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RESEARCH ARTICLE

A CEPHALOMETRIC STUDY ON EFFECTIVENESS OF ORTHODONTIC TREATMENT OF BIMAXILLARY PROTRUSION WITH PREMOLAR EXTRACTION - A RETROSPECTIVE STUDY

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ABSTRACT

Objectives: This study was designed to evaluate for an appropriate treatment plan (extraction or non-extraction) for reducing the dental and soft tissue procumbency of bimaxillary protrusion individuals and also to compare the pre and post-treatment values of the two groups to provide an evidence based approach of premolar extraction in treating bimaxillary protrusion individuals.

Method: The sample consisted of 30 bimaxillary protrusion patients treated with four premolar extraction and 30 treated with non-extraction line of treatment between the ages of 15-30 years taken from the archives of Department of Orthodontics and Dentofacial Orthopaedics, M.S.Ramaiah Dental College & Hospital, Bangalore. Pre and post-treatment lateral cephalograms were evaluated using a series of 27 linear and angular measurements, and the effect of orthodontic correction was determined using different statistical tests.

Results: Pre-treatment (T1) characteristics of bimaxillary protrusion individuals demonstrated increased procumbency due to decreased interincisal angle, increased (upper incisor to SN angle, lower incisor to mandibular plane, upper incisor to NA linear and angle, lower incisor to NB linear and angle, upper incisor to APog and lower incisor to APog) in extraction as well as non-extraction groups but the variation was more in extraction group than non-extraction group. Soft tissue parameters like upper lip to E-line, lower lip to E-line and nasolabial angle showed significant statistics post-treatment with extraction and insignificant statistics with non-extraction. Pretreatment mean values of all four measurements of alveolar width were less in bimaxillary protrusive sample while upper and lower alveolar heights were found to be greater in both groups.

Conclusion: The comparison of skeletal, dental and soft tissue post-treatment (T2) values between extraction and non- extraction group demonstrated that premolar extraction is more effective in reducing the dental and soft tissue procumbency in bimaxillary protrusion patients as compared to non-extraction mode of treatment. Hence it was concluded that only borderline bimaxillary protrusion cases can be treated with non-extraction line of treatment.

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INTRODUCTION

Bialveolar dental protrusion is characterized by protrusive and proclined upper and lower incisors and an increased protrusion of the lips and convexity of the face. Dentists often refer to this condition as just "bimaxillary protrusion," a simpler term but a misnomer, since it is not the jaws but the teeth that protrude (Emad Hussein, 2007). The etiology of bimaxillary protrusion is multifactorial and consists of a genetic component as well as environmental factors, such as mouth breathing, tongue habits, lip habits, and tongue volume (Lamberton, 1980).

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Because the teeth have a normal molar relationship and a relatively normal overbite and overjet, some clinicians in the past considered these cases to be in perfect harmony and balance with their physiognomy (RosaliaLeonardi, 2010). This malocclusion is seen in many ethnic groups around the world but most commonly among African-American (Farrow, 1993 and Scott, 1999) and Asian populations (Lamberton, 1980 and Tan, 1996). The goals of orthodontic treatment of bialveolar protrusion include the retraction and retroclination of maxillary and mandibular incisors with a resultant decrease in soft tissue procumbency and convexity (Chae, 2012). This is most commonly achieved by the extraction of four first premolars followed by the retraction of anterior teeth using maximum anchorage mechanics (Bills *et al*., 2005). Thus for treatment of bialveolar protrusion, anchorage preservation during space

closure is important for maximum retraction of the anterior teeth after premolar extractions (Sung *et al*., 2010). It is rather well accepted by clinicians that the extraction of four first premolars can be effective in the treatment of bimaxillary protrusion. Unfortunately the debate between extraction and non- extraction is still ongoing and some clinicians still suggest without providing much evidence that four first premolar extractions will compromise post-treatment esthetics by "dishing in the profile" whearas others have unfounded belief that a non- extraction approach places the teeth in an unstable position (Hershey *et al*., 1972). Because of the fact that the practice of dentistry and orthodontics is now increasingly defined by an evidence based approach to treatment, it is surprisingly that there is relatively little in the literature providing concrete evidence on the efficacy of this treatment approach. With this in mind, this study was designed to provide evidence of the changes that occur orthodontically by the extraction of first premolars in a large sample of patients with bimaxillary protrusion and comparing with a sample treated with non-extraction protocol. In contrast to the earlier studies where only few parameters were taken into account in this study we have done a comparison of skeletal, dental, soft tissue and handelman's parameters all together pre and post treatment in extraction and non-extraction treatment approaches for bimaxillary protrusion individuals. Also comparison was done between extraction and non-extraction approaches of treatment through which we can have enough information as to find out which treatment plan (extraction or non- extraction) can be adopted in treating a particular bimaxillary protrusion case.

