Cephalometric Assessment of Post Treatment Vertical Changes in Patients Undergone Fixed Orthodontic Treatment

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Abstract

Introduction: Orthodontic treatment planned to correct sagittal or transverse discrepancy must always consider movement in vertical plane as well. Hence, the purpose of this study was to evaluate changes in vertical planein adult Orthodontic patients who had undergone fixed Orthodontic treatment with the extraction of first premolars.

Materials and Method: The pre and post treatment lateral cephalogram of fifteenpatients weretaken and traced, and several cephalometric variables (hard and soft) were measured to evaluate the vertical changes.Data was analyzed statistically.

Result: Significant difference in parameters likeInterincisal angle, linear distance of incisor and molar to palatal plane, Interlabial gap and Maxillary incisor exposure whereas non-significant difference was seen in the other parameters like Mandibular plane angle, Y- axis, Gonial angle, Anterior lower facial height, Maxillary and Mandibular height etc.

Conclusion: The changes in vertical parameters like facial height and clockwise rotation of mandibular plane was not seen in the present study. The appropriate measures that are incorporated in our biomechanics as per the case to minimize changes in vertical dimension must be followed strictly.

Keywords: Vertical height, Cephalometrics, Growth pattern, Anchorage.

Introduction

Orthodontic treatment planned to correct sagittal or transverse discrepancy must always consider movement in vertical plane as well. Orthodontists have long been interested in the vertical changes caused by Orthodontic treatment, not only when they occur but also what their long-term effects are. Orthodontic treatment is usually planned to prevent an increase in vertical facial height because the stability of this movement is not always reliable, and has deleterious side effects on facial esthetics in some patients. Tooth movement in vertical plane can rotate the mandible clockwise with increase in facial height, and these changes will be deleterious in subjects with vertical growth pattern. Correction of malocclusion in other planes should not accentuate malocclusion in the vertical plane. Much research has been focused on an intriguing question: does the vertical dimension of the face increase or decrease with therapeutic premolar extraction?[1-6]

Although this mystification has been around since the beginning of orthodontics, it has surfaced in debates among many clinicians recently. Recent studies evaluating the effect of fixed Orthodontic treatment on the vertical dimension concluded that Mandibular clockwise rotation in growing patients is believed to be the result of molar extrusion that exceeds posterior facial growth.Some investigators have reported that the mandible usually returns to its original position after treatment. A few studies demonstrated that mandibular opening as a consequence of orthodontic treatment does not invariably return to pretreatment values.However, it has been postulated that positional as well as structural changes in the musculoskeletal complex are quickly established and may allow alterations in the vertical dimension.[7,8]

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. From a biomechanical point of view, this belief is logical and self-explanatory.[9,10,11]Unlike other dental treatments, orthodontic mechanotherapyis 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.

Thus, it is necessary to have an understanding of post treatment stability of increased vertical dimension in adult orthodontic patients. With this in mind, the purpose of this study was to objectively evaluatedentofacial vertical changes in adult Orthodontic patients who had undergone fixed Orthodontic treatment with the extraction of first premolars.

Material Method:

The Sample: A cephalometric study of 15 adults patients was under taken.All subjects had been treated in Department of Orthodontics and dentofacial Orthopaedics of Babu Banarasi Das College of Dental Sciences, Lucknow by fixed Orthodontic treatment. The pre and post treatment lateral cephalogram of fifteen patients were taken and traced, and 25 cephalometric variables (Both hard tissue and soft tissue parameters)were measured to evaluate the vertical changes.

The criteria for sample selection were as follows:

1. All patients were dentally or skeletally either class I or class II.
2. Orthodontic treatment was initiated when the patient was above 18 years of age.
3. No previous history of Orthodontic treatment besides this patient hadundergone all first premolar extraction as the part of fixed Orthodontic treatment.
4. Full arch mechanics were applied and limited tooth movement cases were excluded.
5. Good cephalometric records of pre-treatment and post treatment were available.
6. Patients were treated without surgery.

Figure: 1-Shows pre and post profile and frontal, lateral intra-oral photographs of one of the patients selected for the study.

Material:

- Pre and Post lateral cephalogram of the patient,
- 0.03 pencil, eraser,
- Geometry box
- Tracing sheets
- View box

Cephalometric Analysis

Method: The master tracing of pre and post ceph of the patients were done. 25 landmarks were selected to measure 25 vertical parameters of the patient.

