128.5 7.2763	79.5-85 82.15 1.8625	77-82 79.4 1.7764	1-4 2.75 0.9204

Post-treatment Range Mean S.D.	0.5-4 2.45 0.9265	2-5 2.95 0.8317	25-37 30.7 3.4897	39-48 43.45 3.0226	9-20.5 15.65 3.6366	28-45 34 5.5777	62-73 66.4 3.8930	79-102 92.1 6.6240	97-124 104.1 7.6223	106-139 128.6 9.1068	80-86 82.35 1.9444	77-82 79.5 1.6330	1.5-4 2.85 0.9443

Table 3: Table showing the Mean, Standard Deviation and Range of net changes of values from (a) Pre-treatment to End of treatment, and (b) Post treatment to End of treatment

Parameter	Pre-treatment - End of treatment			Post-treatment - End of treatment		
	Range	Mean	SD	Range	Mean	SD
Overbite (mm)	0 - 3.5	1.5	1.3944	0.5 - 2.5	1	0.8165
Overjet (mm)	0.5 - 4	2.5	1.0274	0 - 1.5	0.6	0.5164
U1 to palatal plane (mm)	-7 - 0.5	-1.75	2.3004	-2 - 2	0.45	1.2572
L1 to mandibular plane (mm)	-2 - 3	1.3	1.5846	-1.5 - 2	0	0.9129
Occlusal plane to SN (Deg.)	-8 - 3	-1.6	3.3317	-7 - 3	-1.35	2.5282
FMA (Deg.)	-5 - 6	0	3.3333	-5 - 6	0.5	3.2745
Y-axis (Deg.)	-3 - 5	-0.8	2.2509	-5 - 3	0.3	2.4967
IMPA (Deg.)	-1 - 16	7.45	5.8426	-6 - 4	-1.15	3.3669
U1 to SN (Deg.)	2 - 22	14.35	5.9724	0 - 3	0.95	1.0659
U1 to L1 (Deg.)	-33 - -4	-21.3	10.1877	-6 - 12	0.1	4.9318
SNA (Deg.)	-1 - 4	1.5	1.5275	-1 - 1	0.2	0.6749
SNB (Deg.)	-3 - 3	-0.4	1.5776	-1 - 1	0.1	0.6992
ANB (Deg.)	-1.5 - 4.5	1.9	1.7607	-0.5 - 1	0.1	0.3944

Table 4: Table showing 't' value for the net changes from (a) Pre-treatment to End of treatment and (b) Post-treatment to End of treatment

Parameter	Pre-treatment - End of treatment		Post-treatment - End of treatment	
	't' value	Test of Significance	't' value	Test of significance
Overbite	3.40	$p < 0.01$ Highly significant	3.87	$p < 0.01$ Highly significant
Overjet	7.69	$p < 0.001$ Very highly significant	3.67	$p < 0.01$ Highly significant
U1 to palatal plane	2.41	$p < 0.05$ Significant	1.13	$p > 0.05$ Not significant
L1 to mandibular plane	2.59	$p < 0.05$ Significant	0	Not significant
Occlusal plane to SN	1.52	$p > 0.05$ Not significant	1.69	$p > 0.05$ Not significant
FMA	0	Not significant	0.48	$p > 0.05$ Not significant
Y-axis	1.12	$p > 0.05$ Not significant	0.38	$p > 0.05$ Not significant
IMPA	4.03	$p < 0.01$	1.08	$p > 0.05$

		Highly significant		Not significant
U1 to SN	7.6	p < 0.001 Very highly significant	2.82	p < 0.05 Not significant
U1 to L1	6.61	p < 0.001 Very highly significant	0.06	p > 0.05 Not significant
SNA	3.1	p < 0.05 Significant	0.94	p > 0.05 Not significant
SNB	0.80	p > 0.05 Not significant	0.45	p > 0.05 Not significant
ANB	3.41	p < 0.01 Highly significant	0.80	p > 0.05 Not significant

