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ORIGINAL ARTICLE

Relationship of cephalometric hard tissue parameters and nasolabial angle

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Abstract:

Background and aims: Nasolabial angle is an important landmark that affects patient's profile and also appearance of smile. This study has done to assess the relationship between skeletal and dental parameters and nasolabial angle for formulating the individual value of the angle for each patient,

Subjects and methods: Sixty healthy girls who were referred to orthodontic department of Tehran University of Medical Science were included in the study. Eight skeletal, three dental and three nasal soft tissue parameters (14 parameters) were measured on lateral cephalograms.

Results: There were no significant relationships between nasolabial angle and parameters which were analyzed, but derivatives of this angle which named FNA (Posteroinferior angle between Frankfort horizontal plane and columella of the nose) and FLA (Posteroinferior angle between Frankfort horizontal plane and upper lip) showed significant relationship with the parameters. FNA had a positive correlation with U1-Pal, U1-FH, U1-SN, SNA and SNB angles, FLA had positive correlation with SNA, SNB, U1-SN, U1-FH, U1-Pal, and SGn-SN. By means of Multiple Regression analysis for FLA angle, SNB and U1-FH, and for FNA angle, U1-PAL had significant effects.

Conclusion: Hard tissue parameters couldn't affect nasolabial angle, but they had an influence on its derivatives.

Key words: Profile, Nasolabial angle, FNA, FLA, Dental and Skeletal landmarks

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INTRODUCTION

A proportionate relationship between nose, upper lip and chin (i.e., one thirds of face) may result in facial balance [1-3]. Thus including soft tissue considerations in planning orthodontic treatment is necessary and cephalometric analysis plays an important role to quantify it.

An individualized norm can be established for each patient to optimize facial attractiveness with regard tostandard facial traits and the patient's soft tissue features .Over the years, several lines and angles have been used to evaluate soft tissue landmarks related to facial esthetics[4]**.** The nasolabial angle is a clinical and cephalometric parameter for the determination of soft tissue profile changes, and it is related to the anteroposterior position of the maxilla [5].

Capelozza showed that the nasolabial angle indicates the sagittal position of the maxilla, thus considered a great clinical importance for it [6].

An investigation about nasolabial angle and growth had done and authors observed that craniofacial growth did not alter the nasolabial angle significantly. They suggested clinical application of the nasolabial angle in orthodontic diagnosis and treatment planning[6] .Prahl-Andersen et al, revealed that the value of the nasolabial angle decreases with age, but it stabilizes during adolescence[7].

Siqueira et al, evaluated the changes of the nasolabial angle resulted from deviations in the upper incisors position induced by craniofacial growth. They concluded that facial and dental alterations that occurred during the craniofacial growth in Brazilian white youths, did not affect the nasolabial angle significantly.

The nasolabial angle is representative of the soft tissue profile and is as an excellent clinical and cephalometric landmark showing anteroposterior position of the maxilla and consequently establishing treatment planning of dental and skeletal malocclusions[8].

The purpose of this study was to investigate the relationship between hard-tissue facial parameters and nasolabial angle. If the skeletal or dental pattern of an individual dictates the value of nasolabial angle, we should take into account different parameters and obtain the value of nasolabial angle regarding patients' acceptable range of it.

MATERIAL AND METHODS

Sixty healthy girls who were referred to orthodontic department of Tehran University of Medical Science were included in the study. All subjects had no prior history of orthodontic treatment, facial surgery; sever dental or skeletal malocclusion (Table. 1), soft tissue scar, and syndromes resulting in missing teeth.Their age ranged from 8 to 14 years.Standard high resolution lateral cephalogramswere obtained in centric occlusion notice to perioral musculature and lips being relaxed. Eight skeletal, three dental and three nasal soft tissue parameters (14 parameters) were measured on lateral cephalograms. The following landmarks were used to assess facial skeletal framework:

1. SNA: angular position of the maxilla to the cranial base
2. SNB: angular position of the mandible to the cranial base
3. ANB: angular position of the jaws to each other
4. FA (Facial angle) : the angle between Frankfort horizontal plane and N-Pog line angle
5. FMA (Frankfort Mandibular Plan Angle): the angle between Frankfort horizontal plane and inferior border of mandible
6. S-Gn-FH: the angle between Frankfort horizontal plane and S-Gn line angle
7. AFH (Anterior facial height): the distance from N to Me
8. PFH (Posterior facial height): the distance from S to Go

The following landmarks were used to assess dentition:

1. U1-SN: the angle between axis of upper central incisor and SN plane
2. U1-FH: the angle between axis of upper central incisor and Frankfort horizontal plane