MATERIALS AND METHODS

30 Standardized pre and post-treatment lateral cephalograms of healthy subjects having class- I bimaxillary protrusion treated with all four premolar extraction & 30 standardized pre and post-treatment lateral cephalograms having class –I bimaxillary protrusion treated non extraction were taken from the archives of Department of Orthodontics, M.S.Ramaiah Dental College and Hospital, Bangalore. The subjects were selected based on the following criteria:

Inclusion criteria

- A minimum age of 18 years for male and 15 years for female at the start of treatment.
- 30 subjects who had undergone fixed orthodontic treatment with extraction of four first premolars and subsequent retraction of anterior teeth.
- 30 subjects who had undergone fixed orthodontic treatment by non-extraction mechanotherapy.
- Pretreatment Class I molar relationship.
- Pretreatment interincisal angle less than 124^{o}.

Exclusion Criteria

- Patients with congenitally malformed or missing teeth.
- Patient with any skeletal and dentofacial deformities.
- Patient who have undergone any prior orthodontic treatment.
- Patients with grossly destructed teeth.
- Patients with periodontally compromised teeth.3

Pre and post-treatment cephalometric radiographs were then traced manually on acetate sheets over an illuminated opal light box using 0.5 mm microtip lead pencil. Analysis of both the pre-treatment and post-treatment radiographs was done for 27 linear and angular measurements. The mean, range and standard deviation was determined for each of the pre-treatment measurement. The treatment results were analyzed in the following parameters by measuring the changes between the pretreatment (T1) and post-treatment (T2) cephalograms:

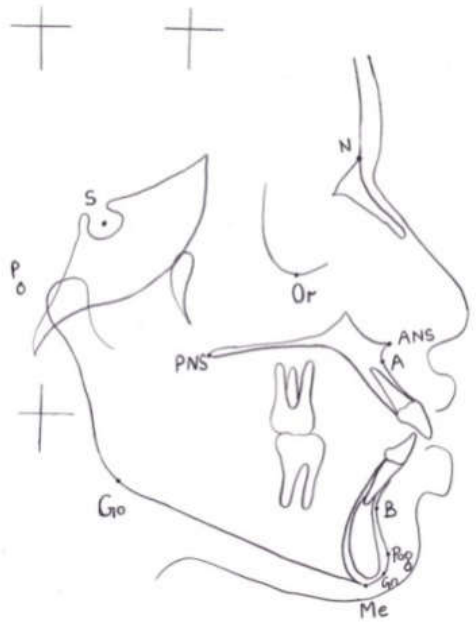


Fig. 1. Cephalometric landmarks

(S-sella, N-nasion, Point A-subspinale, Point B-supramentale, Or- orbitale, Po- porion, Go-gonion, Pog-pogonion, Gn-gnathion, Me-menton, ANS-anterior nasal spine, PNS-posterior nasal spine)

Planes used in the study are

- **SellaNasion plane (SN):** This plane is represented by a line passing through the Sella point to Nasion point.
- **Occlusal Plane:** The occlusal plane is drawn through the region of overlapping cusps of the first premolars and first molars.
- **Mandibular plane:** The mandibular plane is drawn between the gonion and the gnathion.
- **Frankfurt plane:** The Frankfurt plane is drawn between porion and orbitale
- **E- plane:** The line drawn between the most prominent point on the nose and the chin.

Statistical Analysis

Data was entered in Microsoft excel and analysed using SPSS (Statistical Package for Social Science, Ver.10.5) package and Microsoft word and Excel have been used to generate graphs, tables etc. The following methods of statistical analysis have been used in this study.

Table 1. Cephalometric measurements of hard tissue (skeletal & dental) and soft tissue parameters

