Original Article

Cephalometric Floating Norms as a Guide toward a Harmonious Individual Craniofacial Pattern among Filipinos

Marian Almyra Sevilla-Naranjilla[a]; Ingrid Rudzki-Janson[b]

ABSTRACT

Objective: To construct a harmony box based on correlated cephalometric variables, which may serve as a valuable diagnostic tool in orthodontic treatment planning, by analyzing the harmonious relationships of existing individual craniofacial patterns among Filipinos.

Materials and Methods: Eighty-one subjects, 37 females and 44 males, were selected from the student population of a University according to established inclusion criteria. Five cephalometric angular measurements were obtained and digitized. Pearson correlation coefficients described the high association among the five variables. The bivariate linear regression analysis was used to construct a harmony box, which contained the cephalometric floating norms of the five correlated variables. Multiple regression analysis and the standard error of the estimate were calculated to construct the harmony schema, which describes the individual craniofacial pattern.

Results: Correlations between the five variables were significant at .001 and .05 levels. Linear regression equations with corresponding r^2 and standard error of the estimate (SE) were illustrated as the harmony box. The multiple correlation coefficient R, the adjusted R^2, and the SE when one of the five measured variables was predicted from the remaining four by means of a multiple regression analysis were displayed as the harmony schema.

Conclusion: The cephalometric floating norms describing the individual craniofacial pattern among Filipinos were established based on five correlated variables in the form of a harmony box. (*Angle Orthod.* 2009;79:1162–1168.)

KEY WORDS: Floating norms; Harmony box; Harmony schema

INTRODUCTION

After Broadbent[1] and Hofrath[2] simultaneously published methods used to obtain standardized head radiographs in 1931, numerous cephalometric analyses related to standardized norms were developed. These norms were derived from an untreated sample of subjects from the same ethnic group, who were selected from a population with so-called ''ideal'' or ''well-balanced'' faces with normal occlusion.[3–33] For several years, these methods provided useful guidelines for orthodontic diagnosis and treatment planning.

Solow[34] stated that a major drawback of these conventional cephalometric analyses was the use of isolated craniofacial parameters, without their possible interdependence taken into account. Accordingly, Solow demonstrated significant correlations among sagittal and vertical cephalometric variables, leading to the concept of ''craniofacial pattern.'' This implies that even though all the cephalometric values of a patient lie beyond one standard deviation (SD) from the population mean, they still may be considered acceptable if they maintain a certain correlation with each other.

Hasund et al[35] made the first effort to describe combinations of acceptable values for different facial types. Finally, a comprehensive analysis for the assessment of individual craniofacial patterns was performed by Segner[36] and by Segner and Hasund,[37] who constructed floating norms for the description of sagittal and vertical skeletal relationships in a sample of European adults.[38] Thus, the term *floating norms* was used to describe individual norms that float, in accordance with the variation in correlated cephalometric measurements. The five basic cephalometric mea-

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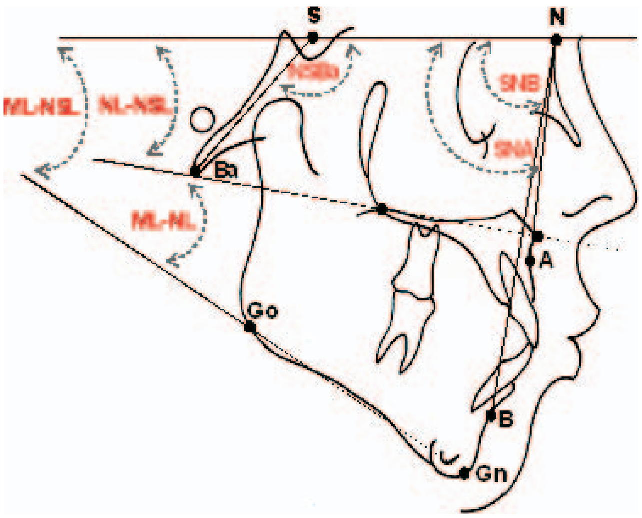


