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Evaluation of Changes in the Vertical Dimension following mesialization of mandibular molars between Average and Hyperdivergent Facial Type: A Retrospective Cephalometric Study

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Abstract

Introduction: Orthodontists believe that extraction of mandibular first premolars produces more incisor retraction, whereas second mandibular premolars extractions result in more mesial mandibular first molar movement. However, these notions are based largely on clinical observations. In addition, according to the wedge effect concept, even small changes in mesial movement of molars result in a pronounced effect on the mandibular plane angle and FVD in this group. In spite of compelling evidence, premolar extractions continue to be implicated as a cause for decreased vertical dimensions

Aim: The aim of the study was to evaluate and compare the effects on the facial vertical dimensions after mesial movement of the mandibular molars following orthodontic treatment with mandibular bilateral premolar extraction in Average and Vertical growth pattern of face.

Methodology: Vertical parameters was recorded in the form of 3 angles (basal plane, mandibular plane, Sn-Go-Gn) and 4 linear dimensions (TAFH, LAFH,PFH,PFH/TAFH; for both pre and post cephalometric radiographs. The mesialisation which was obtained by measuring the parameters (L6o, L6m) pre and post treatment will be compared with each vertical parameter i.e (Angular and linear) which will show the relation of mesialisation with change in vertical dimension in different parameters.

Results: Both groups had increases in linear vertical dimensions (P _0.05), but the change was comparatively greater in the extraction group (P _0.05). Mesial movement of the maxillary and mandibular posterior teeth was coincidental with the extrusion to such an extent that it increased the vertical dimension, although the mandibular plane angle remained unchanged during treatment.

Conclusion: Linear vertical dimensions increased in both the extraction and the nonextraction groups. The changes in vertical dimension were comparatively greater in the extraction group.

I. INTRODUCTION

FACIAL balance is of cardinal concern to health specialists, not only because many vital organs are concentrated in a circumscribed area but also because of the social value of the face. Artists, dentists, physicians, and anthropologists have studied the face from diverse angles. Orthodontists, employing cephalometric techniques, have investigated the relationship between dental occlusion and skeletal balance of the face.[1]

The orthodontic profession has assumed much of responsibility for enhancement of function of teeth and jaws. Since function is closely allied with overbite, the correction of vertical overbite and open bite covers the major part of clinical orthodontics.

The study of beauty and harmony of the face has been central to the practice of orthodontics from its earliest conception. At the turn of the century, there were few sources from which practitioners could learn the principles of "regulating" teeth. Followers of Angle's "new school" believed that, if the teeth were in harmony, the face would be as well.[2] They believed that with their appliances they could make the bone grow, obviating the need for extractions. On the other hand, the "rational school" of Case and his followers believed that malocclusions were inherited and are the result of mixing the various face types and races.

Changes do occur after orthodontic treatment, regardless of the techniques used. These changes may be desirable and called "settling of the occlusion" or undesirable and labeled "relapse. '

In this era of mushrooming research and technological advances, we still have many unrequited or debatable questions. Much research has been focused on an intriguing question: does the vertical dimension of the face decrease with therapeutic premolar extraction?

Schudy,[1-3] described facial types as ‘‘hypo- and hyperdivergence’’ and recommended a non extraction approach in the treatment of hypodivergent facial types and an extraction approach ‘‘to close down the bite’’ in hyperdivergent types.

The extraction of premolars as a practical form of orthodontic therapy has been accepted for many years, the indications for first premolars extraction are usually severe anterior crowding or lip protrusion, while in borderline cases with moderate crowding, fairly well aligned incisors, and a relatively acceptable profile, second premolars can be extracted,1 or to close down the bite like Schudy.

