

Effect of sagittal position of maxilla and maxillary incisors inclination on the position of the upper lip

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Abstract

Introduction: It is paramount to know the effect of change in maxillary incisor position and its correlation to upper lip position since this can affect treatment decision. The soft tissue paradigm also dictates the same emphasising on the position of the soft tissues as the most important determinant of any treatment modality. Hence, the purpose of this study was to determine a correlation, if any, between the skeletal position of maxilla and the upper lip, and inclination of maxillary incisors and the upper lip.

Material and Methods: This was a cross-sectional Comparative study conducted at Margalla College of Dentistry, Margalla Institute of Health Sciences, Rawalpindi. Duration of the study was 6 months. It was carried out on 55 pre orthodontic cephalometric radiographs. Age range was 16-28 years. All types of malocclusion were included in the study however; patients with Craniofacial anomalies were excluded. The Sella -Nasion- point A (SNA) angle, the Upper Incisor-Palatal Plane (UI-PP) angle and the Nasolabial Angle (NLA) were measured. The means and standard deviations were calculated for age, SNA, UI-PP angles and NLA. The Pearson's correlation coefficient was determined for SNA and NLA and for UI-PP and NLA.

Results: The means and standard deviations for age, SNA, UI-PP and NLA were 20.1±3.07 years, 82.27±2.95°, 116.87±9.9° and 100.94±13.96° respectively (Table 1). The Pearson's correlation coefficient for SNA angle & NLA was -0.096 (P>0.05) and UI-PP angle & NLA was -0.298 (P<0.01).

Conclusions: The Pearson correlation coefficient between SNA and NLA shows an insignificant weak correlation (r=-0.096, p>0.05) probably due to a number of uncontrolled variables including but not limited to lip thickness, lip tonicity, actual maxillary length and the bony support of alar base. The Pearson correlation coefficient between NLA and UI-PP shows a weak but statistically significant correlation (r=-0.298, p<0.01), probably due to the nasal component of NLA which can act as a confounding factor.

Keywords: Orthodontics; x rays; nose; lip; correlation study

Introduction

Facial soft tissues are affected by a number of factors including skeletal relationships, dental positions and soft tissue thickness and function; however, the exact nature of these relationships are still debatable. Facial aesthetics have always had a prominent position in every society and culture. A pleasing face is perceived as trustworthy and

an unattractive face is shrouded in suspicion, which is why celebrities and politicians with pleasant faces and attractive smiles gain the most following.¹

Humans are programmed to gravitate towards attractive appearances. So, in this era where facial structures and dental malocclusions can be altered by orthodontics or surgery, an aesthetically pleasing face can be acquired.¹ One of the goals of orthodontic treatment is improvement of patient's life through enhancement of dentofacial functions and esthetics.²

Facial aesthetics can be most easily identified in the profile view. A proportional face would show a complementary relationship between the nose, the lips and the chin. During

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Angle's time, numerical measurements on the Lateral Cephalogram were the determining factor for treatment planning. However, since there has been a paradigm shift to a more soft-tissue oriented diagnosis, treatment planning and stability and success of outcome,³ the skeletal analysis has lost its once pinnacle position to soft tissue analysis.⁴ For the past many years, numerous lines and angles have been used for evaluation of soft tissue landmarks that are related to facial esthetics.⁵ To describe facial attractiveness, norms are used to explain what are the satisfactory facial traits and to establish a range of values within which lies acceptability. These norms are used as a guide in which through various treatments, facial unpleasantness with underlying discrepancies must be brought near to the ideal norms. For calculation of soft tissue profile changes many angles were used one of which is Nasolabial Angle (NLA). It is a clinical and cephalometric parameter, and it is associated with the anteroposterior position of the maxilla.⁶ Out of the various structures of the face, the NLA holds a paramount position.⁷ The NLA describes the relationship between the lower border of the nose and the upper lip. There are numerous methods described in the literature for measurement of this angle, but the one being favoured is that of Dr. Jay P Fitzgerald which involves the intersections of two tangents, the first at the base of nose and the second touching the most anterior point of the upper lip.⁴

It has been seen in previous studies⁸ that NLA is affected by the position of maxilla and its dentoalveolar process. As the upper lip is almost completely supported by the upper anterior teeth embedded in the maxilla, it stands to reason that any displacement of the maxilla or maxillary teeth in the sagittal plane would affect the NLA. The purpose of this study is to determine a correlation, if any, between the sagittal position of maxilla (SNA)

& the NLA and also between the upper incisor inclination (UIPP) & the NLA.

