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Schädelmorphologie philippinischer und deutscher Probanden mit Angle-Klasse-1-Okklusion: Eine kephalometrische Studie

Dissertation
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...to my late father, who serves as my life’s model and inspiration

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1. INTRODUCTION

1.1 Background

In 1931, the methodology of cephalometric radiography came into full fruition when BROADBENT[11] in the US and HOFRATH[33] in Germany simultaneously published methods to obtain standardized head radiographs in the Angle Orthodontist and in the Fortschritte der Orthodontie, respectively[50]. This development led to numerous cephalometric studies dealing with standard values or norms which provide useful guidelines in orthodontic diagnosis and treatment planning. These norms are derived from an untreated sample of subjects from the same ethnic group. They are selected from a population with the so-called “ideal” or “well-balanced” faces with Angle Class one occlusion.

Comparative cephalometric studies have proven that differences in the craniofacial morphology exist among ethnic groups[1,3,4,6,8,9,13-15,27-29,34,41,43,47,49,59,76,82]. These studies revealed a pattern, wherein the non-Caucasian ethnic groups consistently displayed profile convexities due to bilabial dental protrusion when compared with Caucasians[1,4,6,8,9,13-15,27-29,41,43,47,49,59,74,76,82].

At present, three cephalometric studies on Filipino dentofacial morphology were developed according to Steiner analysis[44,62,67]. However, none of these studies were compared to other ethnic groups.

According to FRANCHI et.al.[25], a major drawback of these conventional cephalometric analyses is the use of isolated craniofacial parameters, without taking into account their possible interdependence. SOLOW[72] demonstrated significant correlations among sagittal and vertical cephalometric variables, leading to the concept of “craniofacial pattern”. A comprehensive analysis for the assessment of individual craniofacial patterns was conducted by SEGNER[69] and by SEGNER and HASUND[71], who constructed floating norms for the description of sagittal and vertical skeletal relationships among European adults. These floating norms are represented in a graphical box-like form called the harmony box (Figure 1). It is the result of the pattern of association among five cephalometric variables which exhibit correlations with one another. Any horizontal line connecting the values of the five variables inside the box is considered as a line expressing a harmonious skeletal pattern. A range of accepted variability is allowed and is represented by a harmony schema which can be moved upon the harmony box to include the individual cephalometric variables of each subject.

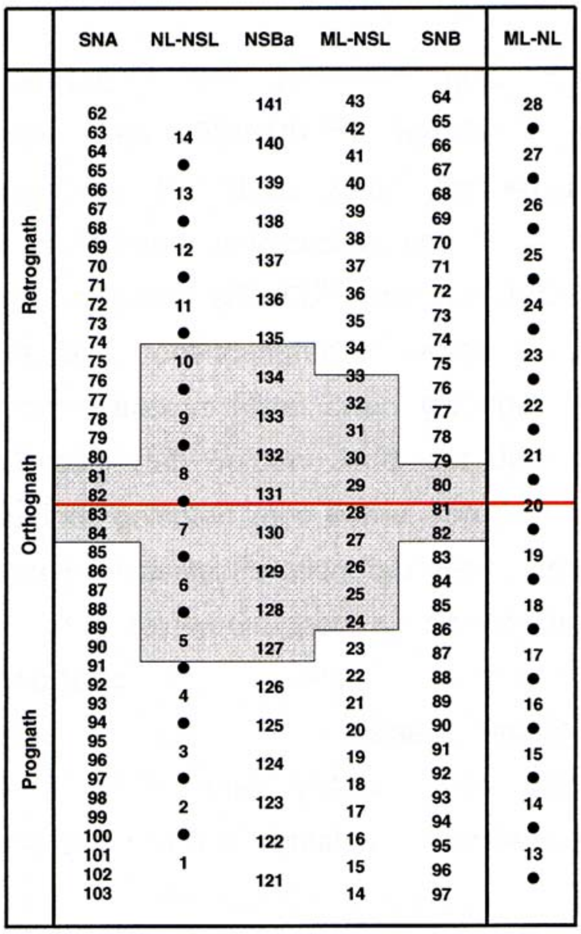


Fig. 1. Hasund-Segner harmony box

1.2 Objectives of the Study

1.2.1 To establish cephalometric norms for soft tissue, skeletal and dental relationships among Filipino adults

1.2.2 To compare these norms with established German standards

1.2.3 To present floating norms in the form of a harmony box for the description of the individual skeletal pattern in Filipino adults

1.2.4 To compare these floating norms with that of the Germans

1.3 Statement of the Problem

1.3.1 What is the normally occurring craniofacial morphology of the Filipinos?

1.3.2 How does the craniofacial morphology of the Filipinos differ from that of the Germans?

1.3.3 How does the Filipino harmony box and schema differ from that of the Germans?

1.4 Significance of the Problem

The three cephalometric studies on Filipino dentofacial morphology were all developed after the Steiner's analysis. However, they have limited number of samples who are not properly selected under strict established criteria. Although the results of the three studies agreed that the Filipino craniofacial morphology is characterized by profile convexity, lip protrusion and bimaxillary dental protrusion, these studies were not compared to other ethnic groups. The harmony box derived from this study will provide an additional diagnostic tool not only in orthodontics, but in orthognathic surgery as well.

1.5 Hypotheses (null)

1.5.1 No difference exists between the craniofacial morphology of the Filipinos and Germans, as a result of student's *t*-test, and cephalometric superimpositions

1.5.2 No difference exists in the floating norms, harmony boxes and schemas between Filipinos and Germans

1.6 Scope and Delimitation

1.6.1 The diagnostic work-up among Filipino subjects are conducted using lateral cephalograms

1.6.2 Only adult patients, with the average age of 18 years old, with Angle Class one occlusion, and well-balanced faces are included

1.6.3 The cephalograms have distinguishable anatomic landmarks used for orthodontic diagnostic purposes

1.6.4 The cephalograms are traced and digitized by only one individual

1.7 Definition of Terms

Angle Class one occlusion. A malocclusion in which the buccal groove of the mandibular first permanent molar occludes with the mesiobuccal cusp of the maxillary first permanent molar.[17]

Bilabial dental protrusion. Labial inclination of the maxillary and the mandibular incisors beyond normal limits.

Cephalogram. A radiograph of the head obtained under standardized conditions, introduced simultaneously in the United States and Germany (1931), by B.H. Broadbent and H. Hofrath, respectively.[17]

Cephalometric analysis. The process of evaluating skeletal, dental and soft tissue relationships of a subject, by comparing measurements performed on the subject's cephalometric tracing with population norms for the respective measurements, to arrive at a diagnosis of an orthodontic problem.

Correlation coefficient. A measure of the linear relationship between two numerical measurements made on the same set of subjects. It ranges from –1 to +1, with 0 indicating no relationship.[19]

Craniofacial pattern. Means that even though the cephalometric measurements of a subject lie beyond one standard deviation from the population norm, the measurements can still be considered acceptable if certain relationships are maintained.[25]

Facial pattern. A term generally used to describe the facial configuration, or the directional tendency of facial growth from a lateral (profile) view.[17]

Floating norms. Individual cephalometric norms that vary (float) in accordance with the variations of correlated measurements.[25]

Harmony box. Graphical box-like form constructed on the basis of correlation between SNA, NL-NSL, NSBa, ML-NSL and SNB; it is constructed based on the linear regressions computed with the SNA as the independent variable and the four other parameters as the dependent variable.

Harmony schema. Represents the range of variability among the five cephalometric variables in the harmony box and is represented by the standard error of the estimate of the multiple regression analysis.

Linear regression. (of X on Y) The process of determining a regression or prediction equation to predict Y from X.[19]

Orthognathic. A facial type with normal anteroposterior relationship of the maxilla and mandible in relation to each other and to the cranial base.[17]

Prognathic. A term used to indicate the situation in which the mandible or the maxilla is protrusive (in the anteroposterior plane) in relation to other cranial or facial structures, due to relatively larger size and/or more anterior position.[17]

Retrognathic. A term used to indicate the situation in which the mandible or the maxilla is retrusive (in the anteroposterior plane) in relation to other cranial or facial structures, due to smaller size and/or more posterior position.[17]

Standard error of the estimate. A measure of the variation in the regression line.[19]

Student's t-test. The statistical test for comparing a mean with a norm, or comparing two means with small sample size but are normally distributed with equal variances.

Well-balanced face. A face with no asymmetry and with acceptable profile.

1.8 Conceptual Framework

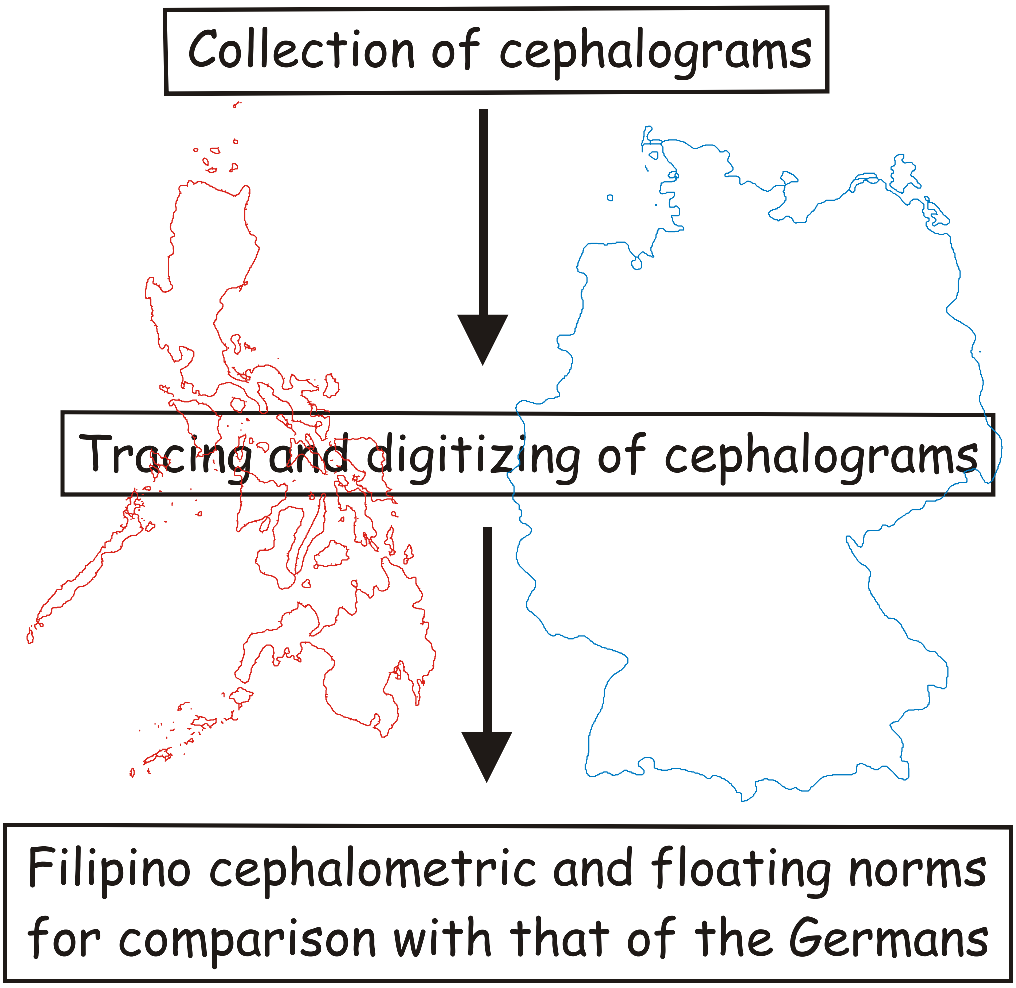


Fig. 2. Paradigm of the Study

2. LITERATURE REVIEW

2.1 A Search for an Ideal – through the centuries

The oldest record of proportions of the face come from artists.[51] In ancient times, beauty and harmony are portrayed in drawings and sculptures. In 400 B.C., the Egyptians developed an intricate quantitative system that defined the proportions of the human body, which became known as canon.[36,52,68] Egyptian artists used a simplified grid system to draw figures to ideal proportions. Horizontal lines marked the location of key points of the body from the top of the head to the baseline. The head was usually depicted within a grid block consisting of 12 squares (Fig. 3).