Figure 1. Cephalometric landmarks and correlated angular measurements.

surements (SNA, NL-NSL, NSBa, ML-NSL, SNB) that were found to show evidence of correlations with each other were SNA, representing maxillary prognathism, SNB, representing mandibular prognathism, NL-NSL, representing maxillary inclination, ML-NSL, representing mandibular inclination, and NSBa, representing the cranial base angle. The intermaxillary angle (ML-NL) was calculated as the difference between ML-NSL and NL-NSL (Figure 1).[36] It should be noted that the sella-nasion line was shared by all measurements, thus enhancing the power of mathematical correlation among the five variables.[34] After evidence of statistical correlation with one another was shown, the linear regression with the corresponding r^2 and the standard error of the estimate (SE) were computed and illustrated in a graphical box-like form, called a *correlation box,* or *harmony box* (Figure 2).

The Harmony Box

The harmony box was constructed by Segner[36] and by Segner and Hasund[37] and was patterned primarily after the Bergen cephalometric analysis established by Hasund et al.[35] It was regarded as the first stage of the floating norms for describing individual skeletal characteristics. The accepted norms of Björk[39] were used and floating norms were developed for commonly used sagittal and vertical measurements, which were represented in the Bergen box.[40]

At present, the improved Segner-Hasund[41] harmony box is widely used as a valuable adjunct in orthodontic diagnosis and treatment planning. It is a method that describes the individual skeletal pattern by illustrating sagittal and vertical skeletal relationships with the use of floating norms. It also reveals the facial type of a patient and determines whether the face is harmoni-

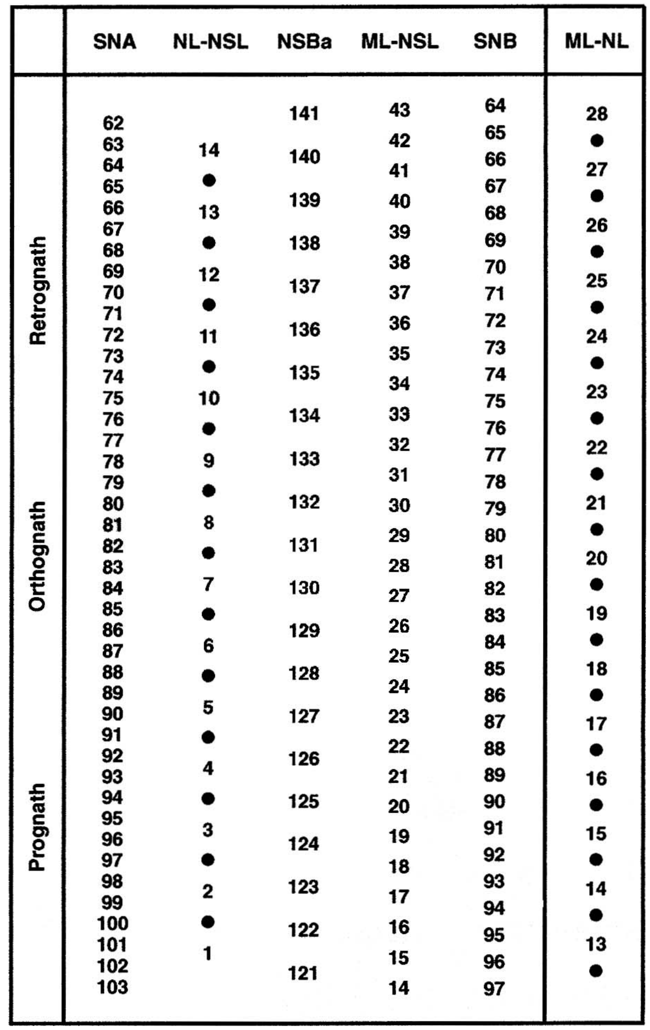


Figure 2. Segner-Hasund harmony box.