Landmarks	Definition
Nasion	The most anterior point on the frontonasal suture in the mid saggital plane.
Sella	Geometric center of the pituitary fossa located by visual inspection.
Gonion	A point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior ramus and the inferior border of the mandible.
Gnathion	A point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior ramus and the inferior border of the mandible.
Gnathion	A point located by taking the mid point between the anterior (pogonion)and inferior (menton)points of the bony chin.
Porion	The most superiorly positioned point of the external auditory meatus located by using the ear rods of the cephalostat(mechanical porion)
Orbitale	The lowest point on the inferior rim of the orbit.
Pogonion	The most anterior point on the chin.
Anterior nasal spine	The anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening.
Posterior nasal spine	The posterior spine of the palatine bone constituting the hard palate.
Articulare	A point at the junction of the posterior border of the ramus and the inferior border of the posterior cranial base (occipital bone).
Menton	The lowest point on the symphyseal shadow of the mandible seen on lateral cephalogram.
Condylion	The most superior point on the head of the mandibular condyle.
Point A (subspinale	The most posterior midline point in the concavity between the anterior nasal spine and the prosthion (the most inferior point on the alveolar bone overlying the maxillary incisors).
Point B (supramentale)	The most posterior midline point in the concavity of the mandible between the most superior point on the alveolar bone overlying the lower incisors (infradentale) and pogonion.
U1	Tip of maxillary incisors
L1	Tip of mandibular incisors
U6	A point on occlusal plane located perpendicular to the distal surface of the crown of the upper first molar
L6	A point on the occlusal plane located perpendicular to the distal surface of the crown of the lower first molar.
Sn (Subnasale)	The point at which the collumella (nasal septum) merges with the upper lip in the midsagittal plane.
ULS (upper lip superior)	A point indicating the mucocutaneous border of the upper lip. The most anterior point of the upper lip (usually).
Stm, (stomionsuperius)	The lower most point on the vermillion border of upper lip.
N' (soft tissue nasion)	The point of greatest concavity in the midline between the forehead and the nose.
Me' (soft tissue menton)	Lowest point on the contour of the soft tissue chin. Found by dropping a perpendicular from horizontal plane through skeletal menton.

Table 1: landmarks used for the analysis (figure 2)

Cephalometric plane	Plane symbol	Definition
Palatal plane	ANS-PNS	This plane is formed by connecting ANS to PNSand is used to measure the vertical tilt of maxilla
SN plane	S-N	This plane is represents the anterior cranial base and is formed by connecting Sella to Nasion
Frankford Horizontal Plane	P-Or	This plane represents the habitual postural position of the head.
Functional Occlusal Plane	FOP	This plane passes is formed by drawing a line that touches the posterior premolars and molars.
Mandibular Plane	Go-Gn	This plane is formed by connecting the point gonion to gnathion at the inferior border of the mandible.
Facial plane	N-Pg	This vertical plane is formed by connecting nasion to pogonion as described in Schudy's Analysis.

Table 2: Planes used for the analysis (figure 3)

These points and planes were used to measure the linear and angular parameters to assess changes in vertical plane.

Name	Description
ANGULAR	
Mandibular Plane (°)	Angle between SN to Mandibular Plane Angle
Y Axis (°)	Angle between Sella Gnathion and Frankfurt Horizontal Plane
Occlusal Plane to SN (°)	Angle between SN to Occlusal Plane Angle
Facial Angle (°)	Angle between Nasion-Pogonion and Frankfort Horizontal plane
Sagittal angle	Angle between mandibular plane and palatal plane.
Gonial angle	Angle between articulare, gonion and menton.
Upper gonial angle	Angle between articulare, gonion and nasion
Lower gonial angle	Angle between nasion, gonion and menton
Interincisal angle	Angle between the long axis of upper incisor and lower incisor
U1 to palatal plane	Angle between long axis of upper 1 and palatal plane
L1 to mandibular plane	Angle between long axis of lower 1 and mandibular plane
LINEAR	
Effective mandibular length	Distance from condylion to gnathion
Effective maxillary length	Distance between condylion to point A
Anterior lower facial height	Distance from point A perpendicular to palatal plane to point B perpendicular to mandibular plane
Posterior lower facial height	Distance from [illegible] perpendicular on palatal plane to [illegible] perpendicular on mandibular plane
U6 to palatal plane	Linear distance between mesiobuccal cusp tip of maxillary upper first molar to palatal plane
L6 to mandibular plane	Linear distance between mesiobuccal cusp tip of mandibular first molar to mandibular plane
U1 to palatal plane	U1 perpendicular on palatal plane
L1 to mandibular plane	L1 perpendicular to mandibular plane
Upper lip length	Distance from subnasale (Sn) to upper lip superior
Interlabial gap	Distance between upper lip inferior and lower lip superior
Maxillary 1 exposure	Distance between upper lip inferior and tip of upper 1
Lower lip length	Distance between lower lip superior and soft tissue menton
Lower 1/3rd height	Subnasale to soft tissue menton
Total height	Soft tissue nasion to soft tissue menton
Maxillary height	Subnasale to maxillary incisor tip
Mandibular height	Mandibular incisor tip to soft tissue menton

Table 3: parameters used for the analysis (figure 4a, 4b)

Data was tabulated for various linear and angular parameters from both pre and post treatment lateral cephalogram as Group I and Group II respectively.