Table 5: Table showing the range, mean and standard deviation of maxillary and mandibular unit length in the a)Pre-treatment b)End of treatment and c)Post-treatment period

Time Period	Maxillary Unit Length			Mandibular Unit Length		
	Range	Mean	SD	Range	Mean	SD
Pre-treatment	88-115	98.55	6.7018	113-128	118.7	5.6638
End of treatment	92-115	98.9	6.2084	115-131	120.6	5.3166
Post-treatment	96-115	98.75	6.1610	115-131	120.9	5.1951

Table 6: Table showing Pearson's Correlation Co-efficient, Standard Error and 't' value for the parameters: Overbite to U1-Palatal plane, Overbite to L1-Mandibular plane and Overbite to U1-L1.

Time Period	Overbite to U1-Palatal plane			Overbite to L1-Mandibular plane			Overbite to U1-L1		
	r	SE	't' value	r	SE	't' value	r	SE	't' value
Pre treatment - End of treatment	0.59	0.29	2.03+	0.63	0.27	2.33*	-0.26	0.34	0.765+
Post treatment - End of treatment	0.19	0.347	0.54+	-0.037	0.35	0.106+	0.5	0.31	1.61+

**p<0.05 significant +p>0.05 not significant*

Table 5 describes the range, mean and standard deviation of maxillary and mandibular unit length in the Pre-treatment, End of treatment and Post-treatment period.

Table 6 shows the Correlation Co-efficient between Overbite and U1-Palatal plane, Overbite and L1-Mandibular plane and Overbite and U1-L1.

Figures 2,3,4,5,6 and 7 are bar graphs representative of changes in the pre-treatment, end of treatment and post-treatment period of the variables-overbite, overjet, U1-SN, IMPA, U1-Palatal plane and L1-Mandibular plane.

DISCUSSION

Bimaxillary dento-alveolar protrusion is the most prevalent malocclusion seen in the Kerala population due to its racial pattern; thereby resulting in significant aesthetic problems to the patients due to the circumoral convexity and protrusion of lips. Management of this malocclusion usually involves extraction of four first premolars and orthodontic retraction. The fixed appliances used belong to two main techniques i.e. the Begg and the Preadjusted Edgewise Appliance (PEA) technique. Treatment with the Begg technique is more economical but requires more clinical skill and chairside time. However, overall treatment time is usually reduced in comparison with the PEA

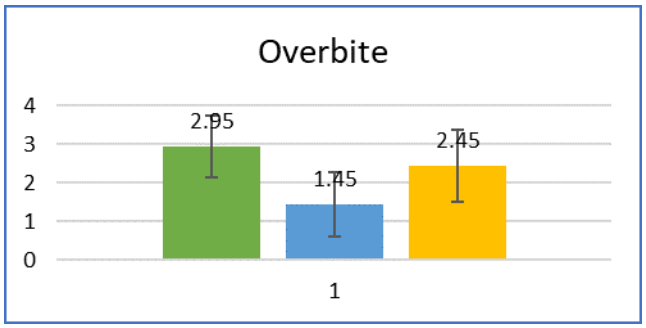

Fig 2: Changes in overbite.

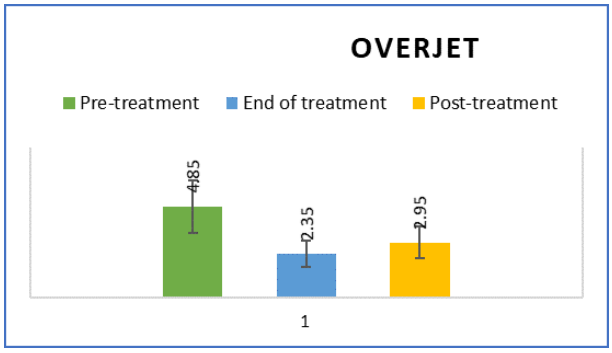

Fig 3: Changes in overjet.