[Sassouni and Nanda (1964)[4]; Schudy (1965)[2]; Mair and Hunter (1992)[5]concurred with this treatment philosophy. If molars move forward without extrusion to the extraction spaces, by the principle of “wedge effect will forward rotate the mandible resulting in vertical dimension decrease. However, there is great controversy concerning the effects of premolar extractions on facial vertical dimension (FVD)

However, others report that extraction has almost no effect on facial vertical dimensions [Staggers (1994)[6] ; Sarac and Cura (1995)[7] ; Bishara *et al.*, (1997)[8] ; Kocadereli (1999)[9]; Hayasaki *et al.,* (2005)[10]]

Chua *et al.*,[11] found that premolar extraction was not associated with any significant change of the lower anterior facial height (LAFH), whereas nonextraction treatment was associated with a significant increase in LAFH. On the other hand, Staggers[6] and Kocadereli[9] found that the vertical changes that occurred after the extraction of first premolars were not different from those that occurred in the nonextraction cases. However, in these two studies, it was pointed out that there was minimal need for protraction of posterior teeth because most of the extraction space was used to relieve crowding or to retract the anterior teeth.

In contrast, in Class II malocclusion, some protraction of the mandibular molars is expected because mandibular premolar extraction space is usually used, at least in part, to correct the Class II molar relationship. Nevertheless, it had been reported that the extraction treatment of Class II malocclusion does not cause a diminution of the LAFH, whereas nonextraction method tends to increase the LAFH.[12]

Orthodontists believe that extraction of mandibular first premolars produces more incisor retraction, whereas second mandibular premolars extractions result in more mesial mandibular first molar movement. However, these notions are based largely on clinical observations. For example, Campbell5 was among the first to suggest that the extraction of mandibular second premolars aids in the Class II correction because it allows more mesial movement of the mandibular first molars. Understanding incisor and molar movements is important because it is the basis for the shift from 4/4 to 4/5 extraction patterns when treating patients with Class II Division I malocclusion.[13]

However the dentoalveolar apparatus is assumed to take the form of an occlusal wedge so that the bite is opened when molars or premolars are extruded or distalized, or it is closed when the molars are moved forward after extraction of the premolars.[14,15] From a biomechanical point of view, this belief is logical and self-explanatory. Unlike other dental treatments, orthodontic mechanotherapy is performed in an environment of biological complexities and complexities associated with the treatment per se. Hence, any differences of opinion regarding this rule (occlusal wedge hypothesis) are not surprising.

To observe changes in FVD, it is appropriate to study hyperdivergent facial type because it is in this group that excess FACIAL VERTICAL DIMENSIONSis of greatest concern. In addition, according to the wedge effect concept, even small changes in mesial movement of molars result in a pronounced effect on the mandibular plane angle and FACIAL VERTICAL DIMENSIONSin this group.[16]

Few studies demonstrated increases in the absolute values of anterior and posterior facial heights, even with premolar extraction with no further change in the mandibular plane angle (MPA).7-10 Some studies suggest that it takes special effort, in addition to the premolar extractions, to reduce the vertical dimension in patients with high MPAs. Pearson11 showed a mean decrease in MPA of 3.9° after premolar extractions, with vertical chincups used before and during orthodontic treatment.[13]

In spite of compelling evidence, premolar extractions continue to be implicated as a cause for decreased vertical dimensions. With this in mind, our intent in this study was to objectively evaluate dentofacial vertical changes among patients with average and hyperdivergent facial type.

II. MATERIALS AND METHODS

The study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, K M Shah Dental College and Hospital, Sumandeep Vidyapeeth. Sample size was calculated on basis of study done by Sarah M. George et al19.

Type I error (Alpha, Significance) / 1.96	0.05
Type II error (Beta, 1-Power) / 0.86	0.20
Power	80%
Difference of means of expansion	0.7
SD	0.5

Here mean difference in expansion is taken as 0.7mm

SD is 0.5

$$n = \frac{2(Z_a + Z_{1-\beta})^2 \sigma^2}{\Delta^2}$$

= 2 (1.96+0.86)^2 (0.5)^2 / (0.7)^2

=2x7.95x 0.74 / 0.49

=12.75/ 0.49

=25

Therefore, a minimum 25 Pre and post cephalometric Here mean difference in expansion is taken as 0.7mm

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$$n = \frac{2(Z_a + Z_{1-\beta})^2 \sigma^2}{\Delta^2}$$

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=2x7.95x 0.74 / 0.49

=12.75/ 0.49

=25

Therefore, a minimum 25 Pre and post cephalometric radiograph per group was required

Therefore, a total 50 pre and post cephalometric radiographs were required.

