

# Rhinion Shift: Change Seen in the Nasal Bone Post Orthodontics: A Cephalometric Study

## Abstract

**Objective:** To evaluate the pre & post orthodontic treatment changes in the nasal bone using lateral cephalograms. **Methods:** 36 patients above 16 years undergone fixed orthodontic treatment treated with premolar extractions in all types of malocclusion were included as samples. Those who have undergone surgical correction were excluded from the study. Pre & Post cephalometric tracings were performed using 4 Linear and 4 angular measurements and statistical analyses were used to compare the changes in the nasal bone before and after orthodontic treatment. **Results:** The angular dimension of nasal bone (SNRh) was found to change post orthodontic treatment in accordance to the changes in the maxilla especially Point A. A decrease in the SNA resulted in the movement of nasal bone in a clockwise direction & vice versa. A tendency of the Angular measurement ANRh to maintain a constant angle by the tilting of nasal bone in accordance to SNA was observed. In linear measurements vertical movement of Rhinion was observed due to the tilting of nasal bone. **Conclusions:** Changes in the nasal bone after orthodontic treatment was considered negligible. But the finding of this study shows that nasal bone is getting tilted to new position post orthodontics. Rhinion shift was observed in accordance to point A.

## Key Words

Nose; nasal bone; rhinion; point A; cephalometrics

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## INTRODUCTION

The growth of the nose and its relationship to the total face are of great interest to those who deal with the facial profile. Therefore a greater appreciation of nasal bone growth is essential for the orthodontist. There are numerous studies that focus on the general changes affecting the soft tissue profile and a few that focus on the hard tissue changes (i.e., nasal bone) of the nose in particular. One of the first study to evaluate growth of the soft tissues was done by Subtelny (1959).<sup>[1]</sup> The study used subjects that ranged from 3 months to 18 years of age and intended to determine the relation of soft tissue to the underlining hard tissue. The study demonstrated that the soft tissue may or may not follow the same pattern of growth exhibited by the underlying hard tissues. Using Subtelny's same sample, Posen (1966)<sup>[2]</sup> studied the growth pattern of the nose. His study demonstrated that after an

initial period of retrusion, the nasal bone and soft tissue base and tip, swung out from beneath the cranium. He concluded that the growth of the nose progresses from early to later stages of development in a steady and consistent manner. Genecov and coworkers (1990)<sup>[3]</sup> studied soft tissue and nose development in three age groups (7 to 9, 11 to 13, and 16 to 18) based on a sample from the Bolton Growth Study. Overall they found that the soft tissues continued growing after the hard tissues ceased to grow. Thus, soft tissues development was independent of underlying hard tissue change. Nanda and co-workers (1990)<sup>[4]</sup> described nose development in greater detail. Lateral head cephalograms of 17 male and 23 female subjects, aged 7 to 18 years, were evaluated for age changes in morphology and position of the nose with reference to the pterygomaxillary vertical plane. Several significant findings were presented. The

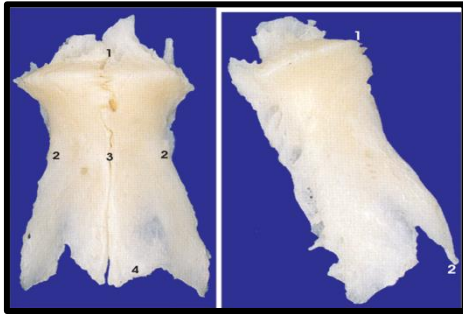


Fig. 1:

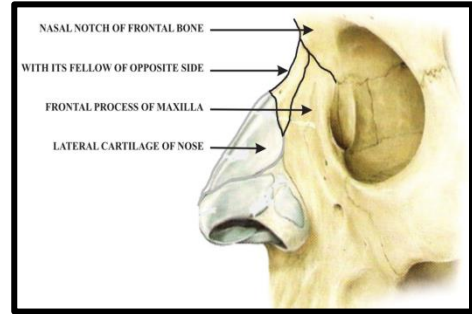


Fig. 2

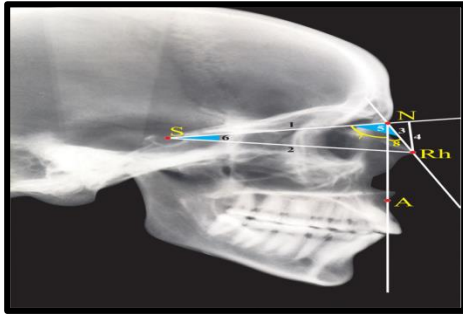


Fig. 3

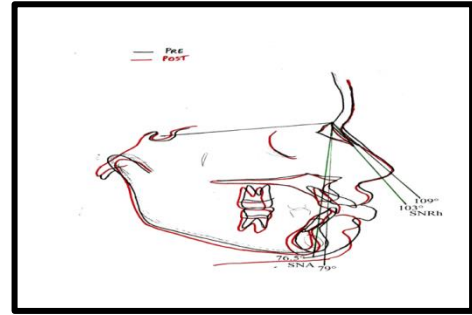


Fig. 4

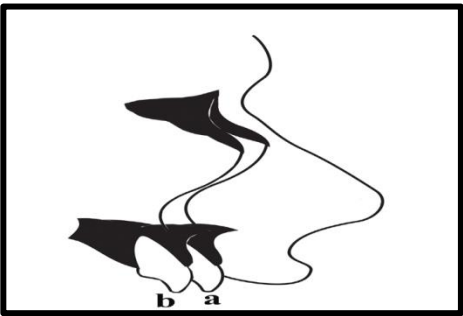


Fig. 5

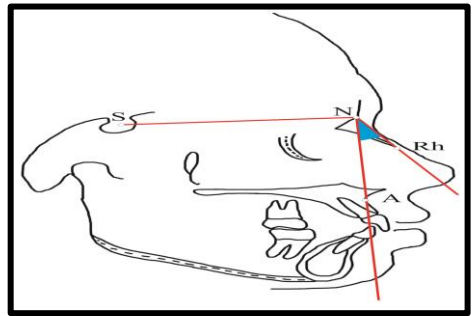


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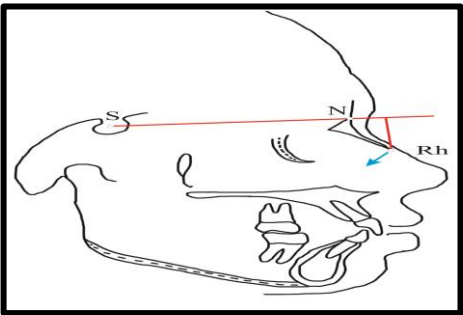


Fig. 7

growth changes on orthodontic diagnosis and treatment planning was emphasized. Bergman and co-workers (2014)<sup>[5]</sup> did a longitudinal study of cephalometric soft tissue profile traits between the ages of 6 and 18 years using data available at the Burlington Growth Centre. They concluded that nasal projection is one of the traits that increased in size over the years. But most of these studies<sup>[6-9]</sup> have focused on soft tissue part of nose & its growth related changes. No studies have been done evaluating changes in nasal bone after orthodontic treatment. So a study that focuses on the changes in

nasal bone after orthodontic treatment gains importance.

The aim of this study was:

- To evaluate the pre & post orthodontic treatment changes in the nasal bone using lateral cephalograms.

**Anatomy of Nasal Bone<sup>[10]</sup>**

The nasal bones are two small oblong bones, varying in size and form in different individuals. Each has two surfaces and four borders (Fig.1).

**Surfaces & Borders (Fig. 2)**

The outer surface is concavo-convex from above downward, convex from side to side and is covered by the Procerus and Compressor naris muscles. The inner surface is concave from side to side, and is traversed from above downward, by a groove for the passage of a branch of the nasociliary nerve. The superior border is narrow, thick, and serrated for articulation with the nasal notch of the frontal bone. The inferior border is thin, and gives attachment to the lateral cartilage of the nose. The lateral border is serrated, to articulate with the

**Table I: Paired sample statistics-Linear measurements (in millimetres)**

	N	Mean	Std. Deviation	Std. Error Mean	P*
SN PRE	36	72.4861	4.99069	.83178	
SN POST	36	73.2083	5.46074	.91012	.066
SRh PRE	36	84.8889	5.94752	.99125	.582
SRh POST	36	85.1806	6.55760	1.09293	
SN Perpendicular to Rh – PRE	36	21.9583	3.50179	.58363	0.019 sig*
SN Perpendicular to Rh- POST	36	23.0139	3.48361	.58060	
NRh PRE	36	24.3194	3.30833	.55139	.266
NRh POST	36	24.7917	3.42757	.57126	