Statistical Analysis

Descriptive stats (Mean, standard deviation) of all parameters at two stages that is pre and post treatment were tabulated of the collected data. Adequate comparison was done between Group I and Group II using Student's T-test.

Measurement of Reliability

To determine the reliability and reproducibility of the measurements, cephalometric radiographs of 5 patients were selected at random, were retraced and parameters were measured again. The measurement of reliability was done by conducting a paired t test of differences between the various parameters measured on first and second set of tracings. The mean measurement error was less than 0.5° for all angular measurements. The error for all linear measurements was also less than 0.5 mm.

Result

Mean values of different parameters at pre-stage and post-stage are shown in Table 4, with the result of paired t tests for skeletal and dental changes between pre-treatment and post-treatment values.

Sno.	PARAMETERS	GROUP I (PRE)		GROUP II (POST)		P VALUE	Level of significnce
		Mean	SD±	MEAN	SD ±		
1	MANDIBULAR PLANE ANGLE	29.93	5.52	30.33	5.23	0.5045	P>0.05
2	Y – Axis	61.60	4.22	62.80	4.93	0.1353	P>0.05
3	OP to SN	12.27	3.24	13.13	3.68	0.3514	P>0.05
4	FACIAL AXIS ANGLE	83.87	2.77	83.47	3.54	0.7329	P>0.05
5	SAGGITAL PLANE ANGLE	24.47	5.26	23.87	5.99	0.5247	P>0.05
6	GONIAL ANGLE	125.20	6.05	126.53	6.40	0.2130	P>0.05
7	UPPER GONIAL ANGLE	51.80	4.55	52.67	4.58	0.3313	P>0.05
8	LOWER GONIAL ANGLE	73.33	5.33	73.80	5.45	0.5135	P>0.05
9	EFF. MANDIBULAR LENGTH	93.53	5.11	95.47	7.43	0.1144	P>0.05
10	EFF. MAXILLARY LENGTH	76.20	4.30	77.40	6.68	0.4283	P>0.05
11	ALFH	52.73	5.05	53.13	4.66	0.5264	P>0.05
12	PLFH	36.00	4.61	36.33	4.32	0.6133	P>0.05
13	INTERINCISAL ANGLE	116.13	12.27	126.00	11.48	0.0404	P<0.05
14	U1 to NF	117.93	10.02	111.33	6.07	0.0325	P<0.05
15	L1 to MP	103.93	6.52	101.33	7.26	0.1639	P>0.05
16	U6 to NF	20.07	2.37	21.00	2.10	0.0054	P<0.01
17	U6 to MP	24.67	3.20	25.93	4.53	0.1522	P>0.05
18	UPPER LIP LENGTH	17.20	3.34	18.27	3.83	0.0838	P>0.05
19	INTER LABIAL GAP	5.67	2.09	3.13	1.96	0.0002	P<0.001
20	MAXILLARY I EXPOSURE	4.67	2.06	2.60	1.92	0.0005	P<0.001
21	LOWER LIP LENGTH	35.20	3.08	36.40	3.66	0.1558	P>0.05
22	LOWER 1/3rd HEIGHT	57.47	5.51	58.27	4.85	0.4125	P>0.05
23	TOTAL HEIGHT	98.07	6.99	99.33	6.81	0.1599	P>0.05
24	MAXILLARY HEIGHT	22.00	3.63	23.00	3.63	0.1613	P>0.05
25	MANDIBULAR HEIGHT	37.87	3.78	38.33	2.97	0.5592	P>0.05

Not significant (NS)(p > 0.05), **= Moderate significant (p <0.01), *= Highly significant (p <0.001)**

Table 4: Means, standard deviations, and p values for the cephalometric parameters in the Pre-treatment and Post-treatment groups.

Discussion

Fixed orthodontic treatment brings about the changes not only in sagittal but also in vertical and transverse plane. Such changes after the fixed orthodontic treatment in patients can vary accordingly. At times, the changes in the vertical plane (like increase in facial height) can be deleterious to the patients in vertical or average growers.Similarly, these changes can be beneficial at times in patients with horizontal growth pattern having a deep overbite. Increase in lip length following retraction of incisors as lip drape closely approximates the retracted incisors. This can also be beneficial after the treatment as it can decrease the incisor exposure giving better esthetics.[12-15]

Evaluation of the results of pre and post treatment cases showed that theverticalchanges occurring after the extraction of first premolars were statistically significantlike, the Inter-incisal angle, linear distance of incisor and molar to palatal plane, Interlabial gap and Maxillary incisor exposure had significant difference whereas non-significant difference was seen in the other parameters like Mandibular plane angle, Y- axis, Gonial angle, Anterior lower facial height, Maxillary and Mandibular height etc.