TIME SCALE OF THE STUDY:

Study was started after IEC approval and was completed within 3 months from SVIEC approval.

SELECTION CRITERIA :

(A) INCLUSION CRITERIA:

- The availability of full records, including pretreatment and posttreatment models, lateral cephalograms, and clearly documented orthodontic treatment mechanics

- The treatment involved the extraction of bilateral mandibular premolars
- Space in the mandibular arch should be completely closed at the end of treatment
- Mandibular intercanine and intermolar widths maintained

(B) EXCLUSION CRITERIA:

- Treated with functional appliances, quad helix, or rapid palatal expansion, headgear before or during fixed appliance therapy;
- Had congenital anomalies, significant facial asymmetries, or congenitally missing teeth

III. METHODOLOGY

The materials for this study were selected from the records of 52 subjects treated in the Department of Orthodontics and Dentofacial Orthopaedics, K M Shah Dental College and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat by fixed appliance therapy. The orthodontic treatment of these subjects included with the extraction of two mandibular first or second premolars.

All subjects which were treated by using the pre-adjusted MBT appliance (MBT prescription, slot size 0.022 x 0.028 inch) and extraction spaces have been closed with sliding mechanics.

On the pre-treatment and post-treatment cephalometric tracings, The samples were divided on the basis of the 2 growth patterns of face: **A.** Average growth and **B.** Vertical growth pattern. The 2 groups were matched on the basis of sex and age at T1, and T2.

Eight cephalometric measurements shown in (Table I) and digitized by 1 investigator using Dolphin Imaging and Management Solutions (version 11.8, build 24; Dolphin Imaging,). Four traditional measurements were used to Identify the growth pattern of the face ie. FMA angle, SN-GoGn, Basal plane angle. At least 2 angles should be indicating the same pattern of growth for segregating the subjects between the Average or Vertical growth pattern.

Cranial base, maxillary, and mandibular superimpositions of the T1 (group 1) and T2(group 2) cephalograms were performed for each subject using naturally stable structures. To quantify the horizontal and vertical treatment, a rectangular coordinate system was used. A horizontal RL was constructed on the T1 cephalometric tracing, registering on T1 sella and orienting below the SN to approximate natural head position. The horizontal and vertical changes of the teeth were measured parallel and perpendicular to RL, respectively.

Changes in molar position were measured at the mesial buccal cusp tip and the mesial contact points and changes in the other vertical parameters were recorded as shown in (Table 2). Displacements were defined as differences between the changes measured on the cranial base and regional mandibular superimpositions. Anterior and superior changes were recorded as positive; posterior and inferior measurements were recorded as negative.

Table 1. *Cephalometric landmark abbreviations and definition*

Abbreviations	Definitions
L6o	**The mesial buccal cusp tip of the mandibular first molar.**
L6m	**The mesial contact point of the mandibular first molar.**
Basal angle	**Angle formed by the intersection of anterior nasal spine-posterior nasal spine and menton-pogonion lines.**
MP angle	**Angle formed by the intersection of menton-gonion and orbital-porion lines.**
Sn-Go-Gn	**Angle formed by the**

	intersection of S-N plane and Mandibular plane
TAFH	**The distance between nasion and menton**
LAFH	**The distance between anterior nasal spine and menton.**
PFH	**The distance between sella and gonion**
PFH/TAFH	**Ratio of the distance between sella and gonion to the distance between nasion and menton.**

Table 2. *Segregation of the Pre-treatment cephalometric radiograph between the Average or Vertical growth pattern*

PARAMETERS	AVERAGE	VERTICAL
FMA	25-27 Degree	Above 27
Basal plane angle	25-27 Degree	Above 27
Sn-Go-Gn angle	32-34 Degree	Above 34

Table 3. *Comparison of Cephalometric Pre and Post-treatment changes in Average and Vertical growth pattern group*

Serial no.	Parameter	T1(Before treatment)	T2 (After treatment)
1	L6o		
2	L6m		
3	Basal angle		
4	MP angle		
5	Sn-Go-Gn		
6	TAFH		
7	LAFH		
8	PFH		
9	PFH/TAFH		