ous or disharmonious. The harmony box is divided into three zones—retrognathic, orthognathic, and prognathic zones—depending on the ANB value of the subject. A horizontal line connecting the values of the five cephalometric variables inside the box represents the harmony line of the subject. A straight horizontal line suggests that the face is harmonious, and the facial type is determined according to the zone where the cephalometric values of the subject fall. For every horizontal harmony line, a range of accepted variability is allowed, which is derived from the SE of the multiple regression analysis and is represented by the harmony schema (Figure 3). The line in the middle of the schema represents the mean values of the five correlated cephalometric variables. It can be shifted upon the harmony box to include all five cephalometric variables of the subject. A subject whose cephalometric values lie inside the schema displays a harmonious skeletal pattern. However, any value that lies outside the schema is the parameter that causes disharmony to the face. Thus, the face is disharmonious.

Numerous studies have been written about floating norms. Aside from the study of Segner,[36] which established floating norms for central Europeans, Franchi, Baccetti, and McNamara[38] established floating norms for North American adults. Tollaro et al[42] provided floating norms for the evaluation of individual skeletal patterns in subjects with full deciduous dentition. Lavergne and Gasson[43] presented a cephalometric classification of facial patterns for younger subjects using floating norms. Ngarmprasertchai[44] and Mahaini[45] constructed floating norms for Thais and Syrians, respectively.

The present study aims to establish floating norms for the description of individual craniofacial patterns among Filipinos.

MATERIALS AND METHODS

Samples

This study was based on 81 subjects, 37 females and 44 males, who were selected from the student population of a University. All subjects were Filipinos with an average age of 18 years (SD = 4.17), with Angle Class 1 occlusion without crowding or spacing and no previous history of orthodontic treatment; they displayed good facial esthetics. Approval from the ethics committee was sought before the interview and clinical examination were performed, and before cephalograms were obtained.

The lateral cephalogram of each subject was taken with the use of one x-ray machine (Panoura, Yoshida Co Ltd, Tokyo, Japan) and by one technician. The cephalometric film of each subject was traced by one investigator. Landmarks were identified, and the five cephalometric angular measurements were obtained and digitized with the aid of a computer program, DiagnoseFix (Dr. Jörg Wingberg, Diagnostik Wingberg GmbH, Buxtehude, Germany). The error of the method was determined by retracing and remeasuring the films, thus generating an average error of less than 0.3 degree.

Statistical Analysis

Descriptive statistics (mean, SD, range) was calculated for the five cephalometric variables. Pearson correlation coefficients described the high association among variables used in constructing the harmony box. Bivariate linear regression analysis was used to construct the harmony box. Multiple regression analysis, particularly the SE, was calculated to construct the harmony schema. All data analyses were performed with the use of the Statistical Package for the Social Sciences (SPSS) program for Windows, version 11.5 (SPSS Inc, Chicago, Ill).