Material and Methods

A cross-sectional comparative study was conducted at Orthodontic Department of Margalla College of Dentistry, Margalla Institute of Health Sciences (MIHS), Rawalpindi. The study was approved from Ethical Review Committee of MIHS. Data was collected using pre-treatment Lateral Cephalograms of patients undergoing orthodontic treatment. A sample of 55 pre-treatment Cephalograms of patients were selected with an age range of 16 to 28 years. Data was collected using non-probability convenience sampling including all types of malocclusion however, patients with craniofacial anomalies were excluded. It is the department protocol to take informed written consent from all the patients before the start of the treatment.

The Lateral Cephalograms were taken from the patient's files and all relevant hard and soft tissue structures were traced and marked, using a sheet of transparent lead acetate tracing paper measuring 8X10 inch and 0.003-inch thickness. The sheet was placed over each Cephalogram and tracings were performed using mechanical pencil (Dollar) with 0.5mm thick lead. The different planes were drawn as shown in Fig 1. The SNA angle was measured as inferior posterior angle formed by intersection of SN and NA lines, the UIPP angle was measured as the inside angle at the intersection of the palatal plane and the long axis of the most prominent upper incisor, and the NLA was measured according to the criteria given by Dr. Jay P Fitzgerald⁴ (by intersections of two tangents, the first at the base of nose and the second touching the most anterior point of the upper lip).

To test the reliability of measurements used (error of method evaluation), 30 Cephalometric radiographs were randomly selected and were retraced in an interval of

one week by a colleague. Method errors were calculated by using Dahlberg's formula.⁹ Thereafter, the measurements were compared by applying paired 't' test to calculate systematic errors, with a p value of less than 0.05. The results of the two measurements showed no statistically significant difference. The statistical analysis was carried out by using Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics, including means and standard deviations were calculated for age, SNA, UI-PP and NLA. The Pearson's correlation coefficient for SNA & NLA and UI-PP & NLA was calculated. P-value of ≤ 0.05 was considered significant.

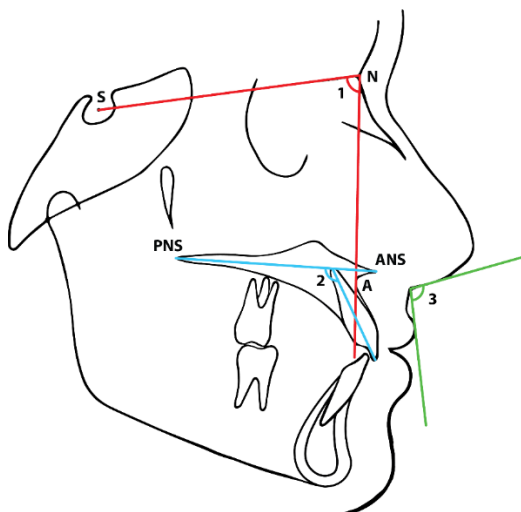


Figure 1. (1) SNA Angle, (2) UI-PP Angle, (3) Nasolabial angle

Results

Sample consisted of 55 pre-treatment Lateral Cephalograms (15 males and 40 females). The means and standard deviations for age, SNA, UI-PP and NLA were 20.1 ± 3.07 years, $82.27 \pm 2.95^\circ$, $116.87 \pm 9.9^\circ$ and $100.94 \pm 13.96^\circ$ respectively (Table I). The Pearson's correlation coefficient for SNA angle & NLA was -0.097 (>0.05) and UI-PP angle & NLA was -0.298 ($P < 0.01$) (Table 2). SNA angle and NLA have an inverse proportionality trend

with a gradient of -0.2114 (Figure 2). UI-PP angle and NLA have an inverse proportionality trend with a gradient of -0.02 (Figure 3).

Table I. Descriptive Statistics of Age and Angular Measurements

	Age (yrs.) Mean \pm SD	SNA Mean \pm SD	UI-PP Mean \pm SD	NLA Mean \pm SD
Females (N=40)	20.3 \pm 3.11	82.8 \pm 3.05 $^\circ$	119.15 \pm 8.74 $^\circ$	100.99 \pm 13.1 $^\circ$
Males (N=15)	19.67 \pm 2.99	80.83 \pm 2.16 $^\circ$	110.8 \pm 1.56 $^\circ$	103.16 \pm 13.55 $^\circ$
Total (N=55)	20.2 \pm 3.07	82.27 \pm 2.94 $^\circ$	116.87 \pm 9.9 $^\circ$	100.94 \pm 13.96 $^\circ$