S.No.	Parameter	Description
1	SNA	Angle between Sella-nasion and Nasion to point A
2	SNB	Angle between Sella-nasion and Nasion to point B
3	N Perpendicular To Point A	The distance between Nasion perpendicular line and point A measured perpendicular to the Nasion perpendicular line
4	Witts Appraisal	Formed by drawing perpendicular lines on a lateral cephalometric head film tracing from points A and B on the maxilla and mandible, respectively
5	Lower Anterior Facial Height	Distance (mm) between ANS and Menton
6	Mandibular plane angle	Angle between mandibular plane & Frankfurt Horizontal
7	Interincisal angle	Angle between U1 axis and L1 axis
8	Inclination of upper incisors (U1-SN)	Angle between U1 axis and SN plane
9	Inclination of lower incisors (L1-MP)	Angle between L1 axis and mandibular planed
10	Lower incisor to occlusal plane (L1-OP)	Angle between L1 axis and occlusal plane
11	Upper incisor to NA (angle)	Angle between U1 axis and NA Line
12	Upper incisor to NA (linear)	Linear distance between incisal edge of U1 and NA
13	Lower incisor to NB (angle)	Angle between L1 axis and NB Line
14	Lower incisor to NB (linear)	Linear distance between incisal edge of L1 and NB
15	Position of upper incisors (UL-Apog)	angle between U1 axis and A-pog line
16	Position of lower incisors (LL-Apog)	angle between L1 axis and A-pog line
17	Upper lip position (UL-E)	Distance (mm) from most anterior point on upper lip to E-plane
18	Lower lip position (LL-E)	Distance (mm) from most anterior point on lower lip to E- plane
19	Nasolabial angle	Angle between a line tangent to base of nose and a line tangent to the upper lip
20	Lower lip thickness	Perpendicular distance (mm) from most anterior point on lower lip to a line drawn through soft tissue B point perpendicular to frankfurt horizontal
21	Upper lip thickness	Perpendicular distance (mm) from most anterior point on upper lip to a line drawn through soft tissue a point perpendicular to frankfurt horizontal

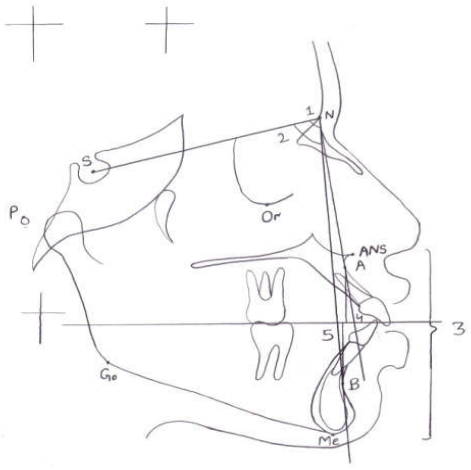


Fig. 2.Tracing of skeletal parameters

1.SNA 2. SNB 3. Lower facial height
4 & 5 witts appraisal (AO, BO respectively)

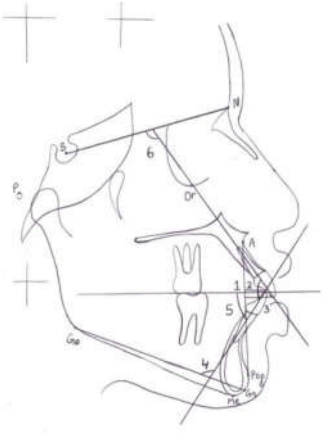


Fig. 3.Tracing of dental parameters

1. Interincisal angle 2. Lower incisor to A-Pog (mm) 3.Upper incisor to A-Pog (mm) 4.Lower incisor to mandibular plane angle
5.Lower incisor to occlusal plane angle 6. Upper incisor to SN angle

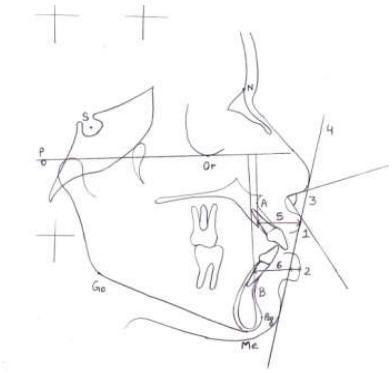


Fig. 4. Tracing of soft tissue parameters

1.Upper lip to E-line (mm) 2. Lower lip to E-line (mm) 3. Nasolabial angle 4. E-plane 5. Upper lip thickness (mm) 6. Lower lip thickness (mm)

Table 2. Cephalometric measurements of alveolar width, from Handelman

S.No.	Measurement	Description
1	UP	Bone posterior (lingual) to upper incisor apex. Apex of the maxillary central incisors to the limit of the palatal cortex, along a plane parallel to the palatal plane, drawn through the apex.
2	UA	Bone anterior (labial) to upper incisor apex. Apex of the maxillary central incisors to the limit of the labial cortex, along a plane parallel to the palatal plane, drawn through the apex.
3	LP	Bone posterior (lingual) to mandibular incisor apex. Apex of the mandibular central incisor to the limit of the lingual cortex, along a plane parallel to the occlusal plane, drawn through the apex.
4	LA	Bone anterior (labial) to mandibular incisor apex. Apex of the mandibular central incisors to the limit of the labial cortex, along a plane parallel to the occulsal plane, drawn through the apex.
5	UAH	Bone superior to upper incisor apex. The shortest distance from the maxillary incisor apex to the palatal plane.
6	LAH	Bone inferior to mandibular incisor apex. The shortest distance from the apex of the mandibular incisor to the lowest point on the mandibular symphysis that is transected by a line parallel to the occlusal plane.