Ancient Greece rejected the rigid Egyptian system for creating images of the human figure. They needed freedom to account for shifting dimensions of organic movement, and the foreshortening of the upper part of the stature relative to the lower part (i.e. long legs, short upper body when standing close to a statue on a base).[58]

In the Egyptian art, the theory of proportions meant almost everything because the subject meant almost nothing. Their concept was not "directed toward the variable, but toward the constant, not toward the symbolization of the vital present but toward the realization of a timeless eternity." To the Greeks, the figure commemorates a human being that lived. "The work of art exists in a sphere of aesthetic ideality." For the Egyptians, it remained "in a sphere of magical reality."[58]

The great physician, Galen, claimed that whatever is most beautiful in man, or in the horse, or in the cow, or in the lion, always come from the mean within each genus.[26] He also stated that beauty arises not in the commensurability of the constituent elements, but in the commensurability of the parts, such as that of finger to finger, and of all the fingers to the palm and wrist, and of these to the forearm, and of the forearm to the upper arm, and in fact, of everything to everything else, just as it is written in the canon of Polykleitos.[56] Polykleitos was a sculptor, not a philosopher, but when he tells us that "the beautiful comes about, little by little, through many numbers",[61] he is expressing an idea with which Plato and many other Greek philosophers would have agreed. The combination of this insistence on perfect commensurability and the attainment of a mean, led to a type of face, called the *classical ideal*, which is an ideal that survived with little variation for centuries.[56]

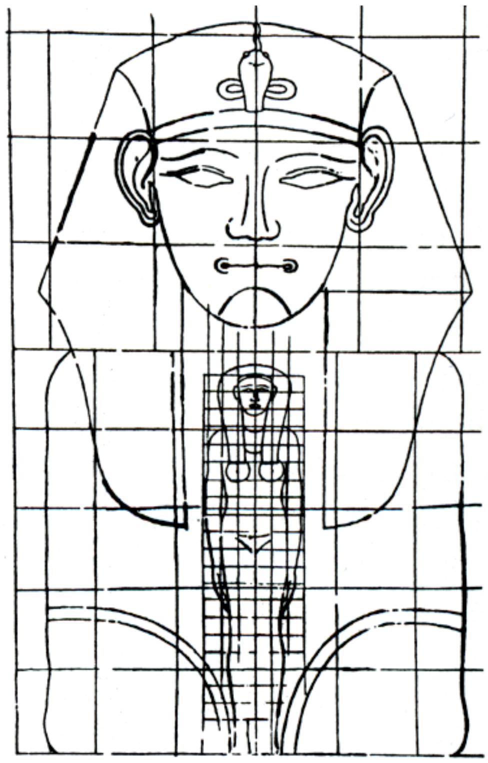


Fig. 3. Front view of a construction drawing for a sculpture of a Sphinx holding the small figure of a goddess between his paws (400 BC). This drawing is composed of two different networks, each for its own system of reconstruction, namely the human head to the scheme of Royal Heads and the small goddess based on the customary canon of 22 squares prescribed for the whole human figure.[58] (From Schäfer H. Von ägyptischer Kunst, ed 4. Wiesbaden: Otto Harrassowitz; 1963. Reproduced with permission).

The Roman architect Vitruvius, prescribed a division of the face into three equal parts marked by the distance from hairline to the root of the nose, from that point to the tip of the nose, and from the tip of the nose to the point of the chin. This basic trisection endured for the next 2,000 years, and can still be found today in popular guides to the drawing of the human figure.[56]

Zeising[81] published an extensive treatise on the fundamental laws that apply to all morphologic principles of the proportions of the human body. In the divine proportion, developed by Greek mathematicians, the length of a line is divided into two parts such that the minor part divided by the major part equals the major part divided by the total. For the division of the total into unequal parts to appear as proportional, the smaller part must relate to the larger as the larger part relates to the total. In reverse, the relation of the total to the major part must be the same as that of the major part to the minor.

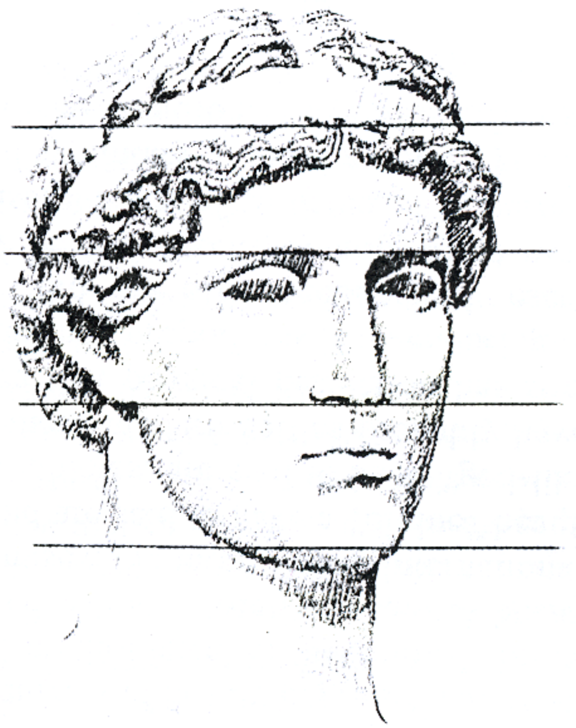


Fig. 4. Classical head showing Vitruvian trisection

In the divine proportion, or golden cut, the major part is 1.61803 times larger than the minor part. The Greek letter *phi*, the initial letter of Phidias Pythagoras' first name, has been adopted to designate the golden ratio. In addition to having mathematical applications, this golden section constitutes an ideal that informs aesthetic assessments.[50] Huntley[35] lawfully considers that the divine proportion - the golden rectangle, triangle, cuboid, and ellipse – represents mathematical beauty and harmony.

In 1509, Luca Pacioli,[57] Pastor, Tutor, and Professor of the Holy Theology, presented an oration on the golden proportion from the mathematical sciences. Its publication contained a drawing of the face in profile, oriented in natural head position and inscribed in a golden triangle and a golden rectangle (Fig. 5).[50]

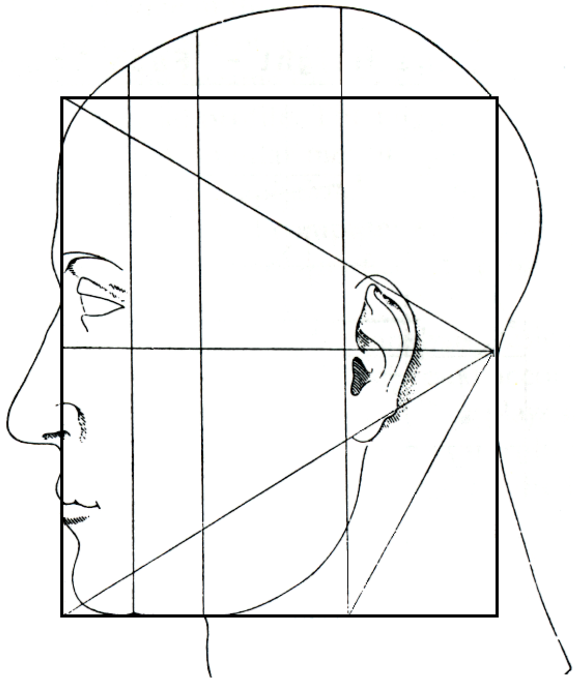


Fig. 5. In 1509, Fra Luca Pacioli[57] in his presentation of the divine proportion to the highest magistrate of Milan showed an illustration of man's face in profile encased in a golden triangle and a golden rectangle. (From Pacioli Fra Luca. Divine Proportione. Constantin Winterburg [trans] Die Lehre vom Goldenen Schnitt, vol 2. Wien: Verlag Carl Greaser; 1889).

It was during the Renaissance when Leonardo da Vinci's drawing of the so-called Vitruvian man demonstrates his understanding, based on the theory of Vitruvius, that the perfect human body could be designed in accordance with the square and the circle, the two most perfect geometric forms (Fig. 6).[56]

Reproductions of this famous drawing obliterated the many faint but precise guidelines superimposed on the figure, but a close examination reveals that the face of the figure has been carefully designed according to the perfect trisection prescribed by Vitruvius. Leonardo considered mathematics to be the source of all knowledge, and the guide to an understanding of the world. Many of his drawings and commentary dealing with human proportions were done in preparation for a treatise that would have rivalled that of Vitruvius, but like so many of his projects, the treatise never materialized.

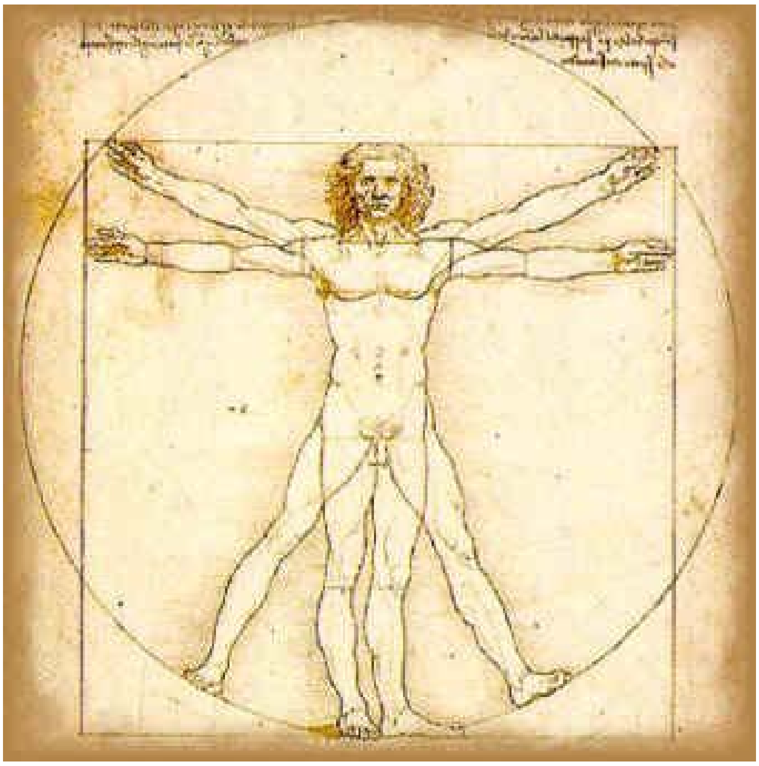


Fig. 6. Study of Human Proportions According to Vitruvius

It was in northern Europe, where Albrecht Dürer, Germany's Renaissance man, made the search for physical perfection something of an obsession in his life, an obsession that eventually gave way to disillusionment. After a long and arduous quest for the mathematical secrets to perfection, he finally admitted that, "what beauty is I know not; only God can know".[58] Long before he conceived his treatise on human proportions, he actively pursued the question of human beauty in a series of works that owe much to antiquity and to the Italian Renaissance. In his engraving of the *Fall of Man*, he used the figures of Adam and Eve as vehicles for demonstrating the ideal classical proportions of the human form. It is the only print to which Dürer signed his name in full, indicating the importance he placed on this work in his own oeuvre.

In the eighteenth century, Petrus Camper refined an essential aspect from an illustration in which Dürer demonstrated that the differences in profile between two individuals could be defined by a change in the angulation of the vertical to the horizontal axes of a coordinate system. For Camper, that angle became the key to characterizing differences in facial profile.

The terms *prognathic* and *orthognathic* introduced by Retsius[45] are tied to Camper's illustrations of facial form in man and primates. As a result, the angle between a horizontal line and the line nasion-prosthion became the time-honoured anthropological method to determine *facial type*. The term *prognathism* refers to the prominence of the face, or jaws, relative to the forehead, and a straight facial profile became known as *orthognathous*.