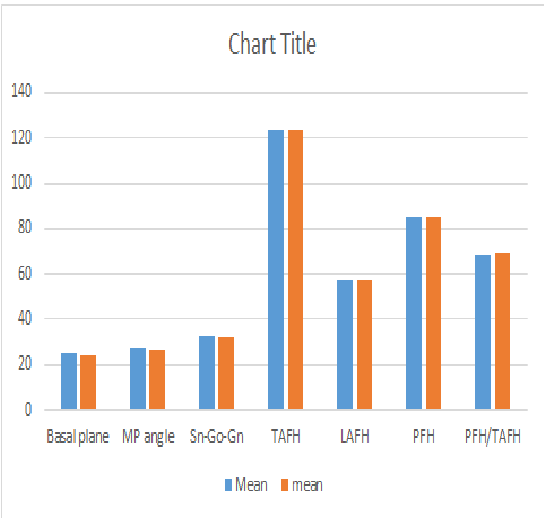
IV. RESULTS

There were no statistically significant between-group differences in horizontal jaw displacements. The mandibular molar underwent 0.6-1.0 mm anterior displacement; the mandible was displaced anteriorly by 2.1 mm. The maxillary incisors moved distally approximately 1.4 mm more in the vertical than horizontal growth pattern group, but the difference was not statistically significant. The L6 migrated mesially 1.9-2.2 mm, with no statistically significant between-group differences. The mandibular incisors moved distally significantly more (approximately 1.5 mm) in the vertical pattern group than in the horizontal growth pattern group. Analysis controlling for L1:NB at T1 showed no statistically significant between-group differences in mandibular incisor retraction (P 5 0.148). The L6s moved mesially by 4.2-5.1 mm. There was a statistically significant between-group difference in the movement of the L6 occlusal contact point, with 0.7 mm more mesial movement in the Group A than in group B. The L6 mesial contact point showed a similar pattern, but the difference was not statistically significant. Changes in vertical jaw and tooth positions that occurred during treatment were also statistically.

Differences in the pretreatment FACIAL VERTICAL DIMENSIONS between groups 1 and 2 were analyzed by the independent t-test. Although SNMP angle and AB-MP angle showed differences (Table 6), there were no differences in other pretreatment measurements of FACIAL VERTICAL DIMENSIONS between groups 1 and 2. Parameters of facial height in group 1 were significantly increased after treatment (P, .05), but angular and proportional measurements were not statistically different before and after treatment (Table 5). Group 2 showed similar results. Facial height measurements were significantly increased after treatment (Table 5). Although the maxilla-mandibular plane angle (MMA) and lower facial height ratio (LFHR) were statistically different in group B the amount of increase was too small to have clinical significance (Table 2). There were no significant differences in other angular and proportional measurements before and after treatment (Table 6). When the amount of change in FACIAL VERTICAL DIMENSIONS during treatment between groups 1 and 2 were compared, there were no significant differences in linear and proportional measurements. Although SN to palatal plane angle (SN-PP) and MMA showed significant changes (indicates.05, Table 4), the amount of increase was too small to have clinical significance. There were no differences in other angular measurements between groups 1 and 2 (Table 6).

Table 4. *Pre and post treatment comparison of average growth pattern group*

	Pre and post treatment comparison of average growth pattern group					
	T1		T2		T2-T1	
Measurements	Mean	SD	Mean	SD	Mean difference	P value
Basal plane	24.6	2.89	24.3	1.55	-0.3	0.32
MP angle	27.3	1.54	26.34	1.54	-0.96	0.12
Sn-Go-Gn	33.23	1.45	32.23	1.45	-1	0.11
TAFH	123.94	5.15	123.43	5.15	-0.51	0.15
LAFH	57.3	3.45	57	3.35	-0.3	0.23
PFH	85.12	3.45	85.02	3.45	-0.08	0.8
PFH/TAFH	68.67	1.49	68.96	1.7	0.31	0.234



