

The Static and Dynamic NLA in Relation to Malocclusion

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Abstract

The naso-labial angle (NLA) is one of the key soft tissue factors to be considered in an orthodontic diagnosis as guidance for the aesthetics of the lip, nose, and so the facial profile. The objective of this study was to assess and compare, the static and dynamic NLA within and between class I and II malocclusions for male subjects using lateral photographic view of the face. Following the study criteria; 100 dental students were collected from faculty of dentistry/ university of Babylon with mean age was 22.8 years. Of these, 60 were class I malocclusion and 40 were class II malocclusion according to angle classification. For each participant in either group, a lateral photographic view was taken in upright head posture using Canon digital camera. Subjects were photographed in 2 frameworks: 1st in the static relation and 2nd in the dynamic relation. SPSS version 26 was used for statistical data analyses using Wilcoxon and Mann-Whitney test. Utilizing an AutoCAD 2024, the NLA was recorded by measuring the angle formed by connecting the two lines passing through subnasale-columella nasi and subnasale-labrale superior points. The NLA values are more and significantly higher in static than in dynamic posture for the 2 groups (93°/82°; 80°/69°) respectively. Moreover, the NLA showed a significant increase in their static and dynamic values in class I compared with class II malocclusion, ($P < 0.001$). These results signify the impact of malocclusion on the NLA and the role of soft tissue dynamics on facial profile compensation. The NLA display a great variation across malocclusions and its posture as well. However, the dynamic NLA is much less than static angle that signify the compensatory mechanism of facial tissues in profile modification which is an important feature to consider in orthodontic diagnosis.

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Introduction

Facial attractiveness with an aesthetic smile and good facial harmony are the key factors in treatment plan of orthodontic specialty. It is well known that facial balance is specified by the facial skeleton and musculature that contributes soft tissue matrix [1,2]. Rather than Angle's school in the early 20th century that emphasized hard tissue paradigm [3], orthodontic planning has been changed to adopt the soft tissue patterns. In other words, the objectives of today's orthodontics are not regulated by skeletal and dental structures unless there is an improvement in facial soft tissues [4-6].

Nevertheless, neglecting the holistic coordination of soft tissues, both jaws, and teeth along with the intricate mechanics of malocclusion, while planning treatment usually may lead to erroneous prediction by specialists about treatment objectives, difficulties, and outcomes [7-10]. In this context, preserving the aesthetics of the facial profile necessitates so many factors to consider; of these, the position of the upper and lower lip, the nasal prominence, the nasolabial angle (NLA), and the mentolabial sulcus depth. In this regard, the NLA is one of the primary key factors to be considered in an orthodontic

diagnosis as guidance for the aesthetics of the lip, nose and so the facial profile. It is formed by two tangents that passing through the lower nasal edge and the edge of the upper lip. As mentioned in literature, the ideal NLA ranges from 90°-95° for male subjects while 95°-115° for female subjects, though such values may vary among the various racial groups [11]. In general, Asian populations reveal increased NLA values and showing a flatter profile and wider angle in comparison with Africans or Caucasians [12]. However, in the literature there are controversial data regarding the standard value of the NLA [13,14],

which also can vary in relation to the sex, race, and initial malocclusion of the patient [15-17]. While static soft tissue parameters provide a stable baseline for diagnostic standardization, however, they offer an incomplete model of human facial function and aesthetics. Human animation and interactions, requiring an analytical shift from the static to the dynamic NLA [18]. During facial expressions such as a maximum smile, the contraction of the facial levator and depressor muscles causes a synchronous dramatic upward and backward displacement of the upper lip as well as pronounced dynamic dip in the nasal tip. This coordinate activation causes a stark discrepancy between static resting and dynamic functional states [10]. So, it is fundamental to evaluate the soft tissue framework that representing the facial profile and its attractiveness at both the resting and smiling position [19].

Extensive previous research has explored the static soft tissue imaging [20,21]; however, studies focusing on the smile dynamics are still lacking. The aims of this research were to assess and compare, the resting (static) and functional (dynamic) NLA within and between class I and II malocclusion for an Iraqi adult sample by taking lateral photographic view of the face.

Material and Methods

In October 2025 to March 2026 the study sample was enrolled from at the Faculty of Dentistry, University of Babylon. Following the criteria of the study; 100 dental students were collected from different classes and all of them are male subjects. Of these, 60 were class I malocclusion and 40 were class II malocclusion according to angle classification. The mean age of the participants was 22.8 and 23.3 years for class I and II malocclusion; respectively. However, both groups were not different statistically in their mean age value ($P > 0.05$). To be included in the study; they should have Class I or II molar relation, no history of orthodontics or maxillofacial surgery, good quality and contrast photographic imaging, no nasal deviation and trauma, no cosmetic nonsurgical lip procedures (filler, botox), no extracted teeth and dentofacial anomalies, competent or potentially competent lips, and no skeletal deep bite or open bite.