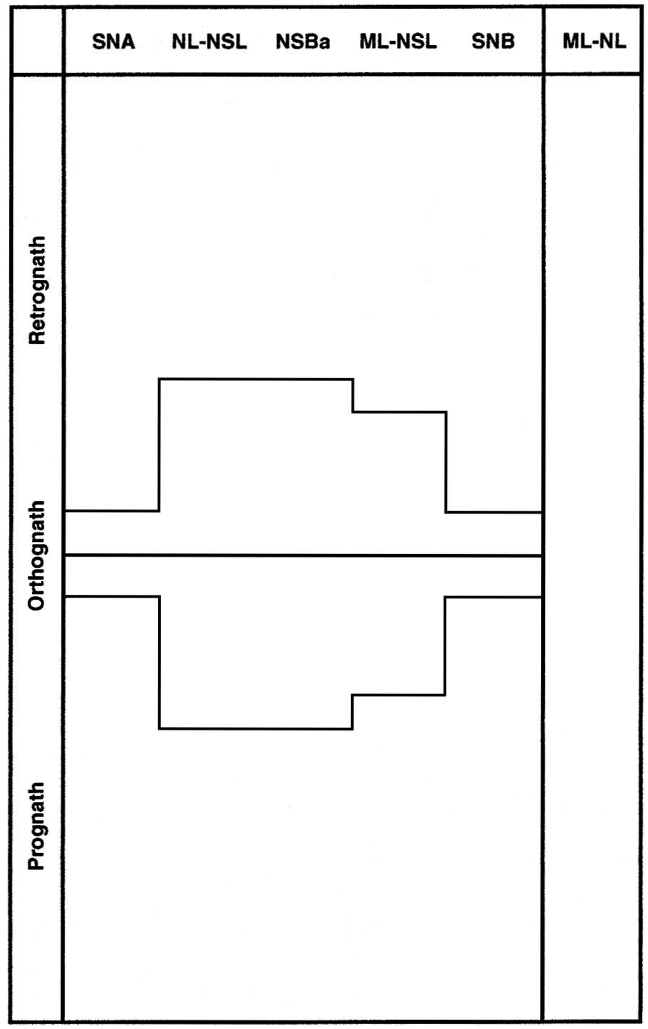


Figure 3. Segner-Hasund harmony schema.

RESULTS

Means, SDs, and ranges for the five cephalometric variables are presented in Table 1. Resulting correlation coefficients are shown in Table 2. All correlations between the five variables were significant at the .001 and .05 levels. Linear regression equations with corresponding r^2 and SE values are reported in Table 3 and illustrated in Figure 4 as the harmony box with

Table 1. Descriptive Statistics (n = 81)

Variables	Mean	SD	Min	Max
SNA	83.34	3.30	74.0	90.7
NL-NSL	9.44	2.98	3.1	19.2
NSBa	130.65	4.87	120.4	140.5
ML-NSL	33.43	4.79	20.5	42.6
SNB	79.87	2.79	71.8	86.6

Table 2. Linear Correlation Coefficients (r) Between SNA, NL-NSL, NSBa, ML-NSL, and SNB of Filipinos (n = 81)

Variables	NL-NSL	NSBa	ML-NSL	SNB
SNA	−0.34*	−0.42**	−0.26*	0.80**
NL-NSL		0.55**	0.30*	−0.46**
NSBa			0.23*	−0.45**
ML-NSL				−0.55**

* $P < .05$; ** $P < .001$.

Table 3. Linear Regressions With Corresponding r^2 and Standard Error of the Estimate (SE) of Filipinos (n = 81)

Variables	Regression Equations	R^2	SE
NL-NSL	= −0.31 SNA + 35.4	0.11	2.82
NSBa	= −0.61 SNA + 181.63	0.16	4.46
ML-NSL	= −0.37 SNA + 64.23	0.53	4.66
SNB	= 0.67 SNA + 23.74	0.63	1.69
SNA	= −0.28 NSBa + 120.13	0.16	3.02
SNB	= −0.26 NSBa + 113.40	0.19	2.51
ML-NSL	= −0.95 SNB + 109.28	0.30	4.01

Table 4. Standard Errors of the Estimate When One of the Variables SNA, NL-NSL, NSBa, ML-NSL, and SNB Is Predicted From the Other Four by Means of a Multiple Regression Analysis of Filipinos (n = 81)

