Original Article

New diagnostic tenet of the esthetic midface for clinical assessment of anterior malar projection

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ABSTRACT

Objective: To determine whether a visual classification of anterior malar support using vector relationships is supported by cephalometric analysis.

Materials and Methods: Forty white subjects between the ages of 10 and 12 years, without craniofacial syndromes or previous orthodontic treatment, were equally divided into groups based on visual assessment of negative and positive vector relationships. Group A comprised 20 subjects (10 male, 10 female) exhibiting a positive vector relationship. Group B comprised 20 subjects (10 male, 10 female) displaying a negative vector relationship. Sella-nasion-orbitale (SNO) angulations were measured to evaluate the subjects' anteroposterior position of the malar eminence relative to the cranial base. Gender differences and significant differences in SNO measurements between groups A and B were assessed with Mann-Whitney *U*-tests.

Results: There was no statistically significant difference between genders. SNO angulations in the negative vector group were smaller than the positive vector controls by an average of 6.0 degrees, and the difference was highly significant ($P < .0001$).

Conclusion: Compared with subjects exhibiting a positive vector relationship, individuals displaying a negative vector relationship had significantly reduced malar support. Anterior malar projection can be effectively classified through visual assessment of vector relationships. (*Angle Orthod.* 2013;83:790–794.)

KEY WORDS: Soft tissue diagnosis; Midface esthetics; Malar projection

INTRODUCTION

Despite the role of the midface in facial esthetics, there is a shortage of diagnostic criteria in orthodontic literature. Arnett's[1–3] facial analysis currently offers the most comprehensive soft tissue analysis in both the frontal and sagittal planes, and he was the first author to systemize such an approach. However, this analysis is designed for surgical treatment planning and not clinical convenience. Extensive records must be taken to evaluate maxillary soft tissue points relative to true vertical, and there are no readily available instruments for making accurate, reproducible measurements of orbital rim relationships.[1,4]

Additionally, skeletal structures of the midface have been notoriously difficult to assess in lateral cephalograms, and this has led orthodontists to focus entirely on the premaxilla for classification of maxillary skeletal development. As a result, regional disharmonies in the anatomy of the maxilla have been neglected, and clinical understanding of the midface has devolved into the use of subjective descriptors. As the profession of orthodontics evolves into new treatment modalities, diagnostic references must expand along with the envelope of treatment.

The relationship of anterior cheek mass to the anterior corneal plane has been used in esthetic blepharoplasty as an indicator of bony support along the malar eminence.[5] In the young white adult, the ideal projection of the cheek prominence should be approximately 2 mm beyond the anterior surface of the cornea in the sagittal plane along the Frankfurt horizontal[4] (Figure 1). Maxillary hypoplasia in this region produces what is called a negative vector relationship with the globe positioned anterior to the malar eminence (Figure 1).[5] Although the association between maxillary development and vector relationships

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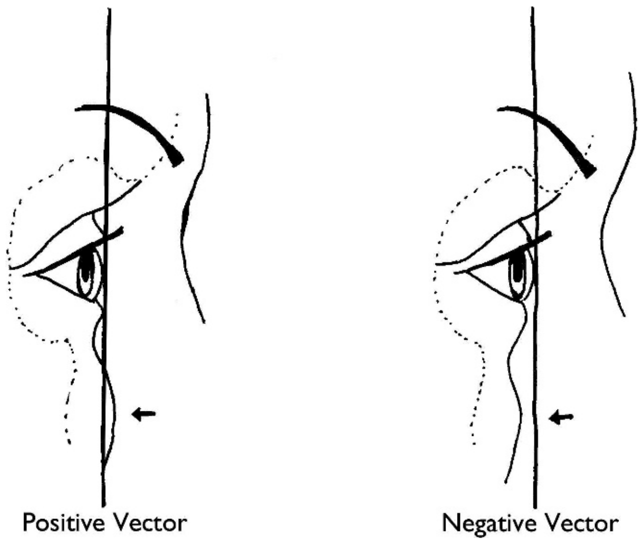

Figure 1. Positive and negative vector relationships.

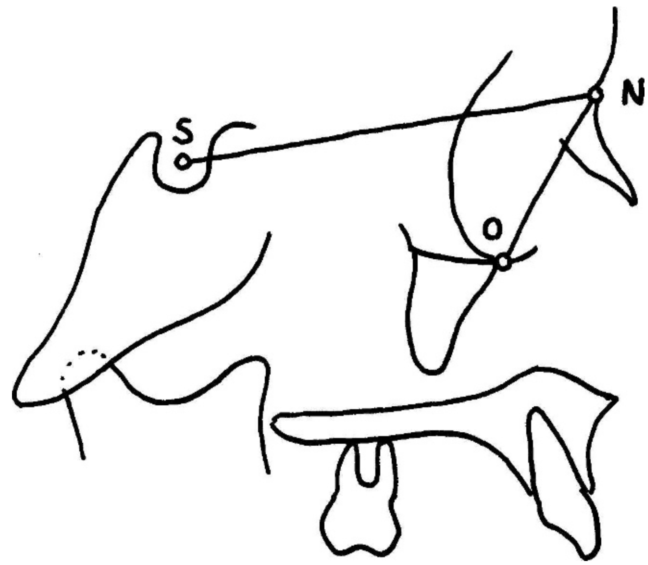

Figure 2. SNO angle.

is a widely held canon in the plastic surgical world, the validity of this principle has not been tested. This study seeks to determine whether visual classification of anterior malar projection using vector relationships is supported by cephalometric analysis.