Graph 1. *Pre and post treatment comparison of average growth pattern group*

Table 5. *Pre and post treatment comparison of vertical pattern group*

	Pre and post treatment comparison of Vertical pattern group					
	T1		T2		T2-T1	
Measurements	T1	sd	T2	sd	mean d	P value
Basal plane	28	2.4	27.12	2.2	-0.88	0.3
MP angle	31.43	2.13	30.01	2.13	-0.42	0.22
Sn-Go-Gn	37.56	2.33	36.06	2.33	-1.5	0.16
TAFH	129.72	5.19	125.72	5.19	-4	0.05
LAFH	63.67	3.12	60.4	3.22	-3.27	0.06
PFH	80.12	3.21	80.78	3.21	0.66	0.08
PFH/TAFH	61.76	1.98	64.25	1.98	2.49	0.04

Graph 2. *Pre and post treatment comparison of vertical pattern group*

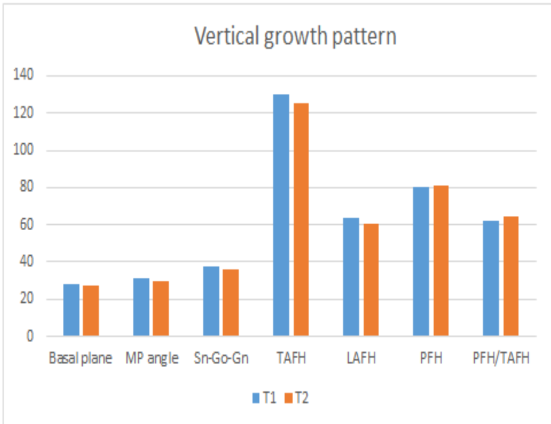
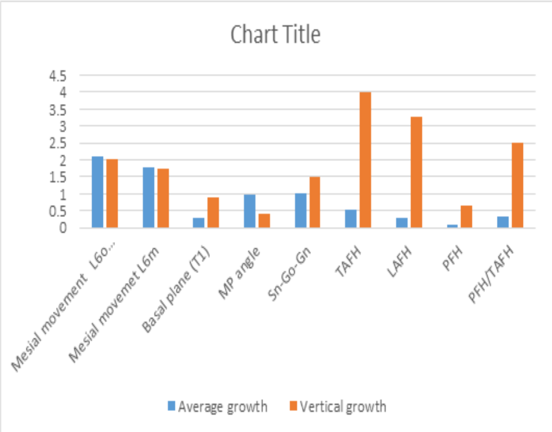


Table 6. *Pre and post treatment comparison of Horizontal and Vertical pattern group*

	T2-T1					
	Average growth		Vertical			
Measurements	Mean deference	SD	Mean difference	SD	Mean difference	P value
Mesial movement L6o T1toT2	2.09	0.8	2.04	0.91	0.05	0.88
Mesial movement L6m	1.78	0.6	1.74	0.68	0.04	0.76
Vertical movement L6	0.87	0.23	0.76	0.33	0.11	0.32
Basal plane (T1)	0.3	2.94	0.88	1.7	0.58	0.56
MP angle	0.96	1.87	0.42	1.23	0.54	0.78
Sn-Go-Gn	1	2.78	1.5	1.87	0.5	0.15
TAFH	0.51	3.45	4	3.13	3.49	0.06
LAFH	0.3	2.98	3.27	2.76	2.97	0.08
PFH	0.08	1.91	0.66	2.45	0.58	0.14
PFH/TAFH	0.31	1.03	2.49	2.78	-2.18	0.04



Graph 3*. Pre and post treatment comparison of Horizontal and Vertical pattern group*

V. DISCUSSION

Previous reports on the relationship between extraction with orthodontic treatment and facial vertical dimensions have shown that the former does not significantly change the latter. Staggers[16]showed that there was no significant difference in the vertical dimension changes between P1 extraction and non-extraction groups, and orthodontic treatment produced increases in the cephalometric vertical dimensions in both groups. Chua et al[10] examined the effect of extraction and non-extraction on lower anterior facial height (LAFH, ANSMe) with a standardized score to account for effects due to growth and concluded that non-extraction treatment was associated with a significant increase in LAFH, but extraction treatment was not associated with any significant changes in LAFH. Cusimano *et al.*,[17] found that there were no differences in facial height of hyperdivergent patients with first premolar extraction treatment when pre- and posttreatment results were compared. This study showed a significant increase of linear measurements after orthodontic treatment in group 1 (Table 5), corroborating the findings of Staggers[16] and Kocadereli.[8]