**Table II: Paired sample statistics- Angular measurements (in degree)**

	N	Mean	Std. Deviation	Std. Error Mean	P*
SNRh PRE	36	113.4306	6.20156	1.03359	0.029 sig*
SNRh POST	36	110.9861	8.70836	1.45139	
NSRh PRE	36	15.2778	2.27861	.37977	
NSRh POST	36	15.7222	2.10931	.35155	.181
SNA PRE	36	84.3333	3.80038	.63340	0.004 hs*
SNA POST	36	82.8056	3.82898	.63816	
ANRh PRE	36	29.7917	4.35460	.72577	.556
ANRh POST	36	29.4722	4.35225	.72537	

**Table III: Correlation of parameters shown significant in paired sample test- Pre Treatment values**

		SNRh PRE	SNA PRE	NRh PRE
SNA (PRE)	R	.670		
	p	<.001 vhs*		
	N	36		
SN Perpendicular Rh (PRE)	r		-.500	.951
	p		<.002 hs*	<.001 vhs*
	N		36	36

frontal process of the maxilla. The medial border, thicker above than below, articulates with its fellow of the opposite side.

#### MATERIAL AND METHOD

The sample used in this study was drawn from the files of our department. The sample contained pre and post orthodontic treatment tracings of lateral cephalometric radiographs of 36 subjects (18 females & 18 males).

The inclusion criteria were as follows:

- Subjects above 16 years as by that age nasal bone growth would have completed almost in both males & females in the normal population<sup>2</sup>.
- All cases undergone fixed orthodontic treatment (treated with premolar extractions in all types of malocclusion) was included in the study except those which have undergone surgical correction. Equal distribution of the sample selection in sex was taken to verify its contribution to the changes in nasal bone. The tracings were completed and

**Table IV: Correlation of parameters shown significant in paired sample test- Post Treatment values**

	SNRh POST	SNA POST	NRh POST
SNA POST	.519		
	<.001 vhs*		
	36		
SN Perpendicular Rh (POST)		-.526	.953
		<.001 vhs*	<.001 vhs*
		36	36

repeated three times by the same examiner on three different time interval. The examiner was also blinded to the previous completed measurements.

The measurements were tabulated in a spreadsheet, and SPSS 17.0 software (SPSS Inc., Chicago, IL) was used to perform statistical analyses. An intraclass correlation coefficient was initially calculated. If the coefficient was greater than .75, the three repeated measurements were averaged. Means and standard deviations were then calculated. Paired *t* tests were used to test the differences of the measurements taken before and after therapy. Finally, various correlation coefficients were calculated. For a critical trial with a power of 80% and an alpha level of .05, a sample size of 25 patients was considered suitable.

#### CEPHALOMETRIC LANDMARKS

The following landmarks were used: (Fig. 3)

**Sella (S):** the midpoint of Sella turcica.

**Nasion (Na):** junction of the frontal and nasal bones at the naso-frontal suture.

**Rhinion (Rh):** tip of the nasal bone.

**Point A (A):** the deepest point in the concavity of the anterior maxilla between the anterior nasal spine and the alveolar crest.

#### PARAMETERS

4 Linear and 4 angular measurements were made on every tracing (Fig. 4). They are as follows:

##### Linear measurements: (millimeter)

1. S to N: the horizontal distance between Sella to Nasion.
2. S to Rh: the horizontal distance between Sella to Rhinion.
3. N to Rh: the vertical distance between Nasion to Rhinion.
4. SN Perpendicular to Rh: the vertical distance measured by a line drawn perpendicular from SN line to Rhinion.

##### Angular measurements: (degree)

5. SNRh: angle formed by the SN line and NRh line.
6. NSRh: angle formed by the NS line and SRh line.

7. SNA: angle formed by the SN line and NA line.

8. ANRh: angle formed by the AN line and NRh line.

**Linear measurements:** S to N & S to Rh are the horizontal linear measurements taken in order to evaluate whether any anteroposterior changes of nasal bone is taking place irt sella post orthodontic treatment. N to Rh & SN Perpendicular to Rh were the vertical linear measurements taken in order to evaluate the vertical changes taking place irt rhinion of nasal bone post orthodontic treatment.