Spix[73] in 1815, proposed to modify the Camper horizontal by drawing a line from prosthion tangent to the occipital condyle. Since the occipital condyle is below the porus acousticus, the face was rotated upwards, yielding slightly greater facial prognathism (Fig. 7).[50]

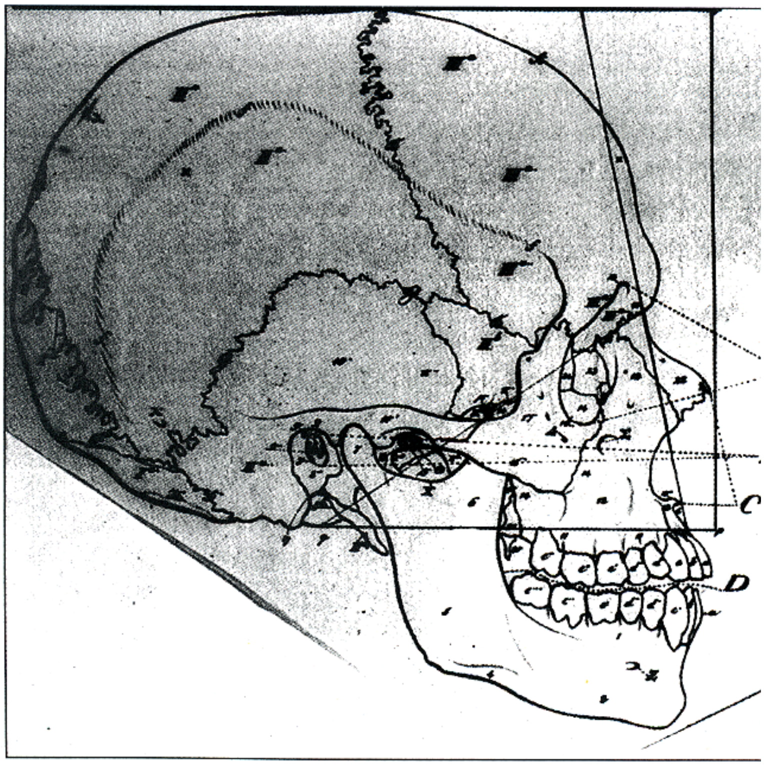


Fig.7. Orientation of the skull by means of a horizontal from prosthion tangent to the occipital condyle. (From Spix JB. Cephalo Genesis. Munich: Hübsch Mannii Verlag; 1815).[50]

Welcker[78], in 1862, demonstrated the descent and rotation of the mandible during ontogenesis, by means of a triangular configuration from basion to gnathion (Fig. 8). This triangular diagram was later modified to a polygon by Hellman[34] to depict facial growth (Fig. 9) and to examine differences among individuals with Class II and Class III malocclusions. After Hellman, the polygon was used by Korkhaus[40] in Bonn and thereafter by Björk[10] for his doctoral presentation on the “face in profile”. (Fig. 10)

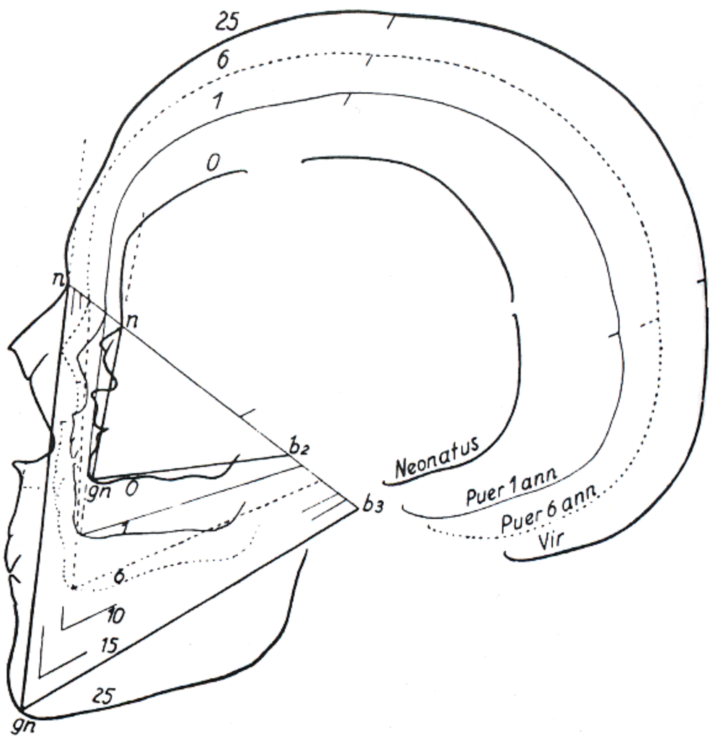


Fig. 8. Analysis of growth changes from birth (neonatus) to 1,6,10,15 and 25 years of age by Welcker[79], by means of a triangular configuration and the line nasion-basion as reference.

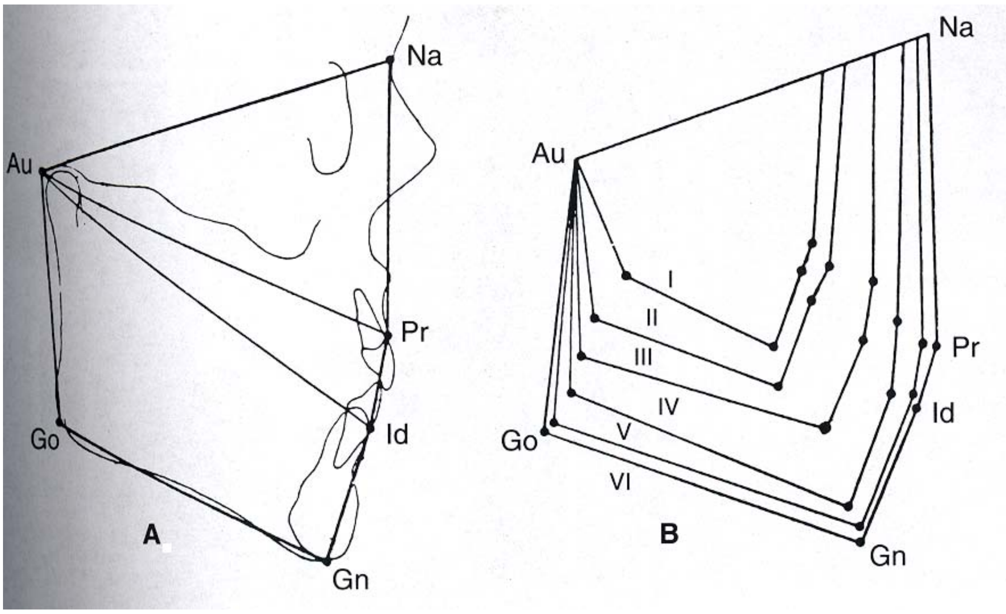


Fig. 9. Analysis of facial growth proposed by Hellman[32], utilizing a polygon and the line from nasion to articulare as reference.

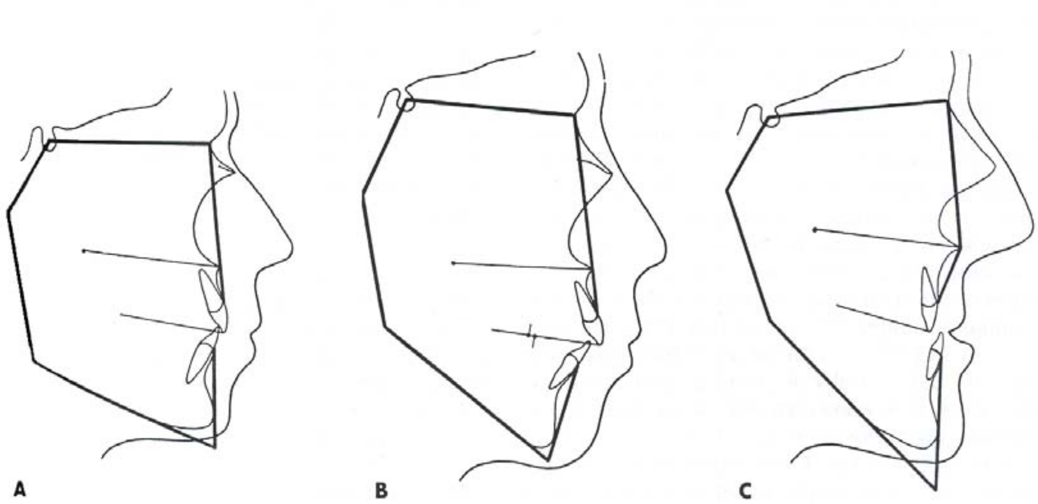


Fig. 10. By application of a polygon to study the "face in profile," Björk findings[10] convey a space-shape analysis that contrasts the facial configuration in three individuals: A, A normal occlusion in a relatively square face with long ramus; B, A normal occlusion in a long face with shallow depth and a rarely encountered skull base inclination whereby the anterior skull base slopes downward rather than upward from sella to nasion; C, A Class III malocclusion with mandibular prognathism, retrusive maxillary incisor segment, steep mandibular plane, large gonial angle, and short posterior skull base. These tracings were made from radiographs taken in natural head position revealing the marked variation in the inclination of the anterior skull base (N-S) in these individuals.

The evolution of cephalometry in the twentieth century is universally linked to Edward Angle's publication of his classification of malocclusion in 1899.[2] He became the acknowledged "father of orthodontics", and in his time, he thought so much of the Greek's ideal of beauty and harmony, that he prominently displayed a bust of Apollo Belvedere in his clinic[60]. He felt that this should represent the aesthetic goal of orthodontics. According to him, "The face of Apollo…represents the profile…so perfect in outline that it has long been the model for students of facial art…and that to change it in the least would be to mar the wonderful harmony of its proportions."[80]

The history of the human face is so fascinating and is one that is intricately woven with the history of science, mathematics, medicine and philosophy. It is intimately involved with questions of public and private morality, and on that level, the history of human beauty remains to be written.[56]

2.2 Modern Cephalometrics

Since the invention of radio-cephalometry by Broadbent (1931) in the United States and Hofrath (1931) in Germany, a great number of papers have been published regarding cephalometrics.[70] In the 1950's and for many years thereafter, radiographic cephalometry was almost exclusively the domain of the orthodontist, until it was later used by maxillofacial and plastic surgeons. Some classic cephalometric analyses are developed to acquaint clinicians and researches of the field with various skeletal and dental measurements, particularly the reasons for their selection and interpretation. Most of them modify the existing analyses or devise their own, generally based on measurements extrapolated from those described, often adding a few of their own measurements.[38]

The integration of computer systems into dentistry has revolutionized the practice of orthodontics. Where headfilms have traditionally been manually traced and measured, now the various cephalometric landmarks can be digitized and stored electronically, and application can perform a number of analyses, providing hard or electronic documentation.[38]

2.3 Cephalometric Analyses

2.3.1 Downs

A set of ten lateral cephalogram measurements and their norms, developed by W.B. Downs in 1948. It was based on a sample of 20 Caucasian individuals 12-17 years old, with what Downs deemed as “clinically excellent occlusions.” The analysis uses the Frankfort horizontal plane as its reference plane.[17]

2.3.2 Steiner

A series of angular and linear cephalometric measurements (including angles SNA,SNB and ANB) introduced by C.C. Steiner in 1953. The analysis uses the SN line as a reference plane.[17]

2.3.3 WITS (Appraisal)

A measurement introduced by A. Jacobson, designed to avoid the shortcomings of the ANB angle in evaluating anteroposterior jaw disharmonies. It is an adjunctive measurement to Steiner’s analysis which can be useful in assessing the extent of anteroposterior skeletal dysplasia and in determining the reliability of the ANB angle. The name is an abbreviation for “University of Witwatersrand,” in Johannesburg, South Africa, where this appraisal was developed.[17]

2.3.4 Tweed

A set of three angular measurements (Tweed triangle), introduced by C.H. Tweed in 1946 (Fig.11). The three angles that were originally described are the FMA (Frankfort-mandibular plane angle), the IMPA (Incisor-mandibular plane angle) and the FMIA (Frankfort-mandibular incisor angle). Their norms, as advocated by Tweed, were based on a sample of 95 individuals (some of them were orthodontically treated) who according to him had good facial outline, rather than ideal. The reference plane for the analysis is the Frankfort horizontal plane. Tweed’s entire philosophy of diagnosis and treatment was built around the relationship of the mandibular incisors to the mandibular plane (IMPA angle).[17]

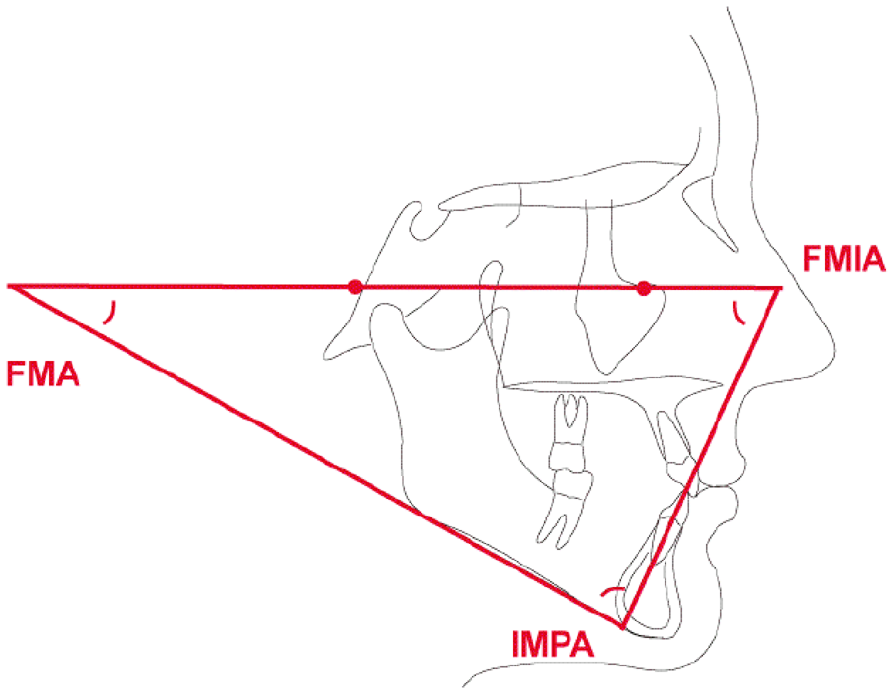


Fig. 11. The Tweed Triangle

2.3.5 Ricketts

Ricketts [68,69] was the first in recent history to expound in detail on the divine proportion and the Fibonacci series as they relate to the face in normal frontalis and norma lateralis, and to the growth of the face. The Ricketts analysis employs the less traditional points, planes, and axes which are different from the other cephalometric analyses. [17]

2.3.6 Munich

The Munich cephalometric analysis was developed by Hasund from Bergen, and was modified in Germany by Segner and Rudzki-Janson.[66] Most of the measurements applied in this analysis are identical to other widely accepted analyses. It consists of 14 angular measurements, five linear measurements and an index. It differs from other analyses in terminology, landmark identification and angle measurements. Gnathion is the lowest point on the symphyseal shadow of the mandible and Menton does not exist. The mandibular plane is called the mandibular line (ML), the palatal plane is called the nasal line (NL) and the SN plane is called the nasion sella line (NSL). The mandibular angle is called the Gn-tgo-Ar and is formed by the mandibular plane and ramal plane. The point of intersection of these two planes is tgo, the gonion tangent point. The Nordeval angle is the angle formed by the mandibular plane and the B-Pg plane, thus describing the chin prominence. The interincisal angle is called OK1-UK1, and OK1 refers to the upper incisor and UK1 to the lower incisor. The Holdaway angle relates the soft tissue profile to the hard tissue profile and is formed by the NB plane and the plane tangent to the soft tissue Pogonion and the upper lip, as described by Segner and Hasund.[71] This cephalometric analysis is used in the present study.