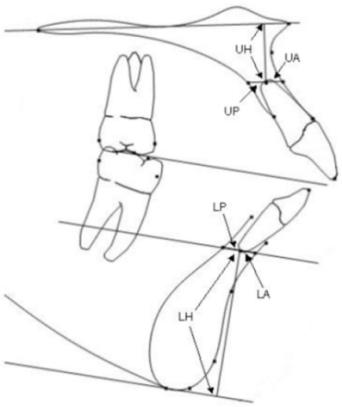
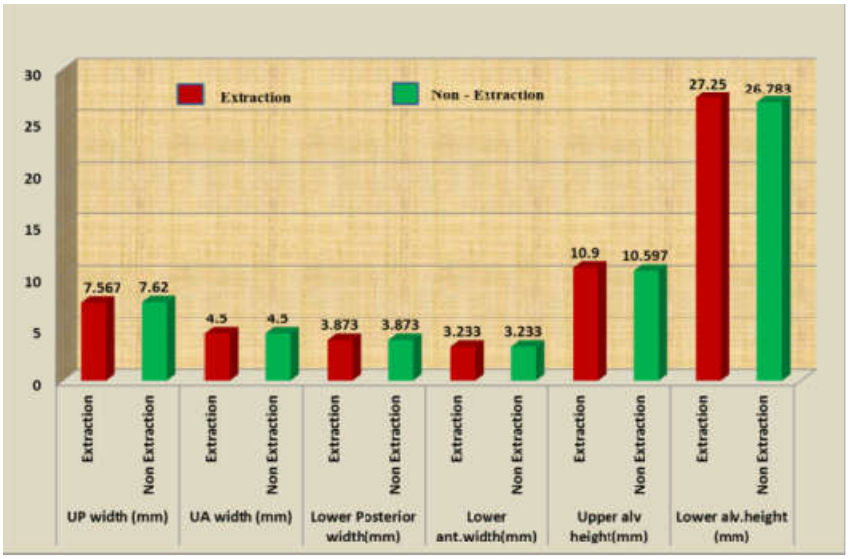


Fig. 5. Handelman's parameters



Graph 1. Comparison of Pre-treatment (T1) mean values of HANDELMAN'S parameters in Extraction Vs Non-Extraction group in Bimaxillary Protrusion individuals

Table 3. Pre-treatment (T1) cephalometric mean values of Hard tissue, Soft tissue & Handelman's parameters in Extraction vs Non-Extraction group in Bimaxillary Protrusion individuals