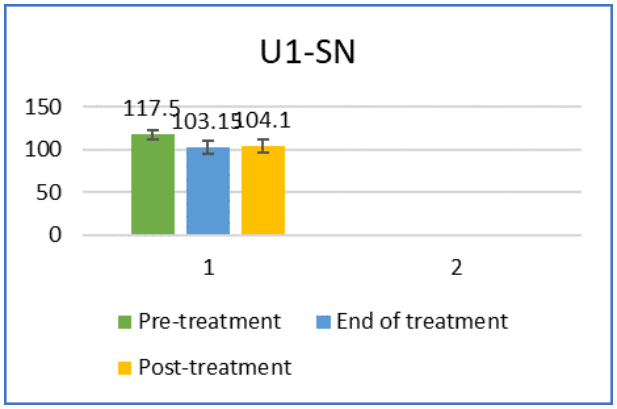

Fig 4: Changes in U1-SN.

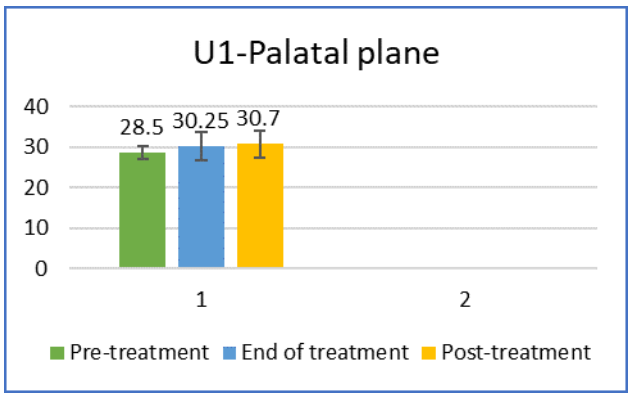

Fig 5: Changes in U1-Palatal plane.

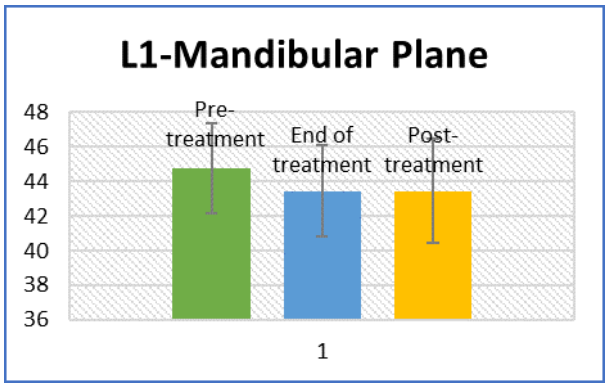

Fig 6: Changes in L1-Mandibular plane.

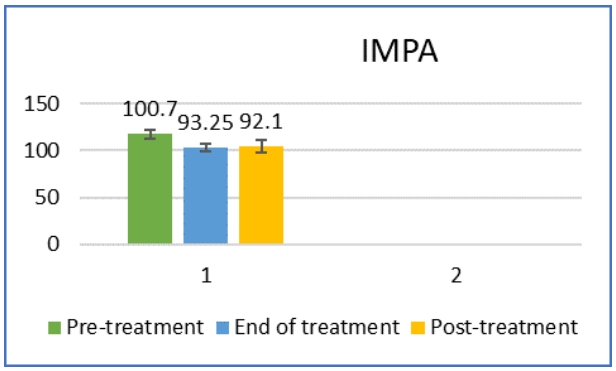

Fig 7: Changes in IMPA.

technique in the management of bimaxillary dentoalveolar protrusion. The results by Sundareswaran[1] and Sharma[2] suggest that the Pre-adjusted Edgewise Appliance used in the treatment of individuals with bimaxillary protrusion produce a significant effect on the hard and soft tissues.