2.4 Races and ethnic groups

Richardson [63] reviewed 12 racial differences in dimensional traits of the human face. He pointed to the difficulty in defining a "race" as compared to an "ethnic group", such as Swedish whites, American whites, etc. In addition, Richardson believes that it is difficult "to accurately identify the various ethnic groups from somatic skull material excluding the teeth, except in the more extreme cases." He wonders whether "we have more than one race, but instead ethnic groups separated by cultural, climatic and geographic boundaries that have caused subtle changes in facial morphology."

For several decades, cephalometric standards for each race and ethnic group have been established using various analyses.[1,3,4,6,8,9,13-16,21,22,24,27,30,34,41,43,44,46,47,49,59,62,67,76,82] They have proven that differences in the craniofacial morphology among races and ethnic groups exist.[1,3,4,6,8,9,13-15,27-29,34,41,43,47,49,59,76,82] These studies revealed a certain pattern, wherein the non-Caucasian ethnic groups, when compared to Caucasians, consistently displayed profile convexities due to bilabial dental protrusion.[1,4,6,8,9,13-15,27,28,41,47,49,59,74,76,82] Chung et. al. investigated on racial variation of cephalometric measurements among Caucasians, Japanese, Chinese, Filipinos and Hawaiians, and found that the Chinese had the greatest incisal inclination, and the Caucasians, the least.[14] It also revealed that there was a general tendency toward bimaxillary protrusion among non-Caucasians, especially the Orientals, due to an imbalance of tooth dimension to the alveolar bone. Lew's study comparing the craniofacial morphology of the Chinese, Malay and Indian showed that the Indians were less protrusive.[43] However, when compared to Caucasians, the Indians exhibited a convex dental pattern.[29] Similar findings were seen among black Americans, African Bantu, Iranians, Mexicans, Saudis, Brazilians, Jewish, Egyptians and Israelis.[1,4,6,8,9,13,14,18,27,28,41,74]

2.5 Brief review of the Filipino racial ancestry

Archaeology has proven that during the pre-historic times, the native Negritos came in contact with Malays and Indonesians who left their ancestral home in Southeast Asia by crossing the seas in their sailboats and settled in the Philippine archipelago. Inter-racial marriages took place and out of these racial mixtures emerged the Filipino people. The cultural influences of both India and Arabia came to the Philippine shores through Malaysia, while the Chinese influences came direct from China.

In subsequent years, the Filipino intermarried, not only with the Indians, Chinese and Arabians, but also with the Spaniards, who colonized the Philippines for 333 years, the Americans, who conquered the country for four decades, the Japanese, the British, the French, the Germans and other peoples of the world. Today, it may be said that the bloods of the East and West meet and blend in the Filipino veins.

According to Dr. H. Otley Beyer,[7] a noted American anthropologist, the racial ancestry of Filipinos is as follows: Malay – 40%; Indonesian – 30%; Chinese – 10%; Indian (Hindu) – 5%; European & American – 3%; and Arab – 2%.

2.6 Floating norms

A study by Solow (1966) assessed that significant correlations among cephalometric variables exist.[72] This finding led to the concept of "craniofacial pattern" which can be described by significant correlations between vertical and sagittal skeletal parameters.[75] This implies that even though all the cephalometric values of a patient lie beyond one standard deviation from the population mean, they may still be considered acceptable if they maintain certain relationships with each other. Thus, the term "floating norms" is used to describe the individual norms that vary (float) in accordance with the variations of correlated cephalometric measurements.[25] These five basic cephalometric measurements (SNA, NL-NSL, NSBa, ML-NSL, SNB) are derived from linear and multiple regression analyses and presented in the form of a correlation box, *the harmony box*, which serves as a valuable adjunct in diagnosing individual skeletal malocclusion. The harmony box also varies according to race and ethnic groups.

3. METHODOLOGY

3.1 Study design

This investigation is a cross-sectional study which is prospectively collected.

3.2 Study population

Filipino samples

Filipino subjects, 44 males and 37 females, are selected from the student population of the Manila Central University according to the following criteria: 1) natural-born ethnic Filipino, 2) good facial aesthetics, 3) Angle Class 1 occlusion with no crowding, 4) all teeth present (third molars may or may not be present), 5) no history of orthodontic treatment. Clinical examinations and interviews are conducted to ensure that the established criteria are properly observed.

German samples

German subjects from Hamburg (Segner) and Munich are combined to comprise the German sample population. A total of 201 samples (Table 1) are selected based on the same criteria applied to the Filipino subjects. The average chronologic age for both samples is 18 years old.

Table 1. Subject population

Subject	**Male**	**Female**	**Total**
Manila	44	37	81
Hamburg	26	45	71
Munich	52	78	130

3.3 Methods

The lateral cephalogram of each Filipino subject is taken using one x-ray machine (Panoura, Yoshida Co. Ltd.) and a single technician.

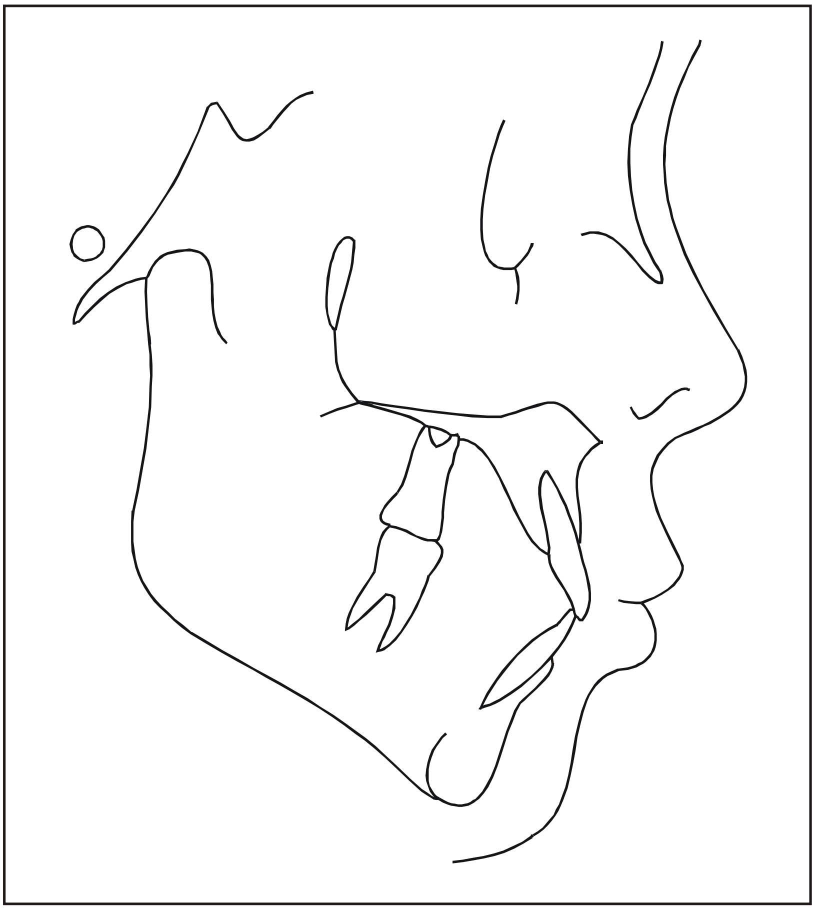


Fig. 12. Cephalometric tracing

3.3.1 Cephalometric tracing

The cephalometric film of each subject is traced by one investigator (Fig. 12). The cephalogram is placed with the profile to the right on the tracing light. It is oriented so that the NSL is parallel to the upper edge of the tracing light (Fig. 13). The headplate is fixed to the tracing light in this position. The points nasion (N) and sella (S) are marked directly on the radiograph with a sharp pencil. The acetate paper is then oriented on the radiograph after a line 8 centimeter from the upper border and 6 centimeter from the right border are drawn to meet at a point. This point would be the point nasion (N). The acetate paper is affixed, using a masking tape, over the headplate so that the sella (S) and nasion (N) points lie on the same line. This is the

NSL plane, the main reference line of all lateral headplate tracings. All relevant linear and angular parameters are measured and digitized with the aid of a computer program, *Diagnose Fix* (Dr. Jörg Wingberg GmbH, Buxtehude, Germany). The error of the method was determined by retracing and remeasuring the films, which generated an average error of less than 0.3 mm for the linear measurements and 0.4° for the angular measurements.

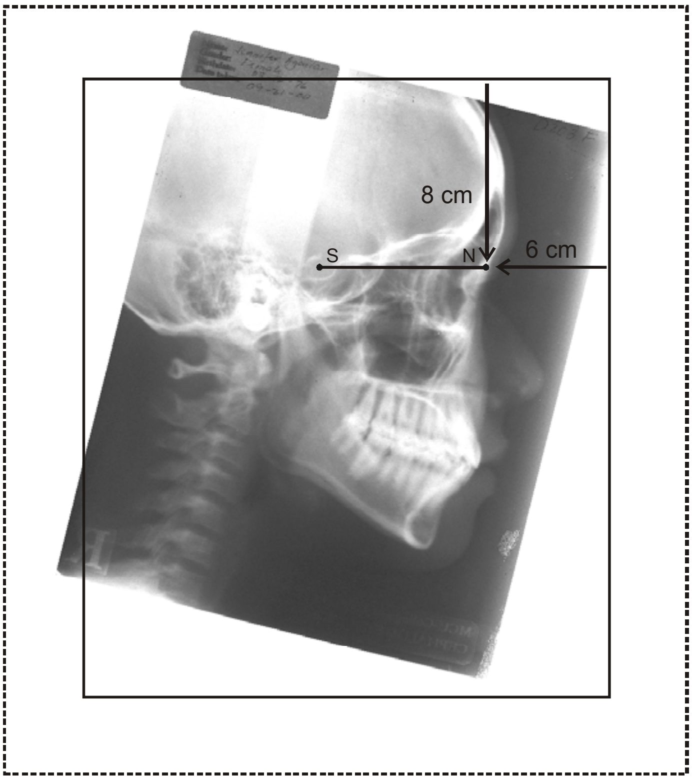


Fig. 13. Tracing light (--), acetate paper (-), lateral headplate, and the structures used in the construction of the reference plane

3.3.2 Cephalometric reference points

In order to describe the facial skeleton precisely for use as the basis for diagnosis and treatment, references points are determined to provide quantitative values for the shape and size of the face. The bony points used routinely are described and shown in figure 14.

S **Sella**:
The point sella is defined as the center of the bony crypt, sella turcica. It is a constructed point lying in the midsagittal plane.

N **Nasion**:
This is the most anterior lying point on the nasofrontal suture.

Ba **Basion**:
Basion is the most posterior and inferior lying point on the clivus in the midsagittal plane.