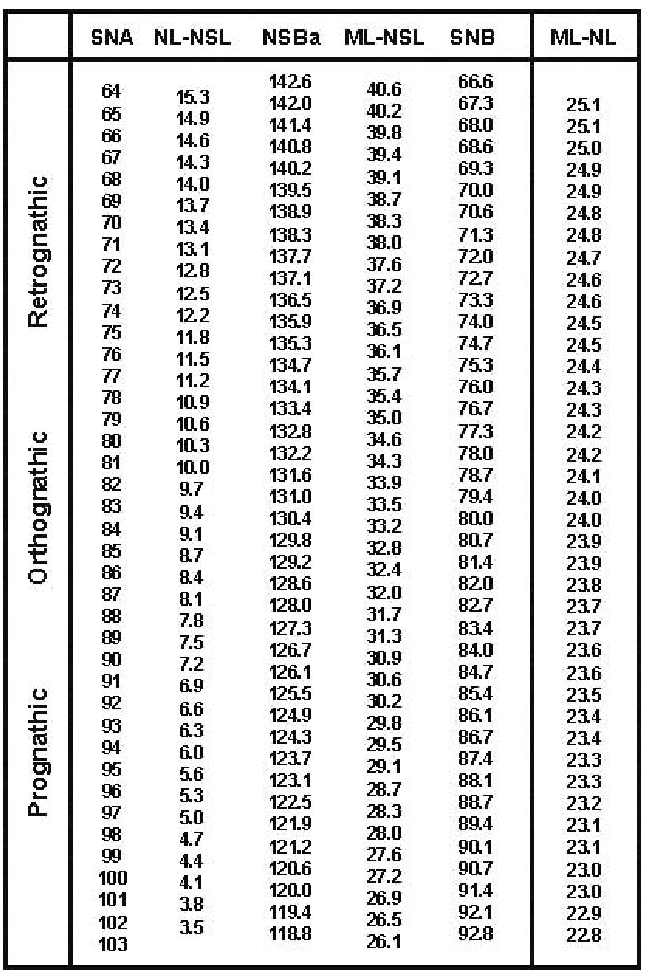
Variables	R	R^2	SE
SNA	0.83	0.68	1.88
NL-NSL	0.61	0.34	2.43
NSBa	0.60	0.33	3.97
ML-NSL	0.64	0.37	3.80
SNB	0.88	0.77	1.34

floating norms. The multiple correlation coefficients R, the adjusted R^2, and the SE when one of the five measured variables is predicted from the remaining four by means of a multiple regression analysis are displayed in Table 4 and illustrated in Figure 5 as the harmony schema.

DISCUSSION

Facial Type

Broadbent and Enlow[46] and Nanda and Ghosh[47] stated that although cephalometric norms have been



SNA	NL-NSL	NSBa	ML-NSL	SNB	ML-NL
64	15.3	142.6	40.6	66.6	25.1
65	14.9	142.0	40.2	67.3	25.1
66	14.6	141.4	39.8	68.0	25.0
67	14.3	140.8	39.4	68.6	24.9
68	14.0	140.2	39.1	69.3	24.9
69	13.7	139.5	38.7	70.0	24.8
70	13.4	138.9	38.3	70.6	24.8
71	13.1	138.3	38.0	71.3	24.7
72	12.8	137.7	37.6	72.0	24.6
73	12.5	137.1	37.2	72.7	24.6
74	12.2	136.5	36.9	73.3	24.5
75	11.8	135.9	36.5	74.0	24.5
76	11.5	135.3	36.1	74.7	24.4
77	11.2	134.7	35.7	75.3	24.3
78	10.9	134.1	35.4	76.0	24.3
79	10.6	133.4	35.0	76.7	24.2
80	10.3	132.8	34.6	77.3	24.2
81	10.0	132.2	34.3	78.0	24.1
82	9.7	131.6	33.9	78.7	24.0
83	9.4	131.0	33.5	79.4	24.0
84	9.1	130.4	33.2	80.0	23.9
85	8.7	129.8	32.8	80.7	23.9
86	8.4	129.2	32.4	81.4	23.8
87	8.1	128.6	32.0	82.0	23.7
88	7.8	128.0	31.7	82.7	23.7
89	7.5	127.3	31.3	83.4	23.6
90	7.2	126.7	30.9	84.0	23.6
91	6.9	126.1	30.6	84.7	23.5
92	6.6	125.5	30.2	85.4	23.4
93	6.3	124.9	29.8	86.1	23.4
94	6.0	124.3	29.5	86.7	23.3
95	5.6	123.7	29.1	87.4	23.3
96	5.3	123.1	28.7	88.1	23.2
97	5.0	122.5	28.3	88.7	23.1
98	4.7	121.9	28.0	89.4	23.1
99	4.4	121.2	27.6	90.1	23.0
100	4.1	120.6	27.2	90.7	23.0
101	3.8	120.0	26.9	91.4	22.9
102	3.5	119.4	26.5	92.1	22.8
103		118.8	26.1	92.8	

Figure 4. Filipino harmony box.