The investigation was done on ten female patients who had undergone treatment for the correction of Class I bimaxillary dento-alveolar protrusion with extraction of four first premolars using Begg light wire appliance. It was a retrospective study and we were able to control and standardize many of the parameters during sample selection. Cephalometric evaluation of pre, end of treatment and 6-month posttreatment cephalometric radiographs obtained from the Records Section of the Department were done. Angular and linear cephalometric measurements are given in Table 1. Cephalometry according to Williams[3] has been relied upon as a necessary criteria to validate a study of changes in facial structures. Experimental findings of Reitan[4] indicate that relapse of orthodontic tooth movement is rapid immediately after removal of the appliance in

tipping, bodily movement and rotation correction. Levin[5] further states that, in no instance was a significant correlation found between post-treatment changes and the duration of post-treatment interval. This further validates the present study.

Overbite:

Overbite corrected during treatment tended to partially relapse during the post-treatment period. Changes in the overbite during the post-treatment period had a positive correlation with the interincisal angle. The present study was not in agreement with the findings of Begg and Kesling[6] and Williams[3] who found that overbite correction was stable after treatment.

A positive correlation of 0.59 was obtained between U1 to palatial plane and overbite change up to end of treatment. Although this was not significant at 5% level, there is a positive correlation of more than 0.5. A positive correlation existed between changes in overbite and L1 to mandibular plane of 0.63 significant at 5% level. U1 to L1 and overbite changes show positive correlation in the post-treatment period. This is in agreement with the findings of Schudy, Sims and Williams.[7-10]

Overjet:

Considerable reduction in overjet occurred during treatment and the results were relatively stable during the post-treatment period. The average reduction achieved at the end of treatment was 2.5 mm and the average increase in the post-treatment period is 0.6 mm.

Maxillary incisors:

There was an increase in U1 to palatal plane during treatment but not much change during the post-treatment period. The increase in the present study may be due to "arc movements" produced by severely proclined incisors during their correction by tipping.

Mandibular incisors:-

LI to mandibular plane decreased during treatment showing a significant intrusion of the lower incisors at 5% level and the results were stable in the post-treatment period. This is in agreement with Begg and Kesling, Williams, Sims, Thompson, Swain and Ackerman and Levin.

Apical base:-

The SNA angle was found to be significantly reduced during the treatment period. The SNB angle was increased slightly although no significant changes were seen at the 5% level. The ANB angle decreased significantly at 1% level. It can be seen that the ANB angle was corrected mainly by the backward movement of point A. This is in agreement with the findings of Haw, Ricketts, Payne and Predemore.[11]

Mandibular plane angle:-

In the present study, the average value of FMA does not show any significant change during or after treatment. This finding is in disagreement to that of Ricketts, Williams, Haw, Baldrige, Cadman and Philips[7-10,12] whose findings indicate an increase during treatment which reverts to the pre-treatment value during retention. This may again be due to changes in growth pattern in the cases under study.

The Y-axis and occlusal plane to SN angle shows an increase in the average values following treatment which shows a tendency to revert back to pre-treatment values. This tendency is similar to the findings by Williams, Turchetta, Barton, Allen, Levin, Baldrige, Haw and Philips.[5,7-10]

Maxillary incisor inclination:-

In the present study, the pre-treatment average of U1 to SN was 117.5^0. The average at the end of treatment was 103.95^0. This gives a significant reduction in the maxillary incisor inclination at 0.1% level. The post-treatment changes have a mean value of 104.1^0 which is significant at 5% level. This is in agreement with Williams[3] study which found a slight proclination of maxillary incisors in the post-treatment period. Sharma[13] in his study in 2010 on retraction with the pre-adjusted edgewise appliance 0.022" Roth prescription found that Point A was retracted with a mean of 2.7 mm ($P < .001$).