**Angular measurements:** SNRh is the angular measurement taken to evaluate the angular changes of nasal bone. NSRh aided to evaluate the inclination of nasal bone in relation to sella. SNA was measured since it is the most commonly used measurement to assess the orthodontic changes in relation to maxilla to which the nasal bone is articulated. ANRh was used to check whether any correlation is there between point A & nasal bone.

#### STATISTICAL ANALYSIS

Paired sample statistics was done to find the mean value of each parameter pre & post treatment. Test of significance was done with paired sample test. A Pearson correlation test was performed between each parameter. The level of significance ( $p < 0.05$ ) was set at the 95% confidence level. Therefore, any value calculated less than or equal to 0.05 was considered significant.

#### Paired Samples Statistics (Table I & II)

- Among the angular measurements SNRh & SNA showed angular reduction post orthodontics. ANRh was seen to remain almost unchanged post orthodontics which was interesting. This explained that there must be a relation between SNRh & SNA. This may be due to the factor that ANRh is the difference between SNRh and SNA ( $ANRh = SNRh - SNA$ ).
- Among the linear measurements SN perpendicular to Rh showed increase in its length post orthodontics. Other measurements didn't show much changes post orthodontics.

- SNRh, SNA & SN perpendicular to Rh pre & post changes showed significant.

#### **Correlations (Table III & Table IV)**

Correlation test shows highly significant correlation between SNA & SNRh. SN perpendicular to Rh shows positive correlation with SNA & a negative correlation with NRh.

#### **RESULTS**

As was previously stated, linear and angular measurements were made on the nasal bone in order to describe its changes in the vertical & horizontal direction along with the angular changes post orthodontic treatment (Fig. 4).

#### **Angular changes in the nasal bones post orthodontic treatment (SNRh, NSRh, ANRh)**

The angular dimension of nasal bone (SNRh) was found to decrease post orthodontic treatment. The angular dimension of nasal bone in relation to Sella (NSRh) was found to remain unchanged. A tendency of the Angular measurement ANRh to maintain a constant angle by the tilting of nasal bone in accordance to SNA was also observed.

#### **Changes seen in the nasal bone in vertical direction post orthodontic treatment (N to Rh & SN Perpendicular to Rh)**

N to Rh which determines the length of the nasal bone remained almost unchanged post orthodontic treatment. SN Perpendicular to Rh indicated a vertical movement of rhinion post treatment.

#### **Changes seen in the nasal bone in horizontal direction post orthodontic treatment (S to N & S to Rh)**

There was no significant anteroposterior movement of nasal bone observed post orthodontic treatment.

#### **DISCUSSION**

The prime focus of this study was in the changes in the nasal bone post orthodontic treatment. There are few studies on morphometrics of nasal bone in prenatal and syndromic patients.<sup>[11-18]</sup> This study is first of its type. A few interesting findings were observed which will be discussed.

#### **Angular changes in the nasal bones post orthodontic treatment (SNRh, NSRh, ANRh)**

The angular dimension of nasal bone (SNRh) was found to decrease post orthodontic treatment in this study in general. The amount of tilting of the nasal bone was seen correlated to the amount of change in the SNA post orthodontic treatment. As we had more of subjects in which SNA decreased post orthodontics more of clock wise tilting of nasal bone was observed (Fig. 5). In cases where SNA was increased post orthodontics the nasal bone

showed an anticlockwise tilt. In short there was a strong correlation between Point A and Rhinion (Rh). Shifting of Point A to a new position resulted in simultaneous shifting of Rhinion along with it which we termed as 'Rhinion Shift'. This resulted in tilting of nasal bone clockwise or anticlockwise in accordance to the movement of Point A. This sought of change was observed in both male & female indicating that the tilting of the nasal bone was independent of sex. The angular dimension of nasal bone in relation to Sella (NSRh) was found to remain unchanged. The contributing factor for this is difficult to understand and hence is to be studied in detail. A tendency of the Angular measurement ANRh to maintain a constant angle by the tilting of nasal bone in accordance to SNA was also observed. This finding supported the correlation between nasal bone & point A of maxilla. That is, in case point A is moving backward Rhinion is also moving back maintaining the angle ANRh constant (Fig. 6). Point A<sup>[19]</sup> is the most commonest landmark used by most of the popular analysis. There are many studies investigating the effects of anterior tooth movement on the position of point A in the literature. One of the recent study showed that if proclination of the maxillary incisors produces posterior movement of the incisor root apex, then point A follows this retraction in half amount.<sup>[20]</sup> Thus they reported about the relation between incisor root apex and point A. In our study we were able to find a relation between point A and Rhinion. As the point A moves backwards Rhinion also seems to be going backward giving a clockwise tilt to the nasal bone. If point A is moving forward the Rhinion also moves forward exhibiting an anticlockwise tilting of nasal bone.