Considering the study criteria, the two groups of samples forming a total of 100 dental students were enrolled in the final analyses. To assess NLA, for each dental student in either group whether class I or II malocclusion, a lateral photographic view was taken in natural head position. To collect data, profile images of the sample were captured utilizing a digital camera (Canon EOS 850 D, 24-megapixel, maximum resolution 6000×4000, 100 macro lenses and 10_18 lens Ring flash + fixlite twin softbox).

The camera was adjusted to be parallel to the apparent plane of occlusion, and at 4 feet distance from the subject. The captured images were stored in a JPEG format with hidden their eyes for anonymity [22].

Keeping upright posture of the head, subjects were photographed in 2 frameworks. 1st the resting (static) position in which the lips were relaxed; and 2nd the smiling (dynamic) position in which the lips are contracted in post smile position [23].

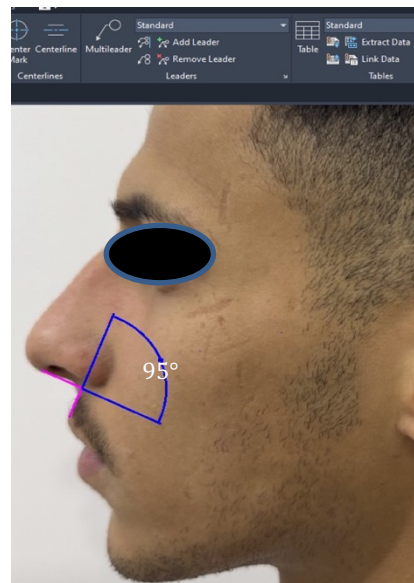


Figure 1. Measurement of NLA in static relation for participant with class I malocclusion using AutoCAD 2024.

To measure the NLA [24], the following components were identified manually on the digital image using (AutoCAD 2024) then the formed NLA was measured (Figure 1). The 1st line is connecting the subnasale (Sn) point and the columella nasi (Cm) point, which represent the upper compartment of the NLA. The 2nd line is connecting the (Sn) to labrale superior (Ls) point, which represent the lower compartment of the angle.

The measured angles of the all sample were recorded in excel sheet and saved in computer for statistical analyses.

SPSS version 26 was used for statistical data analysis. To assess the normality of collected data, Shapiro-Wilk test was used and confirmed that not normally distributed data ($P < 0.05$). As a result, nonparametric tests were utilized. Both, descriptive (minimum, maximum, median, IQR) statistics; and inferential (Wilcoxon and Mann-Whitney tests) statistics were used to compare NLA values within and between groups. P -value < 0.05 was considered as significant.

Results

Almost all the NLA values are more in static than in dynamic posture of the lips for the 2 groups; class I and class II malocclusion. Regarding Wilcoxon Signed Ranks Test, such static NLA values are significantly higher than dynamic NLA values considering both class I and class II malocclusion (P -value < 0.001).

Both angular measurements whether static or dynamic NLA were greater effected by the type of malocclusion. The NLA showed an increase their static and dynamic values in class I compared with class II malocclusion, respectively. Statistically, Mann Whitney test revealed significantly higher NLA values in class I malocclusion than class II malocclusion.

Discussion

Although facial profile is determined by hard tissue structures represented by their underlying bones and teeth, facial attractiveness and esthetic features of the orthodontic patients are brought mostly by soft tissue contours which overlying facial bones from which is originate or attach to it.

An aesthetic balanced profile and soft tissue contour are the main treatment objectives of orthodontic specialty nowadays. Among various anthropometric indices of the face is the NLA which directly influences the assessment of the harmony and aesthetics of a patient's facial profile [25,5]. Moreover, the NLA long considered a primary determinant of nasal rotation and facial harmony in orthognathic surgery and orthodontics as well, it provides deep insight into the structural transition between the mid-face and the peri-oral complex [26]. Facial expression, however, is a dynamical animated process, and traditional static analyses alone cannot completely reflect the impact of orthodontic therapy on the facial function regarding dynamic position [27].

Although the pattern of data collection was easy to achieve, female subjects have some conflict to participate in the study and so all the sample were consisting of male dental students. By such there was an exclusion to growth variation as almost all the facial alteration occur underage of 18 years [28].

The NLA measured in the present study showed that the overall values generally feel close to the established norms in the literature. Regarding the NLA within groups in static behavior, its value was 93° in class I malocclusion which is situated within the standard mean value (90°-110°) [29]. However, it was found to be reduced in subjects with angle class II malocclusion (table 1). The degree of maxillary skeletal and dental contribution to malocclusion, lip fullness and nasal morphology have some of the mentioned angular variation

between studied groups. The study result was coincided with Rahman et al in class I while not in class II malocclusion [30].