Most of orthodontic mechanics are extrusive in nature, and this extrusion appears to maintain or even increase the vertical dimension. This orthodontic extrusion was demonstrated in this study by the mean increase in the upper 6 to palatal plane and the lower6 to mandibular measurements. When the anterior teeth are being retracted, the objective of anchorage is to maintain the position of the posterior teeth. If anchorage is maintained, then very little protraction of the posterior teeth occurs, and the supposed loss of vertical dimension cannot happen. However, in a patient with a Class II or III malocclusion when a portion of the extraction spaces is used to correct the molar relationship, the molars are protracted. Yet this protraction does not necessarily produce a loss of vertical dimension.

The Orthodontic biomechanics should aim at preserving vertical dimension in vertical or average growers as downward and backward rotation of mandible will not only increase the vertical height but also hamper the correction of class II skeletal relationship. Increase in vertical dimension in horizontal growers tend to relapse because of strained muscle pull. Therefore, all efforts should be taken to counteract the extrusive nature of Orthodontic mechanics. Intrusion arches used to intrude incisors have reciprocal extrusive effect on posterior segment. To counteract this action transpalatal arch can be given on upper first molars to preserve the vertical height. Similarly loop mechanics cause a counter action by extruding molars, to compensate the action curve of spee is incorporated along with the alpha and beta bends.

Transpalatal arch, nance palatal button or TAD's should be given to preserve the loss of vertical height in maxillary arch wheras lingual arch and TAD can be given in lower arch to prevent extrusion. Within the limitations of present study, it can be stated that no significant increase in vertical dimension was seen following extraction of all first premolars.

Conclusion

Amongst the various vertical parameters evaluated, U1 to NF, Interlabial gap, maxillary

exposure, interincisal angle and U6 to NF showed significant difference between pre and post treatment values. Hence appropriate measures must be incorporated in our biomechanics as per the case to minimize changes in vertical dimension.

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Figure: 1, Pre and post profile and frontal, lateral intra-oral photographs of one of the patients selected for the study.

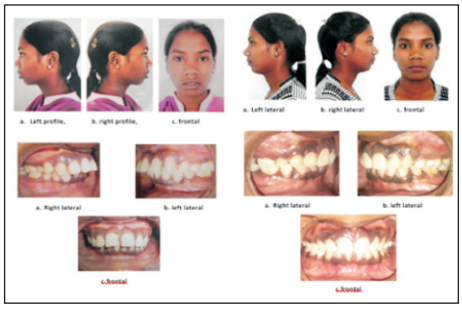

Figure: 2,Landmarks

Figure 2, Landmarks : S-sella, N-nasion, P-porion, C-condylion, Ba- absion, Go-gonion, Me-menton, Gn-gnathion, B-supramentale, A-subspinale, ANS-anterior nasal spine, PNS-posterior nasal spine, O-orbitale, Po-pogonion, Ar- articulare, Sn-subnasale, ULS- upper lip superior, Stm- stomionsuperius, N'- soft tissue nasion, Me'- soft tissue menton.

Figure 3: Planes

Figure 3, Planes : 1. SN Plane, 2.FH Plane, 3. Palatal plane, 4. Mandibular plane, 5.Facial angle 6. Occlusal plane.

Figure: 4 (a): Angular parameters

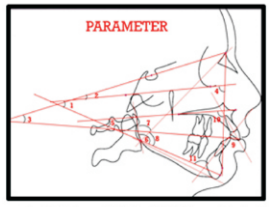

Figure 4(a), Angular parameters: 1. Effective mandibular length, 2. Effective maxillary length, 3. Anterior lower facial height, 4. Posterior lower facial height, 5. U6 to palatal plane 6. L6 to mandibular plane 7. U1 to palatal plane 8. L1 to mandibular plane, 9. Upper lip length, 10. Interlabial

Figure: 4 (b): Linear parameters

Linear parameters 1. Effective mandibular length, 2.effective maxillary length, 3.ant. Lower facial height, 4.post. Lower facial height, 5.u6 to palatal plane, 6.l6 to mandibular plane, 7.u1 to palatal plane 8. L1 to mandibular plane, 9.upper lip length, 10.interlabial gap, 11.maxillary 1 exposure, 12. Lower lip length, 13.lower 1/3rd height, 14.total height, 15. Maxillary height, 16.mandibular height