#### **Changes seen in the nasal bone in vertical direction post orthodontic treatment (N to Rh & SN Perpendicular to Rh)**

N to Rh which determines the length of the nasal bone remained almost unchanged post orthodontic treatment. As the duration of orthodontic treatment of the selected subjects was within 3 years & also the age criteria was above 15 years there was no significant changes in the length of the bone. Posen (1967)<sup>[7]</sup> observed that an average of 90 per cent of the total nasal bone growth from 3 months to 18 years of age was accomplished by the age of 13 years in the normal population. The growth patterns for this dimension, in both males and females, were basically similar throughout the period studied.

SN Perpendicular to Rh indicated a vertical movement of rhinion post treatment. This was observed due to its correlation to tilting of nasal bone (Fig. 7).

#### **Changes seen in the nasal bone in horizontal direction post orthodontic treatment (S to N & S to Rh)**

There was no significant anterioposterior movement of nasal bone observed post orthodontic treatment.

To concise as the point A moves backwards Rhinion also seems to be going backward giving a clockwise tilt to the nasal bone. If point A is moving forward the Rhinion also moves forward exhibiting an anticlockwise tilting of nasal bone. We also observed in surgical cases where the maxilla is advanced or distracted forward the nasal bone is getting an anticlockwise tilt i.e., SNRh is getting increased along with the increased SNA or forward movement of point A. This tilting of the nasal bone may be either due to the soft tissue pressure from the muscles, upper lip, alar base etc., or due to the movement of the nasomaxillary complex as a whole component as nasal bone being a unit of it. The anatomical continuity of nasal bone as lateral border of pyriform aperture ending as ANS and further going downward as premaxilla can also attribute for the correlation seen. Changes in the nasal septal cartilage attached to rhinion may also have some influence to the shift seen. Further studies are required for the clarification of the same. Mentioning about the normal nasal bone growth major studies done are from Posen (1967)<sup>[7]</sup> & Subtelny (1959).<sup>[9]</sup> Posen (1967)<sup>[7]</sup> in his study evaluated: Nasal bone & soft tissue base & tip, swung out from beneath the cranium. He observed angular dimension of nasal bone continually increased over time demonstrating the nasal bone moves up and forward (anti clockwise). This accounts for the change in dorsum shape from concave to a more flat or convex shape. Subtelny (1959)<sup>[9]</sup> in his study evaluated: The nose from 1 to 18 years had a downward & forward growth & its profile was closely related to growth of nasal bone. Both the studies showed that as the age progresses nasal bone shows an anticlockwise tilt with an increase in the SNRh angle (nasal bone inclination). But in this study a clockwise tilting of the nasal bone was observed in subjects with decreased SNA & anticlockwise tilting of the nasal bone in subjects with increased SNA post orthodontics which makes it clear that normal anticlockwise tilting of nasal bone is getting disturbed due to orthodontic forces.

The tendency of the Angular measurement ANRh to maintain the constant angle post orthodontics requires special mention as this gives a hint on the correlation of SNA & SNRh (ANRh=SNRh minus SNA); i.e., if SNA increases SNRh has to increase to maintain the constant angle of ANRh.

#### **CONCLUSION**

In this study a tilting of nasal bone was observed after orthodontic treatment. The tilting of nasal bone was correlated to the amount of change in the SNA post orthodontic treatment. A tendency of the Angular measurement ANRh to maintain a constant angle by the tilting of nasal bone in accordance to SNA was observed. Vertical movement of Rhinion was also observed in accordance to the tilting of nasal bone. In short a definite correlation was observed between Point A and Rhinion.

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