but disagreeing with those of Chua et al.20 P1 extraction did not significantly change angular and proportional measurements (Table 3), supporting the results of Kocadereli,[8] Cusimano et al.,[17] and Chuaet et al[10]. Taner-Sarisoy[18] reported that treatment with fixed appliances and premolar extractions did not significantly alter the growth pattern. Yet, LAFH can be significantly influenced by orthodontic treatment. The net increase of LFHR is due to extrusion of molars by treatment mechanics and residual vertical growth of the patients. It is possible that mesial molar movement may help accommodate these effects and work to maintain LFHR. Group 2 had more cases with increased LFHR (74.1% and 51.9%) and fewer cases with decreased LFHR (14.8% vs 40.7%) than group 1. It has been shown that molars can be extruded when extraction space is closed.[8,16] Extrusion appears to maintain or even increase the facial vertical dimension. Therefore, greater mesial movements can possibly allow for more molar extrusion due to the chosen mechanics of space closure. If extrusion of the posterior teeth keeps pace with the increase in anterior facial height, SN-MP will be maintained and the bite-closing effect of mesial molar movement will be nullified.[17] If the vertical growth of the ramus or posterior alveolar bone do not compensate extrusion of molars, LFHR can be increased. In this study, increases of LFHR in group 2 could be due to less compensation for molar extrusion compared with group 1. Residual growth has to be considered because it can influence LAFH. In female individuals the growth is nearly over at 14 years. The average ages of groups 1 and 2 were 15.6 6 3.9 years and 16.2 6 4.0 years, respectively, so we cannot talk about the influence of residual growth because it is very limited at these ages. However, in this study all linear measurements increased after treatment. This result suggests that some residual growth as well as treatment effects took place. This finding is similar to the studies of Staggers[16] and Kocadereli[8] with growing children. Because the mean age of two groups was similar in this study, the effect of growth on LAFH between groups 1 and 2 can be expected to be the same. Thus, the effect of growth on LAFH in this study can be eliminated. In this study the effects of P1 and P2 extractions on change of facial vertical dimensions were compared in relation to the concept that mesial molar movement will close facial vertical dimensions by reducing the wedging effect. However, the results showed that there groups 1 and 2 except for MMA and SN-PP (Table 5). The reason why SN-PP and MMA showed significant differences might be due to differences in skeletal characteristics and arch length discrepancy between groups 1 and 2, even though these met the sample selection criteria such as orthognathic Class I malocclusions within the same range of vertical and anteriorposterior measurements. Garlington *et al*.,[19] observed a significant decrease in LAFH in the mandibular second premolar enucleation cases due to forward rotation of the mandible, but they found no significant differences in total facial height and the MMA. This suggests that there were compensatory changes in the maxillary vertical growth. The results indicate that the null hypothesis is invalid and suggest that the facial vertical dimensions is maintained or even increased regardless of amount of mesial molar movement. Further studies are required on the biological response to treatment effects as well as compensatory mechanisms, particularly those affecting vertical facial dimensions. It would be of interest to study these patients in the long term to determine how LAFH changes with time

VI. CONCLUSION:

Regardless of Vertical or Horizontal growth pattern of face, there was no decrease of facial vertical dimensions. Therefore, the wedge effect concept that the bite is closed by extraction of premolars and forward movement of molars seems invalid. Therefore the decision of premolar extraction should be based on other criteria, such as incisor retraction, area of crowding, tooth sizes, and condition of teeth, rather than on a desire to change Facial Vertical Dimensions.

Statistical methods:

Means and standard deviations for the two groups were calculated for all the variables with SPSS for Windows. The differences between the two groups were determined with the student's t-test. P values less than .05 were considered significant.

Feasibility issue:

The adequate number of cephalometric records was obtained from the archives of Department of Orthodontics and Dentofacial Orthopedics, KMSDCH

Likely outcomes of the study:

The effect on change in vertical dimensions by medialisation of molars was known in average and vertically growing individuals.

CONFLICT OF INTEREST: Nil

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