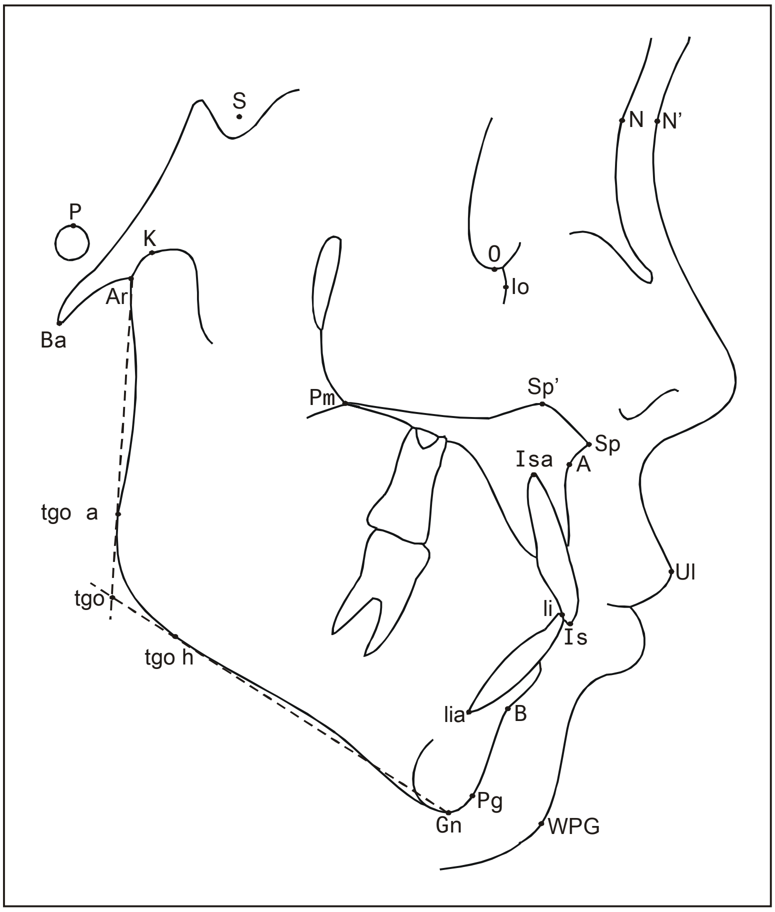


Fig. 14. Cephalometric reference points

Sp Anterior nasal spine:

The point Sp is the most anterior lying point on the anterior nasal spine. The point lies in the midsagittal plane.

A Point A:

The point A is the deepest point on the anterior contour of the maxillary alveolar process in the midsagittal plane.

Pm Pterygomaxillary:

Pterygomaxillary is defined in the lateral headplate as the intersection of the posterior contour of the maxilla with the contour of the hard and soft palate.

Is Incisal point of the maxillary incisor – incision superius:

The incisal point is the midpoint of the incisive edge of the mean maxillary incisor.

Isa Apical point of the maxillary incisor – incision superius apikale:

This is the most apical point on the root of the mean maxillary central incisor.

B Point B:

Point B is the deepest point on the anterior contour of the mandibular alveolar process in the midsagittal plane.

Pg Pogonion:

Pogonion is the most anterior point on the bony chin in the midsagittal plane.

Gn Gnathion:

Gnathion is the most inferior point on the mandibular symphysis in the midsagittal plane. Also referred to as menton.

Ii Incisal point of the mandibular incisor – incision inferius:

The incisal point is the midpoint of the incisive edge of the mean mandibular incisor.

Iia Apical point of the mandibular incisor – incision inferius apikali:

This point is the most apical point on the root of the mean mandibular central incisor.

Ar Articulare:

Articulare is the intersection of the external contour of the cranial base with the dorsal contour of the neck of the mandible (collum mandibulae).

Sp' Spina prime:

The point Sp' is defined as the intersection of the nasal line and the nasion-gnathion line.

tgo Gonion-tangent point:

The point tgo is defined as the intersection of the mandibular line and the ramus line.

WPG Soft tissue pogonion:

The most anterior point of the soft tissue chin profile lying in the midsagittal plane.

Ul Upper lip point:

The upper lip point is the most anterior lying point on the upper lip profile in relation to the N’-WPG line.

N’ Soft tissue nasion:

The soft tissue nasion is formed by the intersection of the extension of the nasion-sella line (NSL) with the soft tissue profile.

3.3.3 Cephalometric reference lines in the horizontal plane

NSL <u>Nasion-sella line</u>:

This is the main reference line which connects the point sella to the point nasion. It also represents the cranial base.

NL <u>Nasal line</u>:

This is the connection between the pterygomaxillare (Pm) and the anterior nasal spine (Sp), which is used as the reference line of the nasal cavity and the maxillary base.

ML <u>Mandibular line</u>:

This is the tangent from gnathion (Gn) to the inferior border of the angle of the mandible. This is the reference line for the body of the mandible.

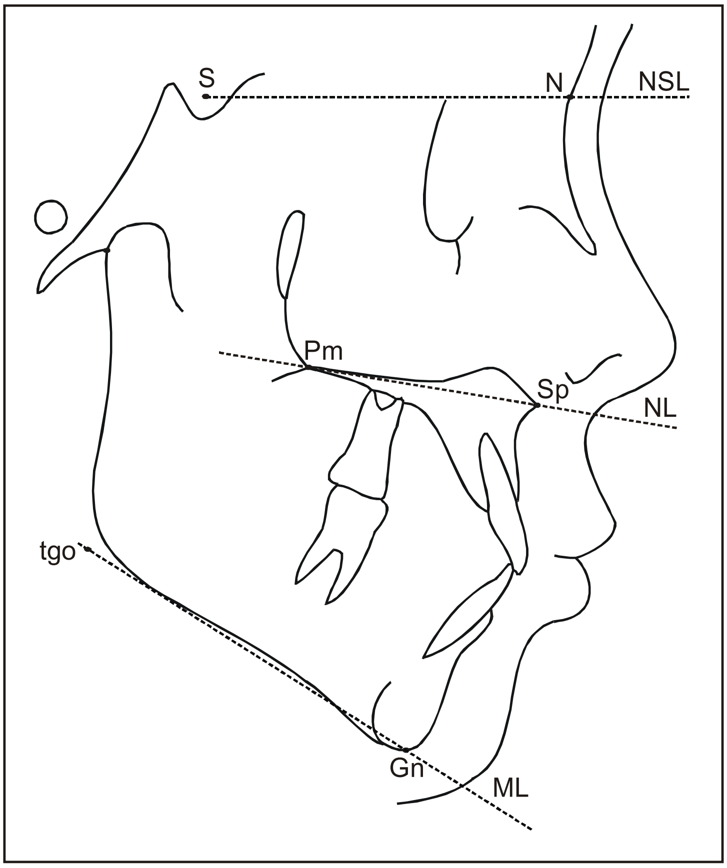


Fig. 15. Cephalometric reference lines in the horizontal plane

3.3.4 Cephalometric reference lines in the vertical plane

NAL Nasion-maxillary line:

This is the line between nasion (N) and point A (A) and is used as the reference line for the position of the maxillary incisor.

NBL Nasion-mandibular line:

This is the line between nasion (N) and point B (B) and is used as the reference line for the position of the mandibular incisors. It is also used for measuring the chin prominence.

NPg Nasion-pogonion line:

This is the line between nasion (N) and pogonion (Pg) and is used to describe the sagittal position of the chin and a reference line for the position of the lower incisors.

Ramus line:

This is the line connecting the point artikulare (Ar) and the gonion-tangent point (tgo).

Clivus line:

This is the line connecting the points sella (S) and basion (Ba).

Nasion-gnathion line:

This serves as the reference line for the computation of the index of the anterior facial height and connects the points nasion (N) and gnathion (Gn).

B-Pog line:

This is the tangent of the chin prominence, connecting points B (B) and pogonion (Pg) and aids in the evaluation of the Nordeval angle.

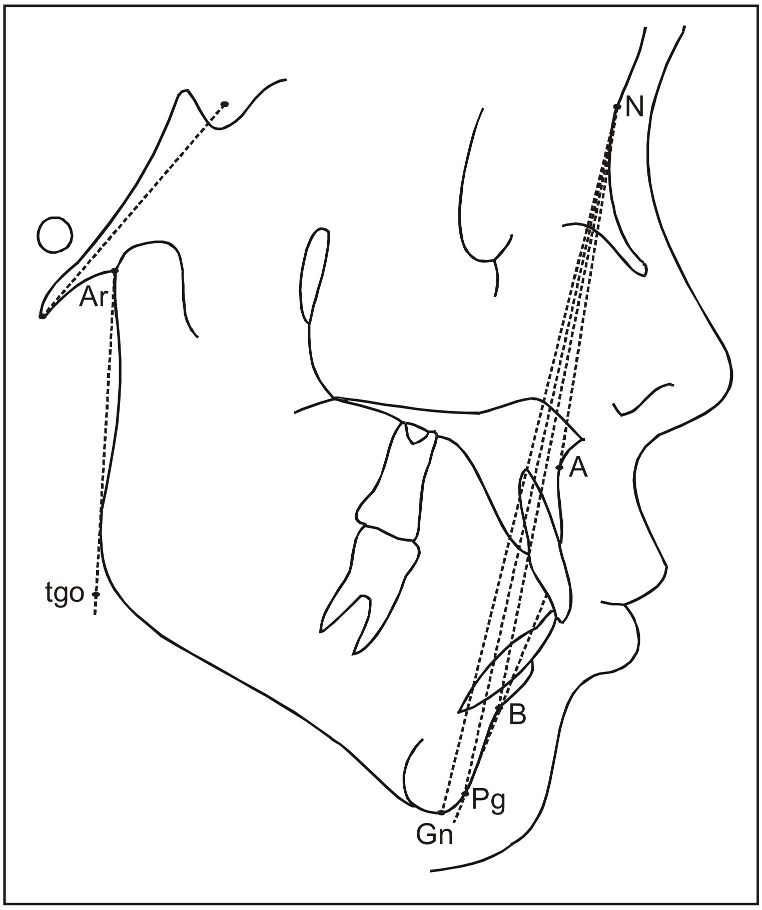


Fig. 16. Cephalometric reference lines in the vertical plane

3.3.5 Cephalometric reference lines in incisor axes

Ok1 Upper incisor axis:

This is the line drawn through the incisal point (Is) and the apical point (Isa) of the mean maxillary central incisor, which represents its long axis.

UK1 Lower incisor axis:

The line between the incisal point (Ii) and the apical point (Iia) of the mean mandibular central incisor, which is used to represent its long axis.

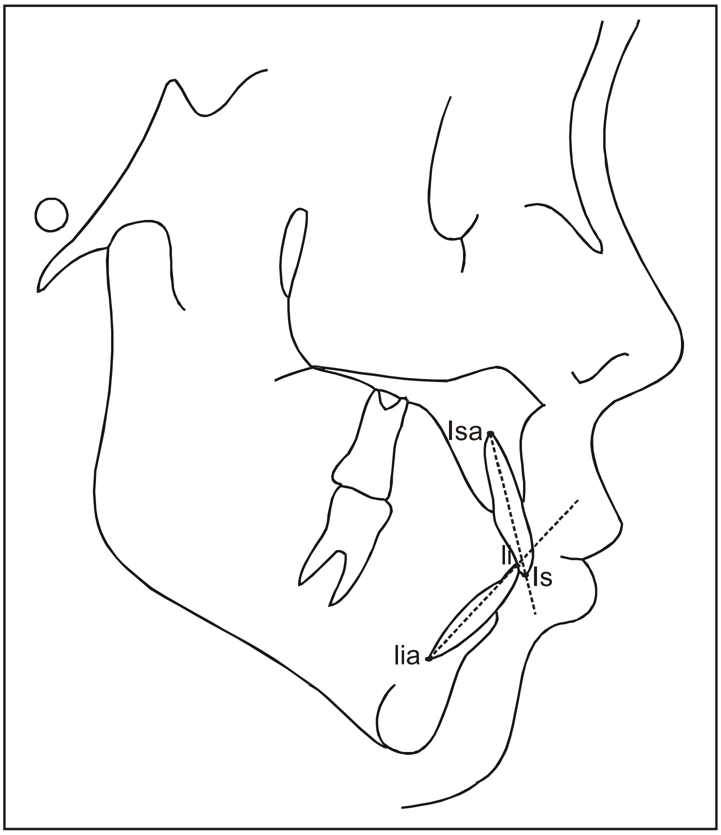


Fig. 17. Cephalometric reference lines in incisor axes

3.3.6 Cephalometric reference line for the soft tissue profile

HL Holdaway line:

This is the line from the soft tissue pogonion (WPG) to the upper lip point (UI), which is used for the evaluation of the lip profile.