3. U1- PAL: the angle between axis of upper central incisor and palatal plane

The following lateral variables were used to assess the nose:

1. FNA: Posteroinferior angle between Frankfort horizontal plane and columella of the nose
2. FLA: Posteroinferior angle between Frankfort horizontal plane and upper lip
3. NLA (Nasolabial angle): the angle formed by the intersection of the columella and the upper lip (figure.1)

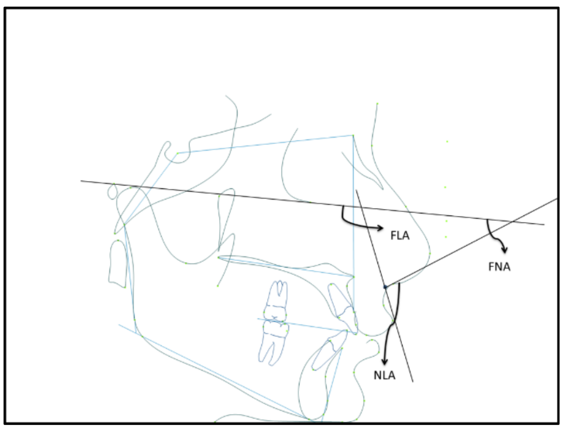

Figure1.Derivatives for nasolabial angle

Statistical analysis:

This study focused on 3 questions:

1. Is there any significant correlation between the nasolabialangle and underlying hard tissue structures, i.e. can prognathism or retrognathism of maxilla affect the nasolabial angle?
2. What are the effects of dentition parameters on this angle?
3. Does the nasolabial angle vary according to the individual skeletal growth pattern? For example can we say horizontal growth pattern subjects have acute nasolabial angle? If it is true, we should consider this item in our treatment planning.

Statistical evaluation was performed with SPSS 18. The mean, standard deviation (SD), maximum and minimum were determined for each of the parameters (Table 1.).

Relationship between derivatives of nasolabial angle (FNA and FLA) and the other variables was assessed with calculating Pearson correlation coefficient (Table 2, 3.).

Stepwise Regression analysis measures the degree of influence of the independent variables on nasolabial angle.

RESULTS

Table.1 shows the descriptive statistical results of the variables. Table.2 and Table.3 reveal that FLA and FNA angles have significant positive correlations with 1-PAL, SNA, SNB, U1-FH and U1-SN; thus it implies that FNA and FLA angles increase if any of 5 above angles become larger in amount, furthermore the correlation coefficient value(r) between SNB and FLA is more than SNB and FNA. SGn-SN angle have a negative correlations with FNA and FLA, so increasing the SGn-SN angle can cause decrease the FNA and FLA angles in amount.

The correlation between linear and angular measurements with age showed in table.4 by means of Simple Regression Analysis.

The results illustrated that changes in amounts of N-ANS, N-Me (i.e., anterior facial height) and S-Go (i.e., posterior facial height) have positive correlations with age. Stepwise Multiple Regression carried out to investigate the correlation between FNA and FLA with other parameters. FLA was significantly related to SNA and U1-FH, whereas FNA had a significant relation with U1-PAL. Results demonstrated that 1 unit increase in U1-FH lead to 0.32 unit increase in FLA, when the SNB is constant, and 1 unit increase in SNB lead to 0.7 unit increase in FLA, when the U1-FH is constant. According to results of the analysis for FNA angle, 1 unit increase in U1-PAL yields 0.42 unit increase to the amount of FNA angle.

Table 1. Descriptive statistical results of variables

Variable	Mean	SD	Minimum	Maximum
Age	10.367	1.785	8	14

ANB	4.541	5.079	-1	10
ANS-Me	67.758	7.047	55	105.50
FA	84.850	4.035	77	97
FLA	92.925	8.669	77.5	118.5
FMA	28.092	4.71	13	37.5
FNA	25.608	7.081	13	41
Jarabak index	61.4	5.717	34	67
U1-PAL	107.750	6.729	86	122.5
N-ANS	50.542	3.492	42	57.50
N-Me	115.858	7.088	102	135
NLA	113.192	9.482	95.50	135
S-Go	71.608	7.096	35	86.5
SGn-FH	61.117	3.435	55	68.5
SGn-SN	70.5	4.010	62	81
SNA	79.150	3.904	67.50	87
SNB	74.658	3.946	66.500	85.5
U1-FH	109.350	7.207	85.5	127.5
U1-SN	100.55	7.002	85	119.5