Table II. Pearson Correlation Coefficient for SNA and UI-PP with NLA

Statistics	Pearson Correlation	
	SNA	UI-PP
Variables	NLA	NLA
R	-0.096	-0.298
P	>0.05	<0.01

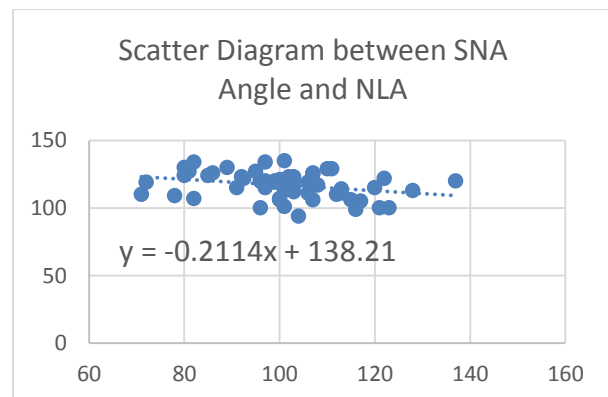


Figure 2. Scatter Diagram between SNA Angle and NLA

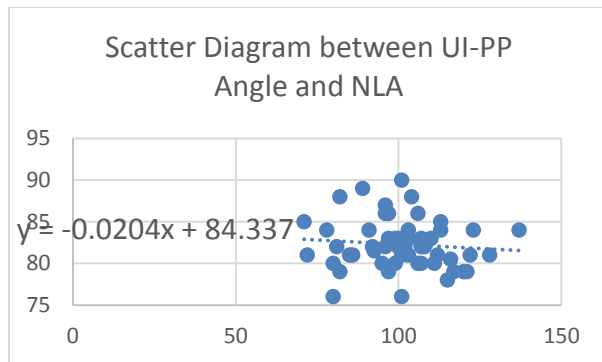


Figure 3. Scatter Diagram between UI-PP Angle and NLA

Discussion

In this study, we focused on three cephalometric parameters that depict the position of the maxilla, the maxillary dentoalveolar complex and soft tissue drape to determine if there is any association between them. The main objective of our study was to determine if there was a correlation between the sagittal position of the Maxilla (SNA) and the position of the upper lip (NLA), and between the upper incisor inclination (UIPP) and the upper lip position (NLA).

SNA depicts the relationship between the skeletal base and maxilla, and since the upper lip rests on the maxilla and its dentoalveolar complex, it can be postulated that the position of the maxilla will alter the position of the upper lip, but not with direct proportionality, which can be attributed to the difference in upper lip thickness.⁶

The results in our study showed a weak negative correlation between SNA and the NLA ($r=-0.096$) which is statistically insignificant ($p>0.05$) suggesting that as the SNA increases there could be a slight decrease in the NLA. Our findings are corroborated by the results of Parsad et al (-0.006 ± 0.93), however Parsad had a much weaker correlation.¹⁰ Their study sample included 180 individuals with almost equal

males and females. Our sample consisted of 55 subjects with a higher proportion of females. Both samples had similar age ranges. Their lower r -value could be due to the inclusion of more males in the study sample as Enlow and Hans reported that the male nose was proportionately larger, more protrusive, and longer than the female nose,¹¹ and Ferrario et al. also found that volume of nose, external nasal surface, and linear distances were larger in males than in females.¹²

The insignificant weak correlation from our study was also found by Tabatabaei et al,¹³ ($r=-0.05$) who concluded that the nasolabial angle could not be influenced by the maxillary position as dramatically as with several morphologic factors and growth could alter skeletal discrepancies. The Iranians attempted to reduce the effect of the nose by dividing the nasolabial angle into upper and lower with respect to true horizontal. Even then the lower NLA was only weakly correlated to SNA ($r=0.11$). They further attempted to consider only skeletal class 1 cases ($r=-0.27$) but their results were still insignificant.

Another Indian study attempted to establish a correlation between the nasolabial angle and the effective maxillary length. The correlation was also found to be insignificant.¹⁴

Fitzgerald measured 6 hard tissue and 3 soft tissue parameters, but he found no significant relation between the soft tissue profile of the nasolabial region and the underlying skeletal components, and his conclusions were similar to ours, where he stated that NLA could not describe variation in hard tissue.⁴

Capalezzi,¹⁵ on the other hand, maintained that the nasolabial angle indicated the actual sagittal position of the maxilla, thus should be considered of great clinical importance. Freer and Saxby also concluded that upper and lower lip position and posture is heavily influenced by Points A and B.¹⁸ Seban et al²¹ also found that in their study regarding upper premolar extraction and retraction of upper

incisors, maxillary retrusion (reduction in SNA) was associated with upper lip retrusion (increase in NLA).