Measurement	Groups	N	Mean	SD	MIN	MAX	NORM MEAN
LAFH (mm)	Extraction	30	74.000	3.677	70	80	70
	Non- Extraction	30	74.000	3.677	70	80	
MPA (angle)	Extraction	30	29.500	7.154	9.0	36.4	23.4
	Non- Extraction	30	27.000	2.656	21.0	33.0	
SNA(angle)	Extraction	30	83.383	1.705	80.0	86.0	82
	Non- Extraction	30	82.900	3.546	76.0	88.0	
SNB(angle)	Extraction	30	81.283	1.363	78.0	83.0	80
	Non- Extraction	30	81.300	2.744	75.0	85.0	
N Perpend to point A (mm)	Extraction	30	4.167	1.315	2.0	6.0	-2 to +2
	Non- Extraction	30	3.133	1.252	1.0	5.0	
Witts Appraisal (mm)	Extraction	30	-0.100	2.339	-3.0	2.0	-1 to 1.5
	Non- Extraction	30	-0.100	2.339	-3.0	2.0	
U/L(angle)	Extraction	30	105.93	6.95	97	124	130
	Non- Extraction	30	110.367	6.646	99	120	
U1/SN (angle)	Extraction	30	116.23	6.11	110	133	103
	Non- Extraction	30	112.667	4.915	103	120	
L1/MP(angle)	Extraction	30	104.633	7.770	92	118	90
	Non- Extraction	30	100.833	4.706	92	109	
L1/OCC (angle)	Extraction	30	33.300	3.175	28.0	40.0	14.4
	Non- Extraction	30	27.867	3.794	20.0	34.0	
U1/NA (angle)	Extraction	30	34.067	4.899	26	45	22
	Non- Extraction	30	32.667	4.751	25	40	
U1/NA (mm)	Extraction	30	11.317	3.239	7.0	17.0	4
	Non- Extraction	30	10.733	2.800	7.0	15.0	
L1/NB (angle)	Extraction	30	36.467	4.049	28.0	43.0	25
	Non- Extraction	30	30.100	3.863	24.0	38.0	
L1/NB (mm)	Extraction	30	11.500	2.835	5.0	18.0	4
	Non- Extraction	30	10.617	2.658	7.0	15.0	
	Extraction	30	13.333	3.155	8	19	2.7
U1/Apog	Non- Extraction	30	13.300	2.261	10	17	
UL-E (mm)	Extraction	30	1.05	1.62	-5	6.0	-4
	Non- Extraction	30	1.000	2.464	-3.0	6.0	
LL-E (mm)	Extraction	30	4.90	1.77	-4	9.0	-2
	Non- Extraction	30	5.033	3.449	-4	8	
Nasolabial (Angle)	Extraction	30	92.3	15.4	102	122	102 degrees
	Non- Extraction	30	95.117	13.107	75.0	120.0	
Lower lip thickness (mm)	Extraction	30	2.400	2.298	-1.0	6.0	1.0 mm
	Non- Extraction	30	2.400	2.298	-1.0	6.0	
Upper lip thickness (mm)	Extraction	30	8.033	2.539	3.0	11.0	1.0 mm
	Non- Extraction	30	3.033	2.173	.0	7.0	
UP width (mm)	Extraction	30	7.567	3.392	2.6	13.8	8.4 mm
	Non- Extraction	30	7.620	3.313	2.6	13.8	
UA width (mm)	Extraction	30	4.500	3.469	2.5	15.0	4.9.mm
	Non- Extraction	30	4.500	3.469	2.5	15.0	
Lower Posterior width(mm)	Extraction	30	3.873	1.181	1.3	4.6	4.3 mm
	Non- Extraction	30	3.873	1.181	1.3	4.6	
Lower ant. width(mm)	Extraction	30	3.233	2.816	2.0	13.0	3.7 mm
	Non- Extraction	30	3.233	2.816	2.0	13.0	
Upper alv. height(mm)	Extraction	30	10.900	5.384	5.0	17.0	6.1 mm
	Non- Extraction	30	10.597	5.108	5.0	17.0	
Lower alv. height (mm)	Extraction	30	27.250	9.728	20.0	48.0	22.7 mm
	Non- Extraction	30	26.783	8.763	20.0	48.0	

Table 4. Comparison ofPost-treatment (T2) mean values of Hard tissue, soft tissue parametersbetween Extraction, Non- Extraction and Standard norms in Bimaxillary Protrusion individuals

S.No	Parameters	Normal vs Extraction		Normal vs Non Extraction		Extraction vs Non extraction	
		Mean Diff.	p' value	Mean Diff.	p' value	Mean Diff.	p' value
1	LAFH (mm)	-2.833	0.309	-3.667	0.124	-0.833	0.468
2	MPA (angle)	-6.473	0.111	-3.233	0.649	3.240	0.012
3	SNA(angle)	-0.367	0.989	0.133	0.999	-0.500	0.619
4	SNB(angle)	-0.400	0.976	-0.633	0.914	0.233	0.904
5	U/L(angle)	-2.82	0.819	19.200	<0.001	22	<0.001
6	U1/SN (angle)	-0.45	0.923	-7.567	0.117	-7.11	<0.001
7	L1/MP(angle)	-3.067	0.344	-4.933	0.049	-1.867	0.032
8	L1/OCC (angle)	-8.633	0.005	-6.233	0.060	2.400	0.035
9	U1/NA (angle)	-0.967	0.950	-4.367	0.095	-3.400	<0.001
10	U1/NA (mm)	-0.600	0.919	-1.983	0.175	-1.383	0.001
11	L1/NB (angle)	-0.717	0.932	-0.967	0.852	-0.250	0.935
12	L1/NB (mm)	-0.700	0.874	-1.933	0.182	-1.233	0.004
13	U1/Apog	0.900	0.399	0.900	0.399	0.000	1.000
14	L1/Apog	-1.650	0.038	0.150	0.994	1.800	<0.001
15	UL-E (mm)	-2.95	<0.001	-4.957	0.015	-2.007	<0.001
16	LL-E (mm)	-3.83	<0.001	-6.967	0.018	-3.137	<0.001
17	Nasolabial (Angle)	0.900	0.245	7.317	0.820	6.41	0.0514
18	Lower lip thickness (mm)	-0.633	0.853	-0.633	0.853	0.0	1.000
19	Upper lip thickness (mm)	-1.517	0.085	-0.833	0.533	0.683	0.018