Table 2. Correlation analysis between NLA, FLA, FNL, and age and 15 others

Variable	FLA		FNA		NLA	
	r	P	r	p	r	P
Age	-0.1102	0.404	0.076	0.565	0.057	0.664
ANB	-0.0992	0.455	0.0120	0.928	0.0258	0.846
ANS-Me	0.1473	0.26	-0.14	0.26	-0.21	0.10
FA	0.17	0.18	0.23	0.07	0.009	0.94
FMA	-0.11	0.39	-0.21	0.10	-0.07	0.57
JI	0.003	0.97	0.10	0.43	0.13	0.30
U1-PAL	0.29	0.02*	0.39	0.002*	-0.01	0.90
N-ANS	-0.19	0.12	0.02	0.86	0.21	0.10
N-Me	0.03	0.78	-0.08	0.53	-0.07	0.54
S-Go	0.03	0.78	0.06	0.64	0.07	0.57
SGn-FH	- 0.16	0.20	-0.24	0.05	0.001	0.99
SGn-SN	-0.30	0.01*	-0.24	0.05	0.09	0.47
SNA	0.41	0.001*	0.31	0.01*	-0.11	0.39
SNB	0.43	0.000*	0.33	0.01*	-0.09	0.48
U1-FH	0.38	0.002*	0.32	0.008*	-0.14	0.26
U1-SN	0.45	0.001*	0.27	0.03*	-0.23	0.07

r: correlation coefficient value
* P<0.05

Table 3. Variables with significant positive relation with FNA and FLA

Variable	FLA		FNA	
	r	P	r	p
U1-PAL	0.29	0.02	0.39	0.002
SNA	0.41	0.001	0.31	0.01
SNB	0.43	0.000	0.33	0.01
U1-FH	0.38	0.002	0.33	0.0080
U1-SN	0.45	0.001	0.27	0.03

Table 4. Simple Regression Analysis between age and other variables

variable	r	p
ANB	0.027	0.835
ANS-Me	0.176	0.206
FA	0.006	0.96
FMA	0.02	0.885
JI	0.18	0.17
U1-PAL	0.08	0.552
N-ANS	0.529	0.001*
N-Me	0.56	0.001*
S-Go	0.956	0.001*
SGn-FH	0.1	0.955
SGn-SN	0.19	0.294
SNB	0.04	0.77
SNA	0.006	0.942
U1-FH	0.05	0.733
U1-SN	0.11	0.900

* P<0.05

Table 5. Multiple regression analysis for dependent variable (FLA)

Independent variables	Residual variables	coefficient
SNA	SNB*	0.7
SNB	U1-FH*	0.32
U1-FH	_	_
U1-SN	_	_
NLA	_	_
Age	_	_

Table 6. Multiple regression analysis for dependent variable (FNA)

Independent variables	Residual variables	coefficient
Age	U1-PAL*	0.42
U1-PAL	_	_
U1-FH	_	_
U1-SN	_	_
SNA	_	_
SNB	_	_

DISCUSSION

The aim of this study was to evaluate the influence of hard tissue parameters of craniofacial skeleton on the amount of nasolabial angle and answer to this question that if it is possible to predict this angle from measuring the craniofacial parameters, thus we may change our treatment plan to provide a specific nasolabial angle at the end of our treatment that suits to any individual patient.

Nasolabial angle is an important auxiliary parameter in the diagnosis of anteroposterior maxillary discrepancies, and is a strategic region of facial profiles[5]. Furthermore the nasolabial region is a keystone of facial aesthetics and is important in planning and execution of orthognathic surgery(9) and off course orthodontic treatment. As a consequence, the clinical application of this angle contributes to the differential diagnosis of skeletal malocclusions, particularly of Class II malocclusions. For attenuation of labial inclination of maxillary incisors, extraction of maxillary first premolars and retraction the anterior segment can be useful, addition to class II malocclusion cases with maxillary protrusion, bimaxillary protrusion cases can be treated by the extraction of four premolars to improve esthetic in frontal facial features[(10).] The nasolabial angle is representative of maxillary inclination; when this variable is increased, it reflects a maxillary retrusion, and when it decreased it show that maxilla was protruded[(11).] In other cases application of headgear may be indicated. Subapical anterior maxillary segmental osteotomy is indicated for cases that skeletal discrepancy is more sever; addition to correction of maxillary protrusion, the amount of nasolabial angle may be reached to its normal range[(12).] Further than nasolabial angle, other nasal characteristics like alar base width, nostril width and nostril axis angle, columellar length and collumelar angle may show significant changes[(13).] Tabrizi et al, mentioned that nasolabial compartment is a single unit and any change in one part may affect the whole unit [(14).]