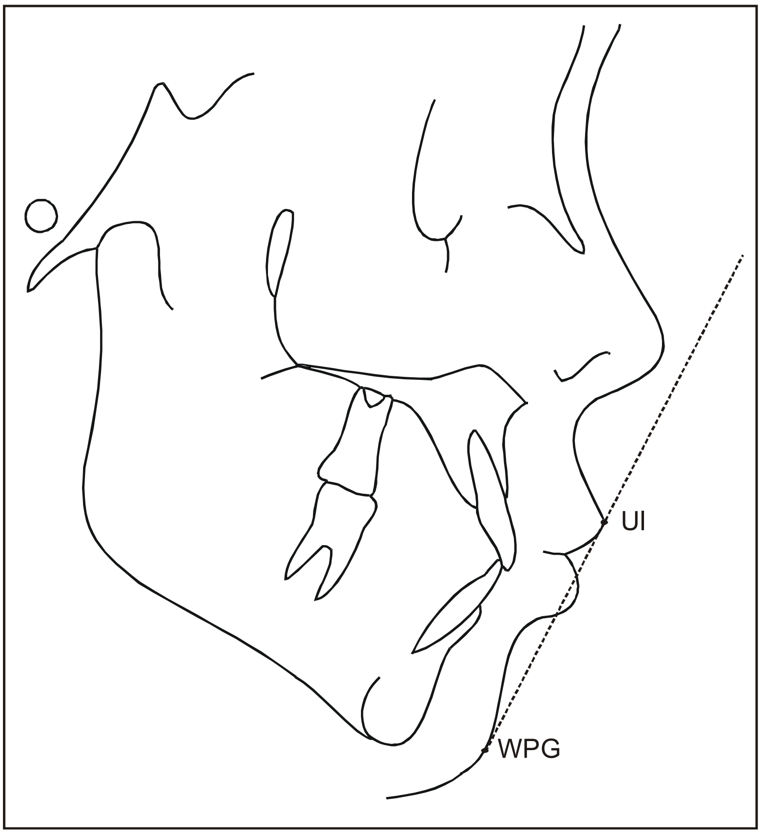


Fig. 18. Cephalometric reference line for the soft tissue profile

3.3.7 Linear and angular measurements

Twenty linear and angular measurements are obtained from the cephalometric tracings with the aid of a computer software, DiagnoseFix 2001. These parameters are used to compare the craniofacial morphology between Filipinos and Germans.

Skeletal parameters in the sagittal plane: (Fig. 19 – 26)
SNA, SNB, ANB, SNPg, NSBa, Gn-tgo-Ar, N-angle, Pg-NB (mm)

Skeletal parameters in the vertical plane: (Fig. 27 – 32)
NL-NSL, ML-NSL, ML-NL, N-Sp’, Sp’-Gn, Index

Dental parameters: (Fig. 33 – 37)
OK1-NA (°), OK1-NA (mm), UK1-NB (°), UK1-NB (mm), OK1-UK1 (°)

Soft tissue profile (Fig. 38)
Holdaway angle (°)

1. SNA (°)

= maxillary prognathism

This angle expresses the anteroposterior position of point A in relation to the cranial base.

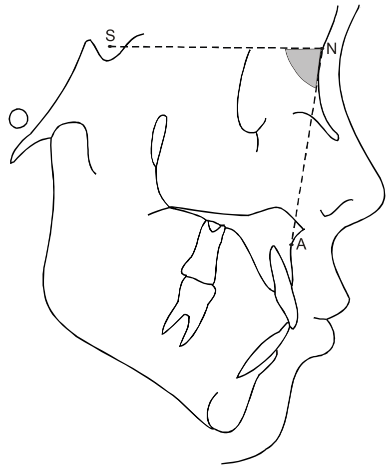


Fig. 19. SNA (°)

2. SNB (°)

= mandibular prognathism

This angle describes the anteroposterior position of the mandible in relation to the cranial base.

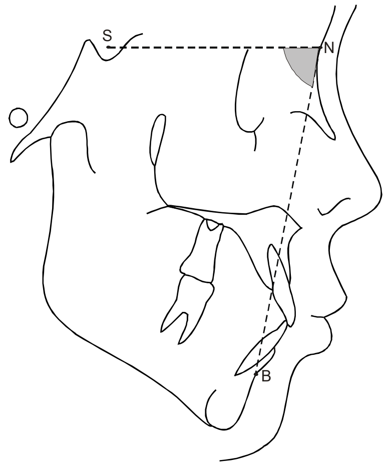


Fig. 20. SNB (°)

3. ANB (°)

= This angle describes the sagittal position of the maxilla and the mandible in relation to the cranial base.

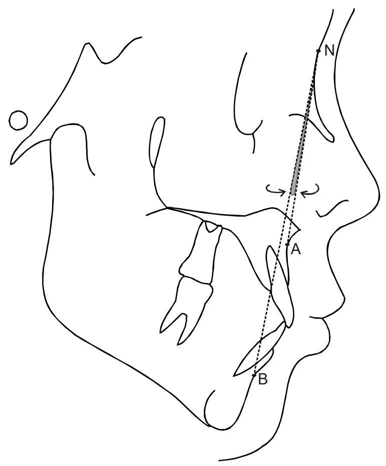


Fig. 21. ANB (°)

4. SNPg (°)

= pogonion angle

This angle indicates the sagittal position of the chin in relation to the cranial base.

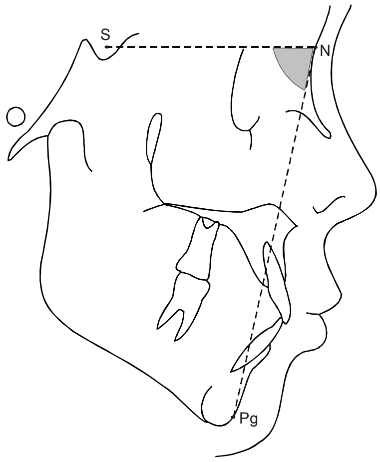


Fig. 22. SNPg (°)

5. NSBa (°)

= cranial base angle

This angle describes the relation of the clivus to the cranial base.

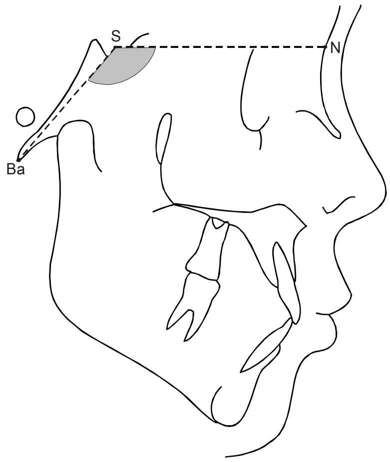


Fig. 23. NSBa (°)

6. Gn-tgo-Ar (°)

= mandibular angle

This angle expresses the form of the mandible by relating the body and the ramus.

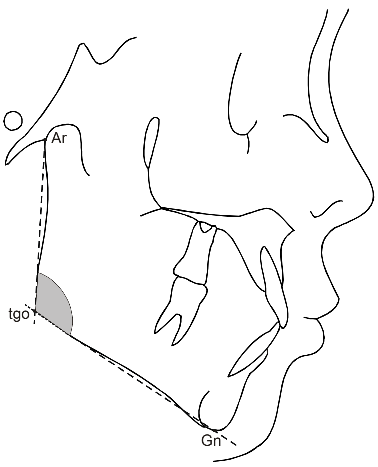


Fig. 24. Gn-tgo-Ar (°)

7. N angle (°)

= Nordeval angle

This angle expresses the prominence of the bony chin in relation to the mandibular plane.

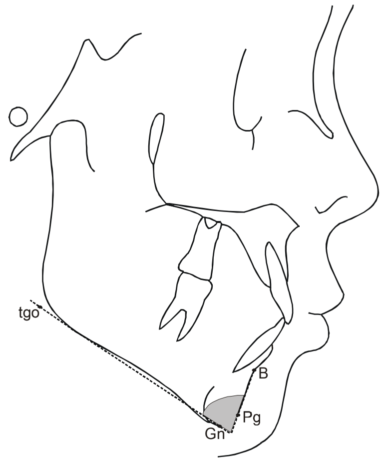


Fig. 25. Nordeval angle (°)

8. Pg – NB (mm)

= chin prominence

This is the distance from Pogonion (Pg) to the NB line, which describes the size of the bony chin prominence.

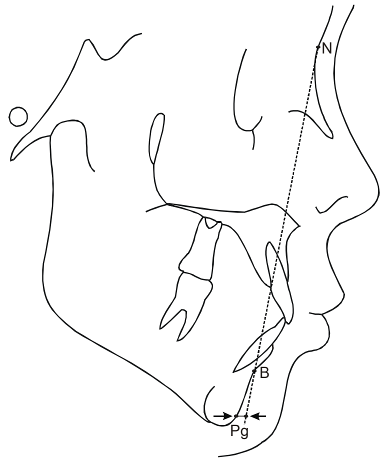


Fig. 26. Pg – NB (mm)

9. NL – NSL (°)

= maxillary inclination

This angle expresses the degree of maxillary inclination in relation to the cranial base.

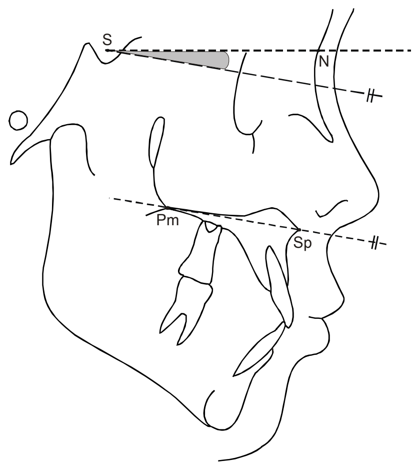


Fig. 27. NL-NSL

10. ML – NSL (°)

= mandibular inclination

This angle expresses the degree of inclination of the mandible relation to the anterior base of the skull.

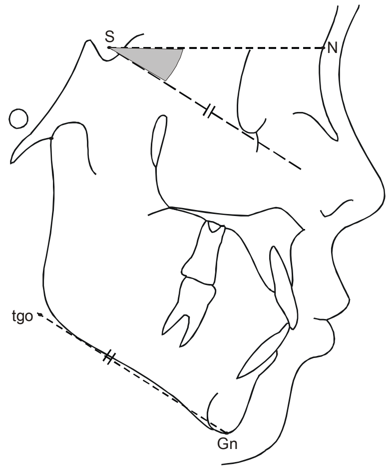


Fig. 28. ML – NSL (°)

11. ML – NL (°)

= vertical apical base relationship

This angle expresses the degree of inclination of the mandible in relation to the maxillary base.

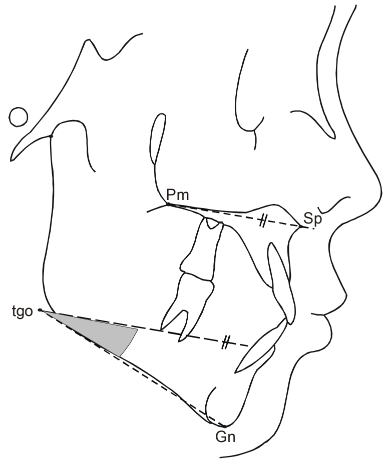


Fig. 29. ML – NL (°)

12. N – Sp' (mm)

= middle anterior facial height

This distance measures the middle anterior facial height.

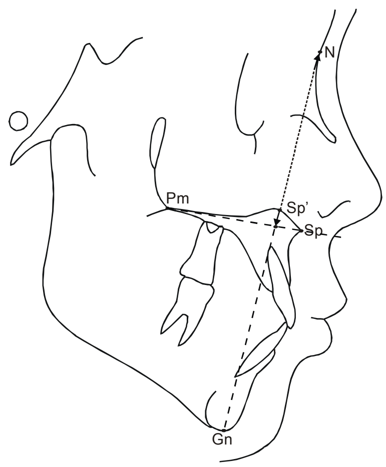


Fig. 30. N – Sp' (mm)

13. Sp’ – Gn (mm)

= lower anterior facial height

This distance measures the length of the lower anterior facial height.

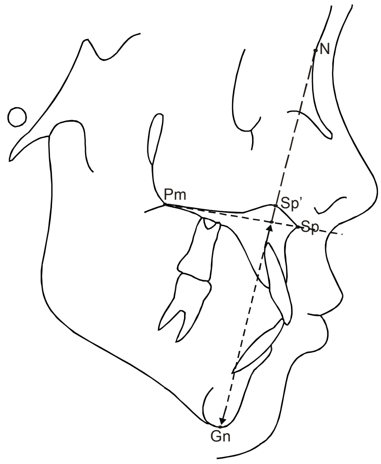


Fig. 31. Sp’ – Gn (mm)

14. N – Sp’ / Sp’ – Gn x 100%

= facial index

This index expresses the relationship between the upper and lower facial heights to the total anterior facial height.