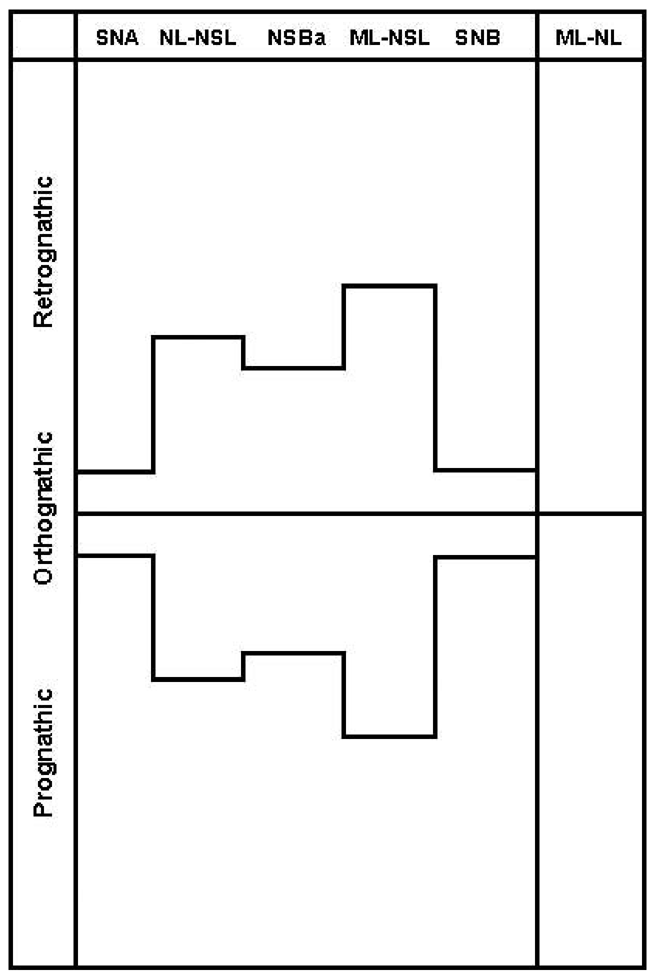


Figure 5. Filipino harmony schema.

established for each race and ethnic group, individual variation still exists. An isolated measured angle or line should not be considered, but rather should be described in relation to the background of the individual's facial type.[48]

The present study provides floating norms in the form of a harmony box and schema to describe the individual craniofacial pattern among Filipinos. Unlike the conventional cephalometric analyses, in which the cephalometric values of a subject are compared with established population norms specific for an ethnic group, cephalometric evaluation by means of floating norms is based on correlation patterns among the five measured variables. This means that as long as the sagittal (SNA, SNB) and vertical (NL-NSL, MN-NSL) cephalometric measurements of an individual exhibit correlation with one another, the skeletal pattern is considered acceptable.

Table 1 presents the mean sagittal and vertical cephalometric measurements for Filipinos. Statistical correlation among these variables is revealed in Table 2. SNA and SNB displayed the highest correlation at the .001 level, and ML-NSL exhibited lesser correlation with the other parameters at the .05 level. Table 3 illustrated the linear regressions that were used to construct the harmony box displayed in Figure 4. The three zones describing the facial types were based on the ANB value, obtained as the difference between SNA and SNB.

In the upper zone of the harmony box, SNA and SNB values are below the mean values given in Table 1, with a corresponding ANB value of 0 to 4 degrees. Here, the facial type is described as retrognathic. In the middle zone, SNA and SNB values agree with the mean values in Table 1, with an ANB value of 2 to 6 degrees. Here, the facial type is described as orthognathic. In the lower zone, SNA and SNB values are above the established mean values, with an ANB value of 4 to 8 degrees. Hence, the facial type is prognathic.