Incisor mandibular plane angle:-

In the present study, IMPA is consistently reduced in all the cases. It is noteworthy that pre-treatment values ranged from 94^0 to 107^0 with a mean of 100.7^0. The reduction in IMPA at the end of treatment ranged from -1^0 to 16^0 with a mean of 7.45^0. Furthermore, a slight increase in retroclination was noted in the post-treatment period. In the study by Sharma[13], mean point B was retracted 2.1 mm ($P < .001$).

Inter-incisal angle:-

The inter-incisal angle is an important parameter in bimaxillary dento-alveolar protrusion. The inter-incisal angle changed significantly at the end of treatment in the present study at 0.1% level. No significant change was observed in the post-treatment period. This in agreement with the findings by Levin[5] and Sharma[13] where the mean interincisal angle increased from 105.9^0 to 132.8^0. Sundareswaran and Vijayan[1] in 2017 using Pre-adjusted Edgewise Appliance 0.022" MBT prescription reported significant improvement in maxillary and mandibular incisor inclinations whereby the interincisal angle changed from 98.94° to 123.05° reflecting the effectiveness of this treatment modality in Bimaxillary protrusion patients.

Maxillary and Mandibular unit length:-

Maxillary unit length shows no significant changes at the end of treatment while the mandibular unit length shows significant changes at the end of treatment. This finding appears to show that there is a restrictive effect of Class II elastics on the maxilla and a forward placement of the mandible.

CONCLUSIONS

The results of the investigation gave the following conclusions: -

1. Overbite corrected during treatment generally tended to partially relapse in the post-treatment period. Changes in overbite during treatment were significantly correlated to the changes in L1 to mandibular plane. A positive correlation was also found between U1 to palatal plane and overbite changes during treatment. Changes in the overbite during the post-treatment period had a positive correlation with the interincisal angle.
2. Considerable reduction in overjet occurred during treatment. Though there were changes in the post-treatment period, the results were relatively stable.
3. There was an increase in U1 to palatal plane during treatment but not much change was seen in the post-treatment period for this parameter.
4. L1 to mandibular plane decreased during treatment showing an intrusion of the lower incisors. This change was stable in the post-treatment period.
5. There was no significant change in the average value of FMA during and following treatment.
6. The occlusal plane to SN and Y-axis angle increased during treatment. This tended to revert to the pre-treatment value during the post-treatment period, although the changes observed were not statistically significant at 5% level.
7. The maxillary incisor inclination was significantly reduced during the treatment period. But observations in the post-treatment period showed a slight proclination of the maxillary incisors.
8. The incisor mandibular plane angle was significantly reduced during the treatment period. There was a slight increase in retroclination in the post-treatment period.
9. The inter incisal angle increased considerably during the treatment period. There was no significant change in the post-treatment period.
10. The apical base discrepancy was mainly corrected by the posterior movement of point A. Point B was relatively stable in its horizontal orientation. There was considerable correction during the treatment period, and this was relatively stable in the post-treatment period.
11. Class II elastic force appeared to restrict the maxillary growth, while at the same time, there

appeared to be a forward placement of the mandible.

The present study using cephalometric radiographs was mainly confined to some morphologic changes in the dentition and jaws. It is recognized that facial growth and such factors as neuromuscular function, the freeway space, the inherent properties of the periodontium and mucoperiosteum and the state of occlusion must be considered in the assessment of treatment and post-treatment changes. Even when the same technique is used, variations in treatment results may occur due to different biological responses. Therefore, variations may be seen when comparing the present findings with those findings reported in the literature.

In the present study, judicious use of mechanics and orthodontic forces gave good clinical results. Some parameters like overbite, occlusal plane-SN, Y-axis, U1-SN and IMPA showed some changes in the post-treatment retention period. This has to be kept in mind prior to debonding the patient. Further studies using the pre-adjusted edgewise appliance and with a larger sample size to assess the dento-skeletal and soft tissue changes during the retention period would be useful so that the nature and extent of changes could be standardized for the Kerala population.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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