The present study gave a weak ($r=-0.298$) but statistically significant ($p<0.01$) correlation coefficient between the upper incisor position (UIPP) and position of the upper lip (NLA) indicating that as the upper incisor proclines, there is a small but definite increase in the NLA. This value suggests a stronger correlation than was calculated by another Pakistani study¹⁷ ($r=-0.097$). Their insignificant correlation could be attributed to the large age range (13-35y), including patients in late mixed dentition. Fitzgerald also suggested a weak correlation, and stated that the NLA could be in the normal range while incisors were proclined.⁴

Tabatabaei et al¹⁶ disagreed with that conclusion, and pointed out that the nasolabial angle would be strongly correlated to incisor inclinations, and would be dramatically influenced by dental compensations. However, the objective of this Iranian study was not the incisor inclination and their statement was not supported by statistical data.

Freer and Saxby found that upper and lower lip positions and posture seems to be substantially related to the horizontal positions of upper and lower incisors, and to the angulation of the upper incisor.¹⁸ Our study also showed that there is a relationship between the upper lip and the inclinations of the upper incisors, but it was weak. Perhaps a larger sample size would bring forth a stronger correlation.

Talass et al¹⁹ and also Ramos et al²⁰ and Seben et al²¹ were of the opinion that NLA would increase by upper incisor retraction to some extent, which can be understood as the NLA partially depending on the upper incisor inclination; which is being suggested by our results as well. Talass et al¹⁹ concluded that there was a definite but low predictability of the upper lip associated with upper incisor, similar to the results of our

study. They stated that this could be caused by the complex anatomy and/or dynamics of the upper lip, which cannot be evaluated by the presently available cephalometric techniques. Ramos et al²⁰ found that the incisal edge or the most vestibular point of the incisor, which was our point of reference, has minimal predictive value for lip movement. They concluded that the movement of the cervical point of the upper incisor greatly influenced changes in the upper lip, mainly in the horizontal plane; perhaps using a cephalometric parameter to quantify the cervical point in our study would have provided a stronger correlation. They also stated that the individuality of nasal base growth rather than the upper lip anatomy is the probable cause of the variability in the nasolabial angle. A Japanese study²² also supports the conclusion that the correlation between the horizontal upper lip position and maxillary incisors improved if the point of reference was the maxillary incisor cervical point instead of the incisal edge: which is in fact a good predictor for the horizontal lower lip position. Seban et al²¹ stated that in class ii div 1 cases, upper premolar extraction and retraction of upper incisors resulted in upper incisors retrusion (reduction in UIPP) leading to a reduction of facial convexity and upper lip retrusion (increase in NLA), however they were unable to establish a definite relationship between the variables.

A Middle Eastern study²⁴ also showed a similar correlation between the upper incisor position and the upper lip/NP angle ($r=0.247$) as our study. They concluded that the position of the upper lip was affected most by the underlying hard tissues.

An Indian study²³ showed similar results as our study. They found that the correlation between upper incisor inclination and nasolabial angle was -0.229 . They also found that even dividing the nasolabial into upper and lower compartments, and calculating the correlation between the lower compartment

of NLA and upper incisor inclination, the r -value did not improve. This low correlation can be attributed to a number of confounding factors related to the NLA. The most prominent of these factors are the shape of the lower border of the nose, and the fact that the upper lip is taken as a straight line, rather than as a curve.

The NLA is demonstrative of the soft tissue profile and acts as an indicator for the anteroposterior position of maxilla and maxillary dentition. It remains an excellent clinical and cephalometric parameter to subsequently formulate the treatment plan for dental and skeletal malocclusions.⁴ However, there still appears to be an apprehension among authors and clinicians in judging the contour of the soft tissue profile, as well as in considering the alterations that occur in this facial profile as a result of growth and orthodontic treatment.

It is suggested that further research be carried out on the relationship of the NLA with other soft tissue measurements and a larger sample size, so that exposure to harmful radiation can be reduced to a minimum by completely replacing cephalometrics by anthropometric measurements on profile photographs.

Conclusions

The Pearson correlation coefficient between SNA and NLA shows an insignificant weak correlation ($r=-0.096$, $p>0.05$) probably due to a number of uncontrolled variables including but not limited to lip thickness, lip tonicity, actual maxillary length and the bony support of alar base.

The Pearson correlation coefficient between NLA and UI-PP shows a weak but statistically significant correlation ($r=-0.298$, $p<0.01$), probably due to the nasal component of NLA which can act as a confounding factor.

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