Vertically, the facial type is determined by the degree of inclination of the mandible (ML-NSL) in relation to the anterior cranial base. Thus, an individual may be characterized as having an obtuse (skeletal open bite), normal, or acute (skeletal deep bite) skeletal pattern. In Figure 4, the retrognathic zone displays greater values of ML-NSL, NL-NSL, and NSBa, and in the prognathic zone, the ML-NSL, NL-NSL, and NSBa values are decreased. Generally, the greater the cranial base angle, the more retrognathic the face becomes, and the smaller the cranial base angle, the more prognathic the face becomes. These facts have been confirmed in the present study.

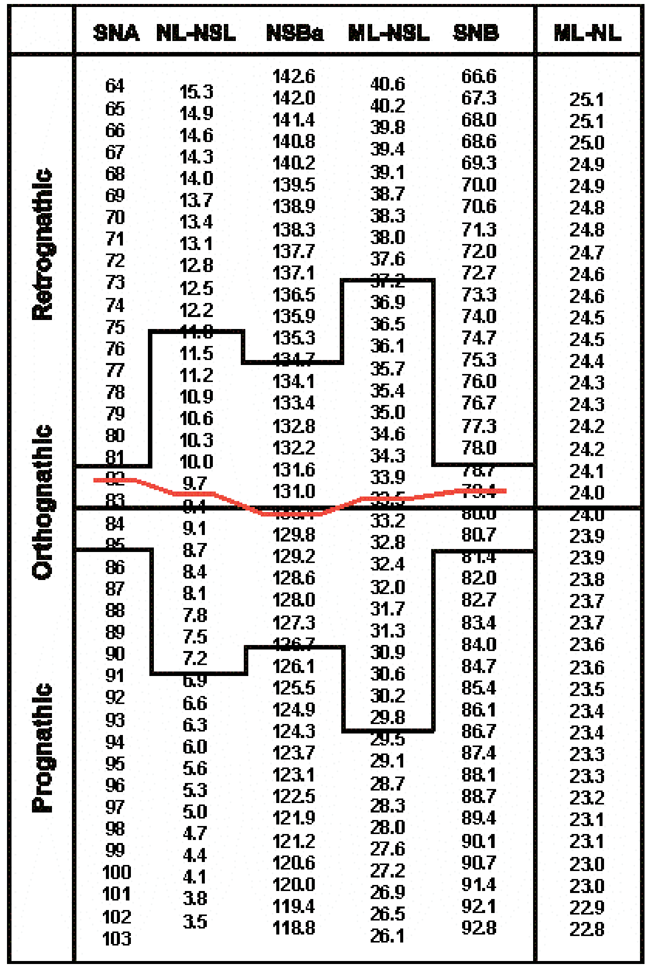


Figure 6. Harmonious combinations.

The Harmony Concept

Di Paolo et al[49] emphasized that a cephalometric analysis not only should detect but should locate the area of the skeletal dysplasia. The harmony box is an adjunctive tool that is used to detect and locate skeletal dysplasia in the craniofacial complex. Furthermore, it should determine whether the combination of the five correlated cephalometric variables inside the harmony box is harmonious. The harmony schema shown in Figure 5 is constructed by computing the SE when one of the cephalometric variables is predicted from the other four by multiple regression analysis, as shown in Table 4. It represents the degree of variability allowed among the five correlated cephalometric measurements in describing a harmonious face. It could be shifted on the different zones of the harmony box to include all five cephalometric variables of a subject. A subject whose cephalometric values fall inside the harmony schema is said to display a harmonious skeletal pattern. A harmonious combination from a correlation point of view would not necessarily require the values to lie on a perfectly straight horizontal line.[36]