Rahman and his co-authors [30] found that the NLA was around 100° in class II malocclusion which was higher than their counterpart conducted in the present study, although it was like static values of class I group conducted in this study. However, they evaluate the nasal and soft tissue angular measurements across different malocclusions using skeletal rather than angle classification of both genders. Such difference in study results can be attributed to methodology and population criteria as the latter study classify their sample according to skeletal pattern and the number of samples were fewer in their malocclusion groups. Moreover, Pop et al in their study were revealed partially similar results of NLA values in static position utilizing lateral cephalometric radiographs and profile photographs even they did not mention the criteria of malocclusion in their sample which contribute to some difference [5]. The static NLA showed a wide range of variation among authors which underscore the great emphasis on the initial sample criteria, ethnicity, and methodology employed.

On the other hand, in both groups the dynamic NLA was reduced while the subjects were smiling and hence create some nasal tip dropping and upper lip shortening due to contraction of muscles of facial expression especially those involved in the main compartment of NLA (Table 1). During facial expressions in maximum smile, the activation of the facial depressor and levator muscles result in a synchronous dramatic displacement in upward and backward direction of the upper lip as well as pronounced dip in the nasal tip [26].

Even though multiple studies have evaluated the ideal NLA in males and females at static in lateral view and have analyzed the angle by cephalometric radiographic imaging with patients at resting position, but the clinical NLA has been less examined, specifically the effect of smiling in masking the NLA discrepancies seen at rest [31,32].

In this context and in contrast to study outcome, the resting as well as the smiling position of the lips made no difference in the NLA (105°) in male subjects with class I malocclusion group were reported by Cheng et al. [23]. Such contrary was attributed to growth potential of the included sample in the latter study, their demographic characteristic, and they underwent soft tissue measurement on 3D facial image using facial scan.

Additionally, when the NL angle in their two relations was compared within each malocclusion group using Wilcoxon test; it showed a significant difference between resting and functional dynamic angle in either sample whether

class I or class II malocclusion ($P < 0.001$). Such difference was the result of higher static than dynamic angular values as mentioned earlier, (Table 1). At rest, facial muscles were relaxed with relative tonicity maintaining facial architecture and morphology, however during smiling, there is a cranial and posterior shift of the upper lip due to muscular vector pulling, typically causing a marked NLA contraction in dynamic relation [33]. However, such study result was not aligned with Cheng et al. who concluded in their 3D facial modeling study no significant difference between resting and maximum smiling position in sample with skeletal class I malocclusion regarding male subjects [23].

Furthermore, considering the NLA values between groups (Table 2); there was a clear gap between class I and class II malocclusions regarding NLA in their different positions and its values were higher significantly in class I than class II group ($P < 0.001$). Individuals with class II malocclusions often have more dentoalveolar protrusion of the maxillary arch, thin and hypotonic upper lip, and downward and backward displacement of the columella and the upper lip; respectively, facilitating by zygomaticus complex, levator anguli oris, levator labii superioris, and depressor septi nasi muscles [26]. However, although the resting angle in class I malocclusion was higher than class II division 1 malocclusion, Santos et al were reported no significant difference in their values between groups [34]. The latter study was conducted on retrieved pretreatment lateral cephalometric radiograph of growing sample whose age between 10 to 16 years which might involve in study misalignment. The ethnicity of the participating subjects in the research and the method of determining the soft tissue points also proposed to affect the overall results [13,24].

Finally, the static and dynamic nasolabial angle display great variation among the published literature, and the present NLA values were stand some degree behind the standards estimates although it was still within the normal value.

Insufficient sample size, 2D photographic view, sample with only male subjects, not include all major types of malocclusions for comparison, deficient of control group, and it was an observational cross-sectional study are some of study limitations.

Conclusion

Both Class I and II malocclusions were displayed significantly higher static than dynamic NLA values implying a degree of soft tissue compensation during facial animation which is an important feature during orthodontic diagnosis specifically in extraction cases.

Both, static and dynamic NLA values were significantly higher in class I than class II malocclusion clarifying the impact of malocclusion on soft tissue morphology at rest and function as well.

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Table 1. Descriptive (min, max, median, IQR) statistics of NLA for class I as well as class II malocclusion group; and inferential (Wilcoxon test) statistics of static and dynamic NLA between each occlusal variety.

NLA	Group	N	Minimum	Maximum	Median	IQR	P value*
Static	Class I	60	43	121	93	14	0.000
	Class II	41	53	105	80	19	
Dynamic	Class I	60	44	104	82	19	0.000
	Class II	41	30	102	69	20	

Table 2. A comparison of static and dynamic NLA values between class I and class II malocclusion using Mann-Whitney test.

Group	NLA*	N	Minimum	Maximum	Median*	IQR*	P-value*
Class I	static	60	43	121	93	14	0.000
	dynamic	60	44	104	82	19	
Class II	static	41	53	105	80	19	0.000
	dynamic	41	30	102	69	20	

* NLA values measured in degrees (°).

* due to not normally distributed data, median and interquartile range (IQR) was used instead of mean and SD values in NLA measurement.

* P-value < 0.05 is significant.