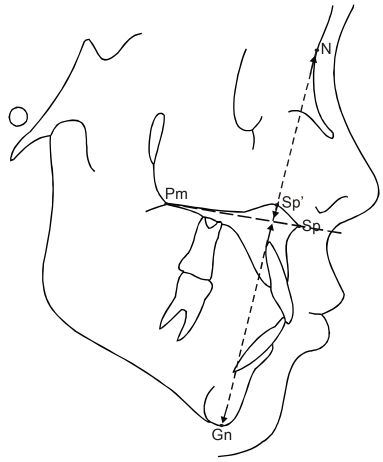


Fig. 32. Facial Index (%)

15. OK1 – NA (°)

= upper incisor axis

This angle describes the inclination of the maxillary incisor in relation to the NA plane.

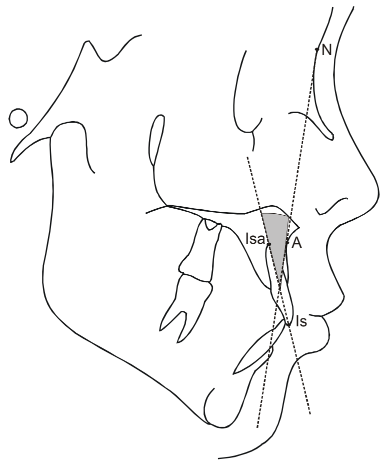


Fig. 33. OK1 – NA (°)

16. OK1 – NA (mm)

= sagittal position of upper incisors

This distance describes the anteroposterior position of the upper incisor in relation to the maxilla.

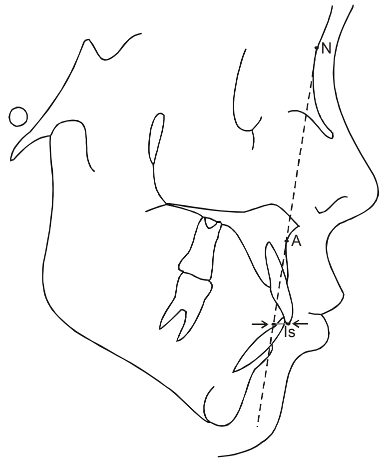


Fig. 34. OK1 – NA (mm)

17. UK1 – NB (°)

= lower incisor axis

This angle describes the inclination of the mandibular incisor in relation to the NB plane.

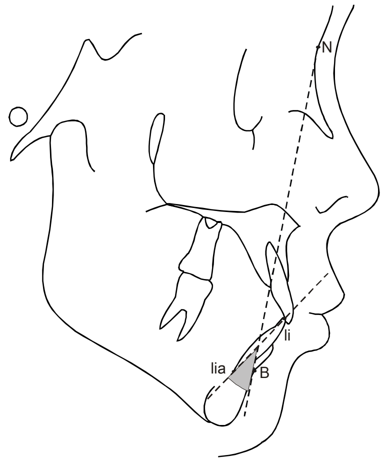


Fig. 35. UK1 – NB (°)

18. UK1 – NB (mm)

= sagittal position of the lower incisors

This distance describes the anteroposterior position of the mandibular incisor in relation to the mandibular base.

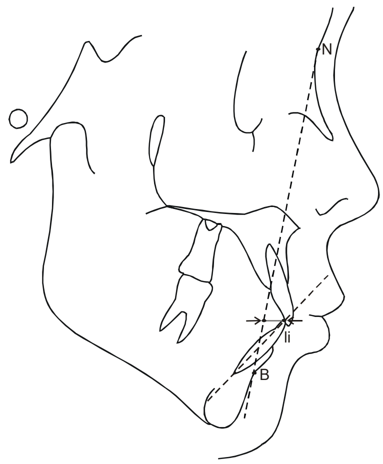


Fig. 36. UK1 – NB (mm)

19. OK1 – UK1 (°)

= interincisal angle

This angle describes the dental pattern.

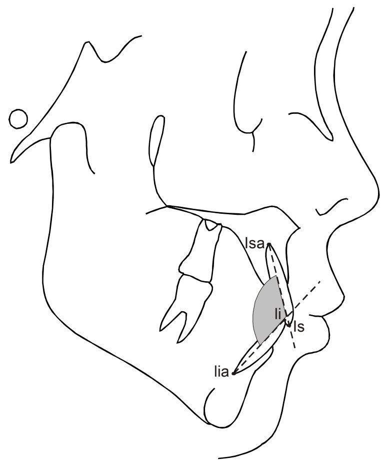


Fig. 37. OK1 – UK1 (°)

20. H – Angle (°)

= Holdaway angle

This angle relates the soft tissue profile to the hard tissue profile.

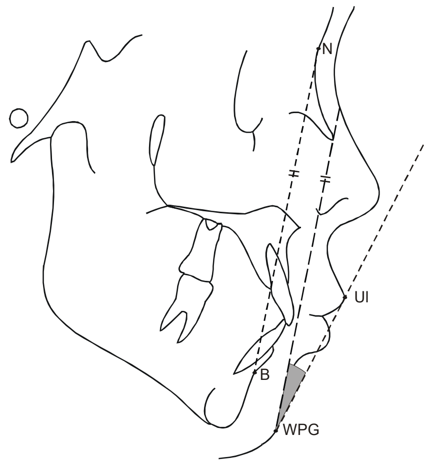


Fig. 38. H – angle (°)

3.4 Statistical analysis

Descriptive statistics (mean, standard deviation) is calculated for all the cephalometric parameters. The results are tabulated and compared with established German cephalometric standards by means of student's *t*-test.

The Levene test is performed to prove similarities of variances.
All variables are analyzed to check for normality of distribution using the Kolmogorov – Smirnoff test.

Pearson's correlation coefficients described the high association among the variables used in the construction of the harmony box:

1) SNA = maxillary prognathism
2) NL – NSL = maxillary inclination
3) SNB = mandibular prognathism
4) ML – NSL = mandibular inclination
5) NSBa = cranial base

The bivariate linear regression analysis is used to construct the harmony box.

Multiple regression analysis, particularly the standard error of the estimate, is calculated to construct the harmony schema.

All data analyses are performed using the SPSS program for Windows, version 11.5 (SPSS Inc, Chicago, Ill).

4. RESULTS

4.1 Measurement of individual cephalometric variable

The twenty cephalometric variables of the subjects from the Philippines (n=81) and Germany (n=201) are tabulated and compared (Tables 2 – 21).

Cephalometric superimpositions registered at the sella and SN lines are made to clearly describe the differences in craniofacial morphology between the two groups (Fig. 39 – 115). These cephalometric tracings are obtained from the average cephalometric values of each group, thus, representing the craniofacial morphology of each race.

The normal distribution of all variables are shown and the corresponding normal curves are compared (Fig. 40 – 118).

The following legends are used to describe the level of *p* significance:

*	$p < 0.05$
**	$p < 0.01$
***	$p < 0.001$
ns	not significant

VARIABLE 1
SNA (°)

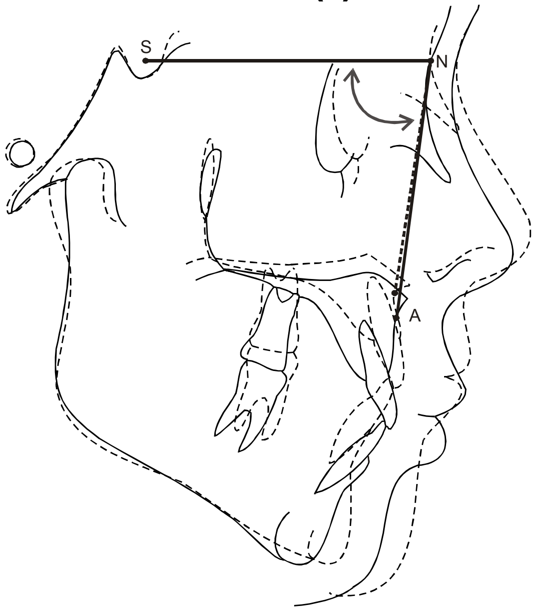


Fig. 39. Superimposition of SNA of Filipinos (-) and Germans (--)

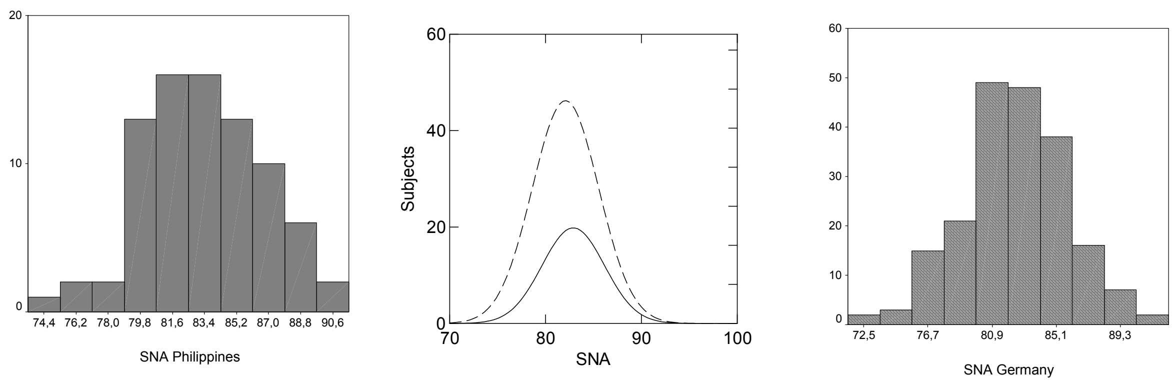


Fig. 40–42. Normal distribution and normal curve comparison of the SNA value between Filipinos (-) and Germans (--)

Table. 2. Comparison of the SNA between Filipinos (n=81) and Germans (n=201)

Gender	Filipinos		Germans		P sig.
	Mean	S. D.	Mean	S. D.	
Male	83.4	3.2	81.6	3.5	***
Female	83.3	3.5	82.9	3.4	ns
Both	83.3	3.3	82.4	3.5	***

Result:

The Filipinos show a larger SNA angle when compared to the Germans. The difference in size is significantly seen among the male subjects. No significant difference is seen among the female subjects.

VARIABLE 2
SNB (°)

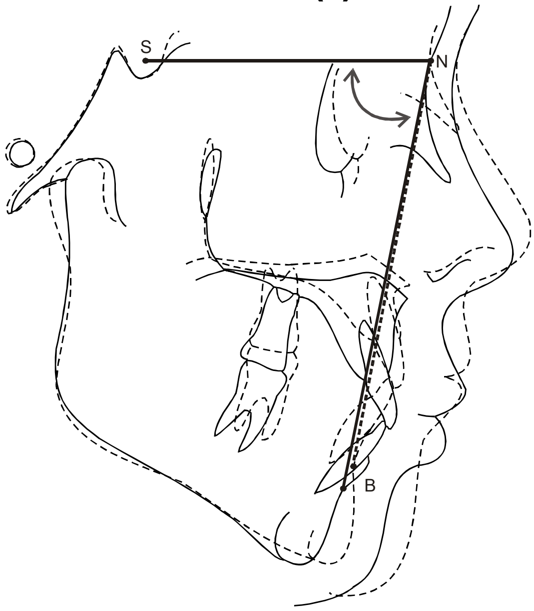


Fig. 43. Superimposition of SNB of Filipinos (-) and Germans (--)

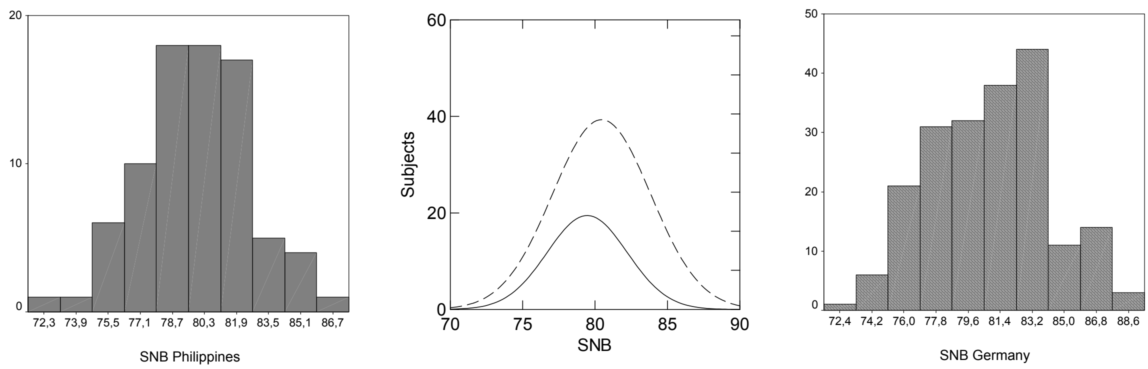


Fig. 44–46. Normal distribution and normal curve comparison of the SNB value between Filipinos (-) and Germans (--)

Table. 3. Comparison of the SNB between Filipinos (n=81) and Germans (n=201)

Gender	Filipinos		Germans		P sig.
	Mean	S. D.	Mean	S. D.	
Male	80.1	2.8	79.8	3.2	ns
Female	79.6	2.8	81.4	3.4	***
Both	79.9	2.8	80.8	3.4	***

Result:

The SNB angle of the Filipinos is significantly smaller when compared to that of the Germans. This difference is significantly seen among the female samples. No significant difference is seen among the males.