Table 5. Pair-wise comparison of Post-treatment (T2) mean values of HANDELMAN'S parameters between Standard Norms Vs Extraction, Standard Norms Vs Non- extraction, and Extraction Vs Non-extraction groups in Bimaxillary Protrusion individuals

Handelman's parameters	Normal vs Extraction		Normal vs Non Extraction		Extraction vs Non extraction	
	Mean Diff.	p' value	Mean Diff.	p' value	Mean Diff.	p' value
UP width (mm)	1.233	0.943	0.780	0.984	-0.453	0.936
UA width (mm)	0.043	1.000	0.400	0.998	0.357	0.968
Lower Posterior width(mm)	0.427	0.945	0.427	0.945	0.000	1.000
Lower ant.width(mm)	0.503	0.993	0.467	0.994	-0.037	1.000
Upper alv height(mm)	-3.970	0.601	-4.497	0.500	-0.527	0.965
Lower alv.height (mm)	-1.997	0.978	-4.083	0.846	-2.087	0.643

Descriptive analysis

- The mean, standard deviation (SD) and the mean of the differences (M-diff.) between pre- and post-treatment measurements were calculated The differences between them:

Standard deviation: $SD = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$

Statistical comparison between pre-treatment and post-treatment measurements

- **Student Paired t' test;** The cephalometric values from the pre and post-treatment cephalograms were evaluated by student paired t-test for both the extraction and non-extraction groups individually to determine whether any statistically significant difference is present or not.
- **Unpaired t –test**; Cephalometric comparison for 27 linear and angular post-treatment (T2) measurements was done between extraction Vs standard norms, non-extraction Vs standard norms and extraction Vs non-extraction groups using unpaired t –test.
- **One way Analysis of Variance (ANOVA);** Comparison of post treatment (T2) cephalometric parameters was also done among the three groups i.e; (extraction, non-extraction and standard norms) altogether using ANOVA test

In all the above test the "p" value of less than 0.05 was accepted as indicating statistical significance. To determine the errors associated with radiographic measurement 10 radiographs were selected at random from the group. Their tracing and measurement were repeated and compared with first measurement by using Student 't' test. No significant difference was found between any of the measurements on the 10 cephalograms traced at two different time points, at a minimum of two weeks apart for the purpose of error testing.

RESULTS

The results of our study and their comparison with standard norms are presented in the following tables and their respective graphs.

DISCUSSION

In this study findings can be discussed in four categories:
[
- Skeletal parameters
- Dental parameters
- Soft tissue parameters
- Handelman's parameters

Skeletal Parameters

Lower facial height change following premolar extractions is a debatable topic in orthodontics (Ramesh *et al*., 2012 and Langberg, 2004). Most orthodontists (Ismail *et al*., 2002; Tsai *et al*., 2002) agree that lower facial height can be influenced following 1st premolar extraction, while others report mild to insignificant changes (Tan, 1996 and Helm *et al*., 1985). The pretreatment mean measurement of lower anterior face height was found to be 4mm longer than normal in bimaxillary protrusion cases. Post-treatment mean measurement decreased by 1.17mm showing the p value >0.05 indicating no significant difference in lower facial height after premolar extraction as well as non-extraction treatment. These results suggested that the mechanics used in the treatment of individuals with bimaxillary protrusion had no significant effects on the vertical dimension. Similar results were obtained by GC Rameshand MC Pradeep (Sivakumar *et al*., 2008) in a study which was undertaken to evaluate the vertical changes following premolar extraction. They found that there was no decrease in overbite and vertical changes following premolar extraction and the explanation for those results given by them was the small sample size, also according to them due to extrusion of molars there was increased downward and backward rotation of mandible which in turn maintained the vertical reduction of the facial height. Mean pre-treatment value of mandibular plane angle was found to be increased by 6.10 mm in extraction group and 4 mm in non-extraction group. The post-treatment mean value increased by 0.373mm with a p value of 0.820 which shows insignificant statistics, this increase was supported by a study done by GC Ramesh *et al*. (Jagannath Sharma, 2010) where they found an increase in the value from pretreatment to post-treatment due to the extrusion of molars in both maxilla and mandible whearsas a study[16] done by Arunachalam and AshimaVakiatham on cephalometric assessment of dentofacial vertical changes in class-I subjects corroborates these findings posttreatment. As noted in table 3 the cephalometric tracings confirmed the presence of skeletal maxillary protrusion with an increased value in both extraction and non-extraction groups but the post-treatment values indicate statistically significant changes in extraction line of treatment showing reduction of SNA and SNB angles. This finding was supported by a study done by Jagannath Sharmaon (2010) skeletal and soft tissue Point A and B changes following orthodontic treatment of Nepalese Class-I bimaxillary protrusive patients where they found statistically significant changes in SNA and SNB values

post-treatment with four premolar extraction. In contrast to these results a study done by Faruk Ayhan Basciftci *et al*. (2003) on effects of Extraction and Non-extraction treatment on Class I and Class II subjects concluded that no significant differences were found in SNA and SNB angles with both modalities of treatment. Young T & Smith R (Young, 1993) also concluded that 1st premolar extractions caused insignificant to no skeletal changes with orthodontic treatment. Our study agreed with these findings as the anterior posterior skeletal hard tissue measurements showed mild to insignificant differences post-treatment.