MATERIALS AND METHODS

Forty white adolescents between the ages of 10 and 12 years were selected for analysis based on a visual assessment of malar globe relationships. Subjects with craniofacial syndromes or previous orthodontic treatment were excluded from the investigation. Institutional Review Board approval was obtained from the Colorado Multiple Institution Review Board #12-1489.

Selected patients were equally divided into groups based on negative and positive vectors. Group A comprised 20 subjects (10 male, 10 female) exhibiting a positive vector relationship. Group B comprised 20 subjects (10 male, 10 female) displaying a negative vector relationship and was matched with group A according to patient age (Table 1). Determination of each subject's vector relationship was made by one operator (Dr Frey) using only profile photographs from the patient's initial records. Profile photographs were standardized by orientation of the patient's head in the Frankfurt horizontal position.[6]

Cephalometric Analysis

In order to quantify skeletal support for each subject, sella-nasion-orbitale (SNO) angulations (Figure 2) were used to evaluate the anteroposterior position of the malar eminence relative to the cranial base. This measurement was selected according to the previous works of Leonard and Walker[7] and Walker.[8] As specified in these papers, orbitale was identified to coincide with Walker's cephalogram point 109[8] (Figure 3). The key ridge and the maxillary sinus were used as guides to consistently locate this landmark.

All cephalograms were digitally traced by one examiner using Dolphin's Imaging Software, (Dolphin Imaging & Management systems, Chatsworth, CA) with the examiner blinded to the vector classification of the subject. Cephalograms were traced by the examiner three times with a minimum of 2 days between tracings.

Prior to the cephalometric analysis, 15 random lateral cephalograms from subjects in the study were selected, and SNO angles were traced and measured at two times within a week by the same operator. The intraclass correlation coefficients (ICC) indicated excellent intraobserver agreement for SNO measurements (ICC = .98) using the specific criteria for landmark identification.

Table 1. Descriptive Statistics for Subject Ages and Comparisons[a]

	Negative Vector (n = 20) Mean	SD	Positive Vector (n = 20) Mean	SD	Difference	*z*	Significance
Males age, mo	137.2	6.1	134.1	8.9	+3.1	0.04	NS
Females age, mo	130.8	7.3	134.2	7.4	−3.4	0.98	NS

[a] SD indicates standard deviation; NS, not significant.

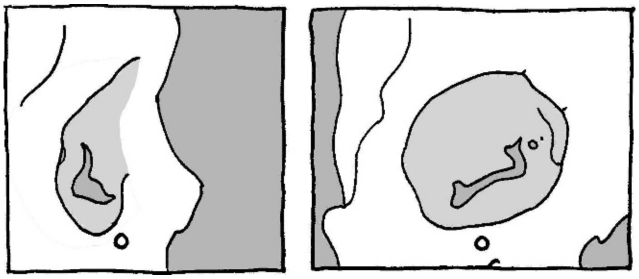

Figure 3. Anatomical orbitale location/Walker's cephalogram point 109.

Statistical Analysis

In an exploratory analysis using the Kolmogorov-Smirnov test, the data showed a nonnormal distribution, thus nonparametric statistics were applied.

Descriptive statistics were computed for angular measurements of Group A males and females, and Group B males and females. Gender differences were examined using Mann-Whitney *U*-tests. Descriptive statistics were calculated for angular measurements of Group A and Group B, and significant differences between SNO measurements for Groups A and B were assessed with a Mann-Whitney *U*-test.

RESULTS

An analysis for sexual dimorphism (Table 2) showed no statistically significant difference between genders.

Differences in skeletal support between the negative and positive vector groups assessed using SNO angles were highly significant ($P < .0001$). SNO angulations in the negative vector group were smaller than the positive vector controls by an average of 6.0 degrees (Table 3).

DISCUSSION

This study sought to evaluate the validity of vector relationships as a means of diagnosing and describing anterior malar projection and esthetics. Comparison of angular measurements for SNO from the negative vector group with the positive vector group in this study showed highly significant ($P < .0001$) retrusion of the malar eminence by 6.0 degrees in subjects with a negative vector relationship. There were no statistically significant gender differences. These findings suggest that vector relationships are an effective means of classifying anterior malar support during macroesthetic evaluation of the patient. Additionally, derived growth curves of sagittal orbital relationships have demonstrated the stability of vector relations from preadolescence into young adulthood, allowing for malar retrusion to be identified early in development.[9]

Wide variation in landmark identification of orbitale has been observed in the past[10]; however, using the protocols outlined in this study, excellent intraobserver agreement was attained for SNO measurements (ICC = .98). Though not directly examined by this study, it should be noted that numerous subjects demonstrating a negative vector relationship did not also display scleral show. Scleral show has been a traditional hallmark of maxillary hypoplasia,[11] but may be less sensitive to deficiencies in malar development than vector relationships. Additionally, considerable difficulty was encountered in identifying male subjects with positive malar architecture for use in the study. Potentially, malar retrusion is more prevalent in the male population.