Inada E. et al, investigate the relationship between cephalometric nasal and skeletal landmarks ofthe carlvarium of cadavers of preschool children. They traced lateral cephalograms of 80 Japanese children, 40 girls and 40 boys with mean age 5 years old, and digitized 22 skeletal and 3 soft tissue nasal points. A stepwise regression analysis was done to determine how combinations of skeletal landmarks explains the location of the nasal landmarks, and an independent group t-test was used to examine for sex differences of coordinates of the nasal landmarks and their related skeletal landmarks in cephalograms. They concluded that the nasal landmarks in preschool children can be predicted from selected skeletal landmarks, and there was no sex difference for the nasal landmarks in children [(15).]

Christopher Rynn et al., attempt to compose a reliable and reproducible method to predict nasal morphology from the skull. The samples composed of 79 adult North American subjects from a database of clinical CT scans of the head; they exclude CT scans from patients over 50 years old, then by means of Amira 3.1.1 software they create a virtual 3D space to evaluate hard and soft tissue landmarks. After that, they pooled with 60 lateral cephalograms of subjects of European ancestry from England to augment nasal profile data. By considering 3 landmarks in millimeters (nasion to subspinale; nasion to acanthion (tip of ANS) and rhinion to subspinale), they concluded that the morphology of the predicted nose can be sufficiently accurate to facilitate recognition of the completed facial reconstruction and it is applicable to skull data in any form: 2D or 3D[(16).]

Xingzhong Zhang et al, compared craniofacial measurements from cephalometric radiographs with analogous measurements from related facial photographs. They included 326 subjects (168 whites and 158 blacks) in the study. Standard lateral cephalometric radiograph and photographic images obtained from all the subjects. All the radiographic and photographic images traced twice and the Pearson correlation coefficient carried out to estimate the correlations between the photographic and cephalometric variables. The findings of the study showed that characterizing facial morphology can be reliably measured from facial photographs. However statistically significant correlations between analogous photographic and cephalometric measures suggest that these modalities measure different aspects of facial morphology and cannot be used interchangeably[(17).]

In the present investigation there was significant correlation between 5 parameters (U1-Pal, SNA, SNB, U1-FH and U1-SN) and two derivatives of nasolabial angle; otherwise we can’t imply that each of them have a reliable correlation with nasolabial angle. The more SNA angle, the more FLA and FNA angles, but FLA has a negative impact on the nasolabial angle and FNA has a positive impact. Thus SNA angle doesn’t affect the nasolabial angle. We use two postoinferior angles attributed to nasolabial angle; perhaps if we considered the antroinferior angle, the results would be altered. In the later measuring each parameter had a significant relationship with just one of the derivative angles: FNA or FLA.

Nanda et al, produced normative data from 104 young white adults with well-balanced faces[(18).] Three nasolabial parameters (lower border of the nose to Frankfort horizontal plane angle, upper lip to Frankfort horizontal plane angle, and nasolabial angle) assessed. A linear comparison of the three nasolabial parameters with six skeletal measurements showed no significant relationship between the soft tissue nasolabial region and the underlying skeletal relationships and this is in agreement of our study.

Garcia Epsona et al, analyzed the nasolabial angle and different factors that influence it[19] Patients of 9.0 +/- 1.4 years of age included in the investigation. Findings of the investigation revealed that the inclination and the position of the upper incisor and the ANB angle constituted the osseous and dental factors with greatest repercussion on the nasolabial angle. Sex and age did not produced significant differences and the labial incompetence determined a more acute angle. In our study these factors had relationships with derivatives of the nasolabial angle rather than the angle itself.

CONCLUSIONS

There was no significant relationship between nasolabial angle and parameters which were analyzed, but derivative angles of nasolabial angle (FLA and FNA) had a significant relationship with cephalometric variables: FNA had a positive correlation with U1-Pal, U1-FH, U1-SN, SNA and SNB angles, FLA had positive correlations with SNA, SNB, U1-SN, U1-FH, U1-Pal, and SGn-SN.

According to table.3, 1-Pal, SNA, SNB, 1-FH and 1-SN had a positive correlation with FNA and FLA, but SGn-SN had a significant negative correlation with FLA angle.

By means of Multiple Regression analysis for FLA angle, only SNB and U1-FH were significant factors, and for FNA angle, U1-PAL was the significant variable in final equation.

Coefficient of variation U1-PAL was 0.42; SNB was 0.7 and for U1-FH was found 0.32.

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