Dental Parameters

Pre-treatment interincisal mean value is increased by 24.07 degrees in extraction and 19.633 degrees in non-extraction group. In contrast to non-extraction, extraction mode of treatment showed an increase in interincisal angle post-treatment and this finding suggested that extraction of four premolars is effective in decreasing the incisor protrusion and proclination that is characteristic of bimaxillary protrusion. This finding is in accordance with a study done by Keating PJ (Keating *et al*., 1985) on the treatment of bimaxillary protrusion -a cephalometric consideration of changes in the interincisal angle and soft tissue profile where he concluded that during treatment, the inter-incisal angle was increased by 20 degrees. Another study done by Tan TJ[6] on profile changes following orthodontic correction of bimaxillary protrusion with a preadjusted edgewise appliance also supported our findings where they concluded that with the extraction of four premolars there is an improvement in maxillary and mandibular incisors thus indicating the effectiveness of extraction line of treatment. The results of our study were not in coordination with a study done by FarukAyhan*et al*[18] where interincisal angle was not showing significant statistics in extraction line of treatment while significant changes were shown in non-extraction treatment. In the present study IMPA decreased from 104.633 to 93.067 degrees with extraction of four premolars showing significant statistics with a p value of less than 0.0001. These results were supported by a study done by Jagannath Sharma (Jagannath Sharma, 2010) where he concluded that IMPA decreased from 107.0 degrees to 94.1 degrees. The mean post-treatment U1 to SN angle was 103.4 degrees. The tip of the upper incisor retracted by 6.5 mm and the tip of the lower incisor retracted by 6.1 mm. Apices of upper and lower incisors showed 1.2 mm and 1.1 mm retraction following treatment. He concluded that nearly proportionate changes existed in the dental points and overlying corresponding soft tissue points. All the linear and angular dental variables were found significant post-treatment with extraction of premolars while upper incisor to SN and interincisal angle showed no significant statistics in non-extraction line of treatment. So it was concluded that with the extraction of premolars there is effective reduction of procumbency in bimaxillary protrusion patients.

Soft Tissue Parameters

Pre-treatment mean value of nasolabial angle was found to be decreased by 7.383 degrees as compared to standard norm, this finding was another indication of the soft tissue procumbency seen in patients with this condition. Post-treatment mean difference showed 8.7 degrees increase with extraction of four premolars showing statistically significant changes post-treatment. Our results were in accordance with the findings of Daniel A. Bills and Chester S. Handelman (Sung, 2010) who concluded the significant increase in nasolabial angle seen in patients (P, .02).

The results of present study were in accordance with a study done by Dimitrios Konstantonisa (DimitriosKonstantonis, 2012) who concluded statistically significant (P <0.5) increase of 5.34 degrees in nasolabial angle within the extraction group. Individuals in this study had increased measures of mean upper and lower lip thickness at 8.033 and 2.400 mm, respectively. Post-treatment mean values showed statistically significant results with a decrease in upper and lower lip thickness by 5.517 mm & 0.767 mm respectively with a P (<0.001). Similar results were shown by Daniel A. Bills and Chester S. Handelman (Bills *et al*., 2005) in their study where they found increased pre-treatment values of upper and lower lip thickness in bimaxillary protrusion. The results of the present study were in contrast to a study done by Erdinc AE, RS Nanda and TC Dandajena (Erdinc *et al*., 2007) who concluded thatduring treatment, upper lip vermilion and superior thickness increased, whereas lower lip vermilion thickness decreased in both groups. In contrast to the results of present study Talass MF, Talass L and Baker RC (Talass *et al*., 1987) did a study which showed the increase in the thickness of both the upper and lower lips post retraction of incisors.