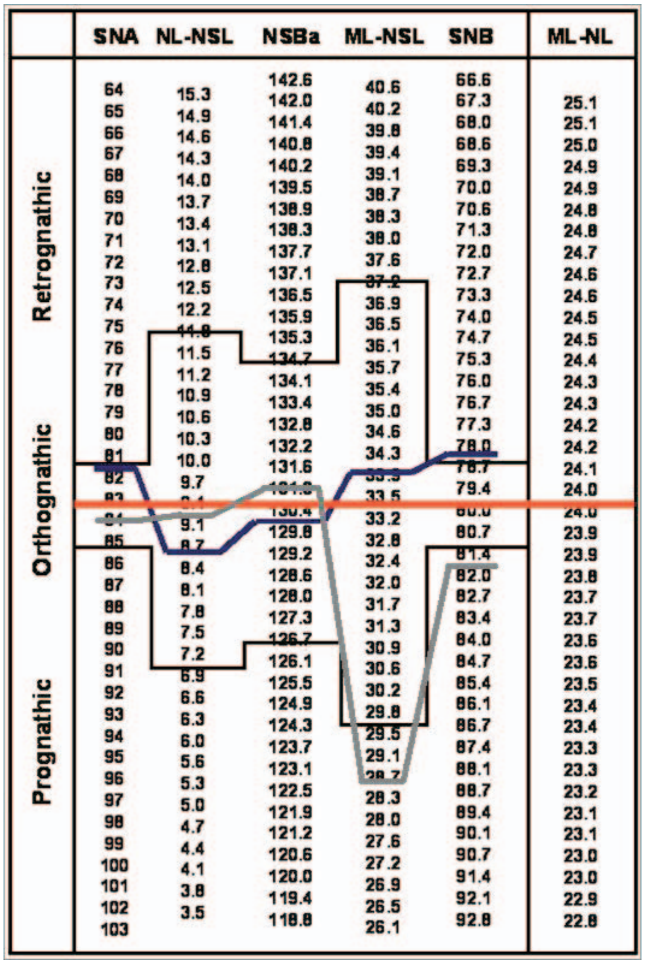


Figure 7. Comparison with Thais (light) and Syrians (dark).

Hence, a subject may be described as retrognathic and harmonious, orthognathic and harmonious, and prognathic and harmonious. Figure 6 shows an example of harmonious combinations represented in the orthognathic zone. All values of the patient lie inside the schema, thus the patient is described as orthognathic and harmonious.

On the other hand, a disharmonious combination may be presented. Although the SNA and the vertical values fit into the schema, the value SNB may not. In this case, the problem is sagittal, and the mandible (SNB) is the jaw at fault. To determine the individualized ANB, a horizontal line from the value SNA to the SNB column is followed, and the difference is computed. In a growing patient, functional jaw orthopedics may be employed by prescribing the use of a bionator to advance and rotate the mandible posteriorly. In an adult patient, orthognathic surgery will correct the facial disharmony. The harmony schema of the Filipinos (Figure 5) is comparable with the Segner-Hasund harmony schema (Figure 3) in terms of four parameters, namely, SNA, NL-NSL, NSBa, and SNB. Yet, the ML-NSL angle among Filipinos showed a greater degree of variability.

Comparison of the Filipino Harmony Box and Schema With Those of the Thais and Syrians

Mean cephalometric values of the five correlated variables among the Thais and Syrians were plotted on the Filipino harmony box and schema (Figure 7). The Syrians corresponded to the orthognathic zone, and all variables lie inside the schema as it is moved slightly upward. This means that the craniofacial morphology of Filipinos and of Syrians is largely similar. Most of the Thai variables lie in the orthognathic zone, with the exception of the ML-NSL angle, which lies outside the schema in the prognathic zone. This means that Thais show a more anterior rotation of the mandible. Thus, they exhibit a shorter vertical facial height than is seen in Filipinos and Syrians.

CONCLUSION

- Cephalometric floating norms for the description of the individual craniofacial pattern among Filipinos are established on the basis of five correlated variables.

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