A positive vector relationship has been identified in anthropometric studies as an important element of the youthful face and malar complex,[4] and should be considered the esthetic ideal (Figure 3). However, esthetic norms are not a substitute for good artistic judgment, and naturally, care should be exercised in applying guidelines too rigidly across different racial backgrounds. Youthful, esthetic facial contours require sufficient maturation and growth of both hard and soft tissues, and although orbital and malar retrusion are often associated with craniofacial syndromes, less severe hypoplasia of the midface is a common facial skeletal variant.[12] Consequently, greater attention must be paid to regional hypoplasias within the maxilla, including those presenting in the absence of malocclusion. Deficient malar and midfacial projection leaves the soft tissues poorly supported, resulting in premature lower lid and cheek descent as well as visible bags, scleral show, and a more aged appearance.[4]

Although orthodontic treatment does not directly alter malar globe relationships, the balance between dentoalveolar and malar support has significant influence over the nasal base-lip contour (Nb-LC; Figure 4).[3] Deficient development of the dentoalveolus, or overretraction of the dentition, can produce flattening of this region as well as undesirable nasolabial folding.[13] Insufficient malar projection, present with a negative vector relationship, results in ptosis

Table 2. Analysis for Sexual Dimorphism[a]

	Males (n = 20) Mean	SD	Females (n = 20) Mean	SD	Difference	z	Significance
Positive vector, °	69.8	2.45	68.8	1.79	+1.0	0.83	NS
Negative vector, °	62.9	2.52	63.6	1.09	−0.7	−0.49	NS

[a] SD indicates standard deviation; NS, not significant.

Table 3. Analysis of Skeletal Differences Between Positive and Negative Vectors[a]

	Positive Vector (n = 20) Mean	SD	Negative Vector (n = 20) Mean	SD	Difference	*z*	Significance
SNO angle, °	69.3	2.09	63.3	1.88	+6.0	5.4	***

[a] SD indicates standard deviation; SNO, sella-nasion-orbitale.
*** $P < .0001$.

of the anterior cheek mass and similar distortion of the Nb-LC due to soft tissue descent. This interplay is important in assessing skeletal contributions to nasolabial contours, determining the optimal position of the upper incisor, and planning orthodontic anchorage if extractions are indicated for normalization of lip contours. In the absence of adequate malar support, accelerated distortion of the Nb-LC and facial decline may be seen with retraction of the dentition. It should also be noted that these effects become evident with age, due to attenuation in the initial compensatory activity of the orbicularis oculi muscle and age related changes of the soft tissue envelope and underlying skeleton.[14] Orthodontists must have a broad understanding of facial aging patterns.

A comprehensive dentofacial analysis is central to the achievement of functional and cosmetic excellence in orthodontic treatment, and vector relationships provide the orthodontist with another useful diagnostic reference. Assessment of malar support will help enhance esthetic orthodontic outcomes and improve surgical orthodontic planning. In addition to determining the hard tissue contributions to nasolabial contours, vector relationships can assist the practitioner in evaluating the need for alloplastic augmentation of the inferior orbital rim and selecting the appropriate maxillary surgery. Additionally, recent scientific evaluations of the effects of bone-anchored maxillary protraction (BAMP) on the malar eminence[15,16] suggest that a negative vector can be viewed as an indicator of skeletal dysplasias, which may benefit from BAMP therapy in the adolescent patient. Further investigation is indicated. Using vector relationships as part of a dentofacial analysis provides the orthodontist with a convenient means of classifying malar support to the midface and will help to better inform treatment decisions.

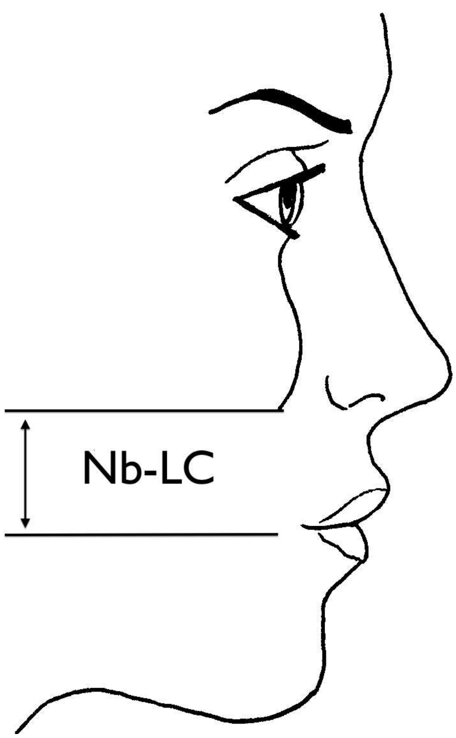

Figure 4. Nb-LC facial region.

CONCLUSION

- Differences in anterior malar projection between patients with negative and positive vector relationships were highly significant ($P < .0001$), and no sexual dimorphism was found.

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