Both the upper and the lower lips were found to be ahead of the E-plane (1.05 mm and 4.90 mm, respectively), and this is in contrast to the norm where the upper and lower lips were behind the E-plane (-4.0 and -2mm respectively). The procumbent position of the lower lip in these patients was consistent with the work of Keating PJ[20] who found the lower lip 6.0 mm ahead of the E-plane in Caucasian patients with bimaxillary protrusion. The fact that the upper lip was 1.05 mm ahead of the E-plane suggested that the subjects in the sample had protrusive upper lips, but, this result was less than the 3.4 mm found by Keating (Keating, 1985). Post-treatment there was decrease in (UL-E) line (LL-E) line by 0.16mm & 3.07mm respectively. Similar results were shown by Tan TJ in their study to determine the changes in soft tissue and skeletal profiles following orthodontic correction of bimaxillary protrusion in 50 Chinese adult patients where they concluded that 2.75mm and 2.09mm reductions in upper and lower lip protrusions, respectively.

Handelman's Parameters

The pre-treatment mean values of all four measurements of alveolar width were less in bimaxillary protrusive sample. In addition, the mean values of both upper and lower alveolar heights were found to be greater i.e; (4.8 mm & 4.55 mm respectively) in extraction group, and (4.497 mm & 4.083 mm respectively) in non-extraction group and these measurements were consistent with the increase in anterior facial height noted in the two groups. Handelman (Handelman, 1996) described a technique for measuring upper and lower alveolar widths and heights on lateral cephalograms and determined these

measurements for a sample of 107 adult Caucasian individuals before orthodontic treatment. The results suggested that individuals with bimaxillary protrusion tend to have a thin and elongated alveolus as compared with individuals with a normal occlusion. Patients at the minimal end of the range for width of the upper and lower posterior alveolus (2.6 and 1.3 mm, respectively) would likely be limited to uprighting of the incisors with minimal bodily retraction. An extremely thin alveolus could be a limiting factor in orthodontic correction of bimaxillary protrusion, and some of these patients may require surgical osteotomies for effective and safe treatment of their dental protrusions. Post-treatment changes in all handelman's parameters were found to be statistically insignificant. Muhle and ten Hoeve (1976) concluded in their study that if apex was moved beyond the alveolus, the cortex in that region would not significantly remodel and the lingual cortical plate of the symphysis could be perforated. A thin alveolus can be encountered in any skeletal type but is most frequently encountered in patients with long lower facial height and severe bimaxillary protrusion. Our results were supported by a study done by Bills *et al* (Bills *et al*., 2005) where they concluded the same findings of increased pretreatment alveolar heights and decreased alveolar widths in bimaxillary protrusion individuals

Conclusion

Following conclusions were made from the present study;

Pretreatment characteristics of bimaxillary protrusion individuals demonstrated increased procumbency due to decreased interincisal angle, increased (upper incisor to SN angle, lower incisor to mandibular plane, upper incisor to NA linear and angle, lower incisor to NB linear and angle, upper incisor to APog and lower incisor to APog) in extraction as well as non-extraction groups but the variation is more in extraction group than non-extraction as compared to standard norms. The pre-treatment values of skeletal parameters such as lower anterior facial height and mandibular plane angle were increased but the post-treatment results did not show significant statistics in extraction as well as non-extraction groups. These results suggested that the mechanics used in the treatment of individuals with bimaxillary protrusion had no significant effects on the vertical dimension. Soft tissue parameters like upper lip to E-line, lower lip to E-line and nasolabial angle showed significant statistics post-treatment with extraction and insignificant statistics with non-extraction indicating retraction of soft tissues along with changes in dental measurements with extraction line of treatment. A significant correlation was found in T1 and T2 values in upper lip thickness which signified retraction of upper lip with extraction as well as non-extraction mechanics. Lower lip thickness on the other hand showed insignificant statistics in non-extraction group showing that there is no decrease in lower lip protrusion. Pretreatment (T1) mean values of all four measurements of alveolar width were less in bimaxillary protrusive sample while upper and lower alveolar heights were found to be greater in both groups.

A thin alveolus may be encountered in any skeletal type but is most frequently encountered in patients with long lower facial height and severe bimaxillary protrusion. It is imperative in planning treatment to consider the orthodontic walls as a limit in repositioning teeth during orthodontic treatment. The extraction of first premolar proved to be highly successful in improving the dentofacial esthetics and achieving greater stability of the occlusal relationships. The results of the present study also showed that the extraction of four premolars can be extremely successful in reducing the dental and soft tissue procumbency seen in patients with bimaxillary protrusion. This provides a stronger evidence-based rationale for the extraction treatment modality. The comparison of skeletal, dental and soft tissue posttreatment values (T2) values between extraction and non-extraction group demonstrated that premolar extraction is more effective in reducing the dental and soft tissue procumbency in bimaxillary protrusion patients as compared to non-extraction mode of treatment. Hence it was concluded that only borderline bimaxillary protrusion cases can be treated with non-extraction line of treatment.

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