VARIABLE 3
ANB (°)

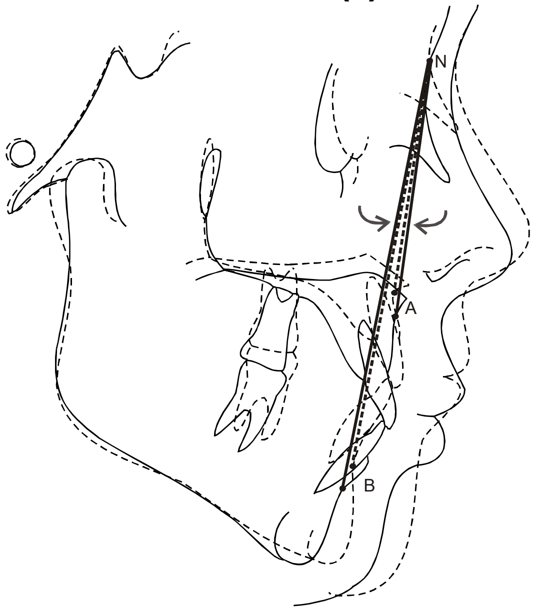


Fig. 47. Superimposition of ANB of Filipinos (-) and Germans (--)

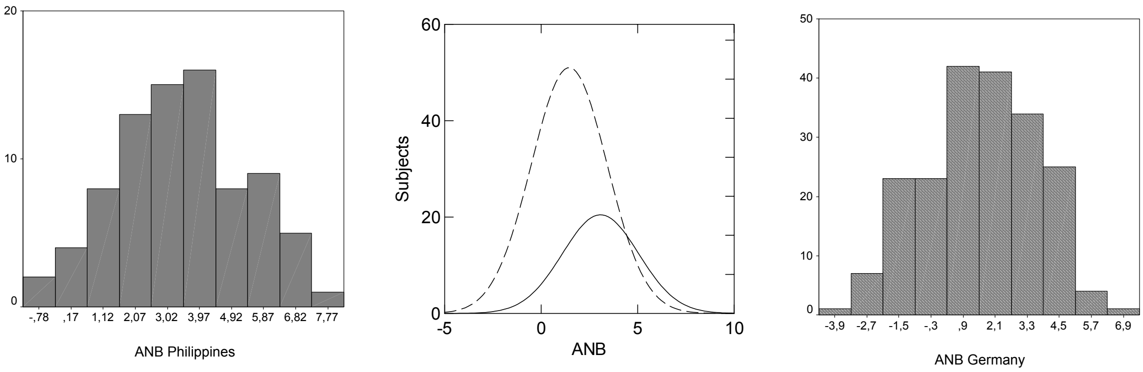


Fig. 48-50. Normal distribution and normal curve comparison of the ANB value between Filipinos (-) and Germans (--)

Table. 4. Comparison of the ANB between Filipinos (n=81) and Germans (n=201)

Gender	Filipinos		Germans		P sig.
	Mean	S. D.	Mean	S. D.	
Male	3.3	2.1	1.8	2.1	***
Female	3.6	1.9	1.5	2.1	***
Both	3.5	2.0	1.6	2.1	***

Result:

The Filipinos consistently exhibit a significantly larger ANB angle, when compared to the Germans.

VARIABLE 4
SN - Pg (°)

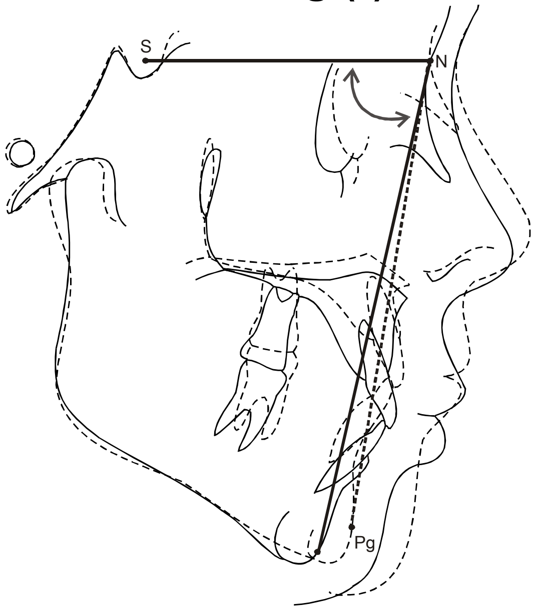


Fig. 51. Superimposition of SN-Pg of Filipinos (-) and Germans (--)

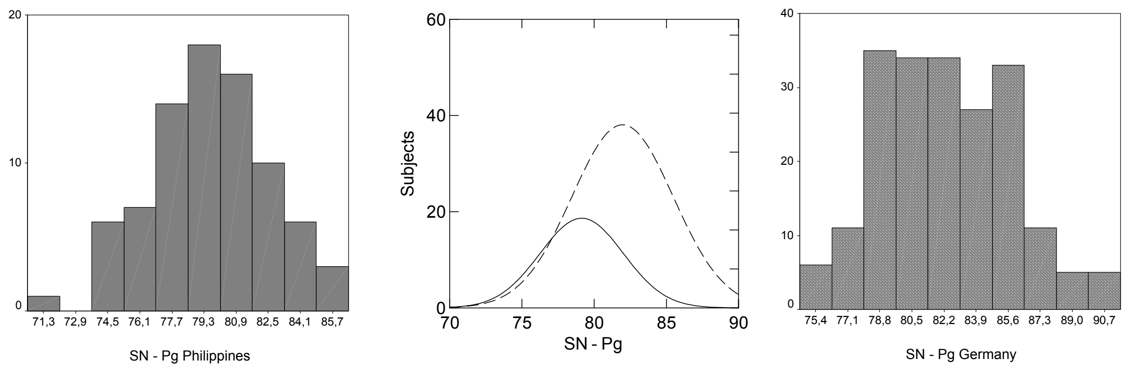


Fig. 52–54. Normal distribution and normal curve comparison of the SN-Pg value between Filipinos (-) and Germans (--)

Table. 5. Comparison of the SN-Pg between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	80.0	3.1	81.2	3.1	**
Female	79.2	2.8	82.9	3.6	***
Both	79.6	2.9	82.2	3.5	***

Result:

The Filipinos show a significantly smaller SN-Pg angle, when compared to the Germans.

VARIABLE 5
NSBa (°)

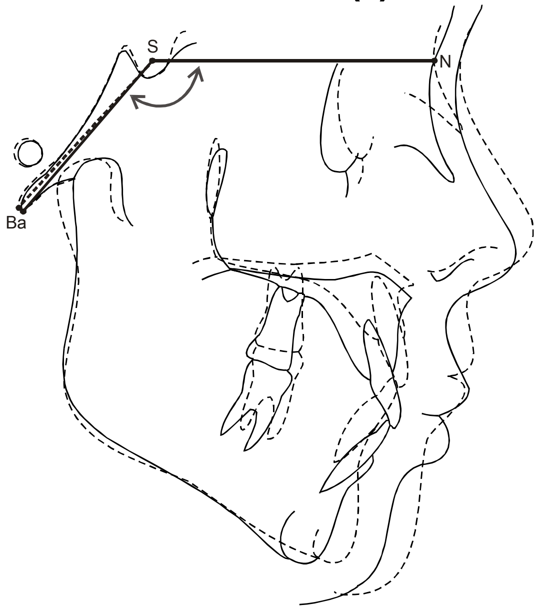


Fig. 55. Superimposition of NSBa of Filipinos (-) and Germans (--)

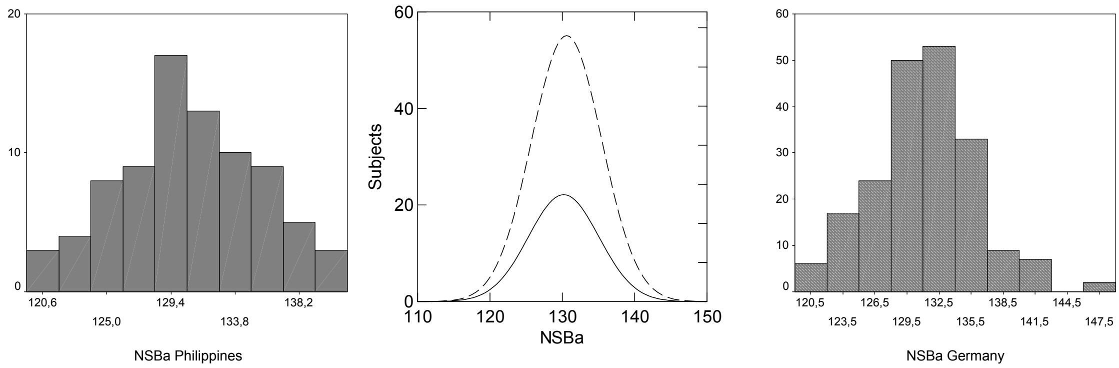


Fig. 56–58. Normal distribution and normal curve comparison of the NSBa value between Filipinos (-) and Germans (--)

Table. 6. Comparison of the NSBa between Filipinos (n=81) and Germans (n=201)

Gender	Filipinos		Germans		P sig.
	Mean	S. D.	Mean	S. D.	
Male	129.4	4.6	131.5	3.9	***
Female	132.1	4.8	130.4	5.3	**
Both	130.6	4.9	130.9	4.9	ns

Result:

No significant difference in the NSBa angle are seen between Filipinos and Germans. However, the male Filipinos exhibit a significantly smaller NSBa angle when compared to German males. On the contrary, the Filipino females show a significantly larger NSBa angle when compared to their German counterparts.

VARIABLE 6
Gn – tgo - Ar (°)

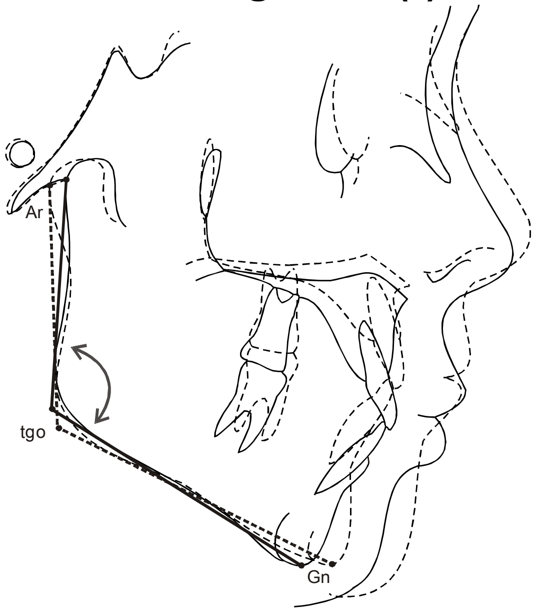


Fig. 59. Superimposition of Gn-tgo-Ar of Filipinos (-) and Germans (--)

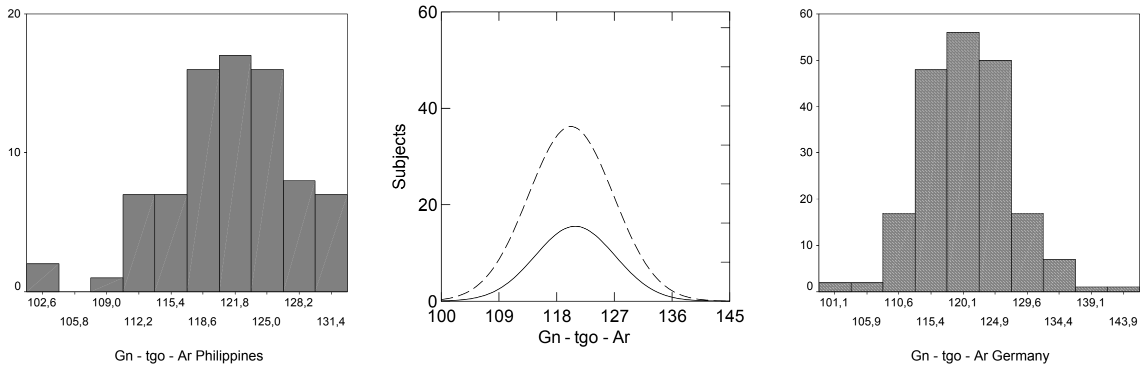


Fig. 60–62. Normal distribution and normal curve comparison of the Gn-tgo-Ar value between Filipinos (-) and Germans (--)

Table. 7. Comparison of the Gn-tgo-Ar between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	120.5	6.4	121.3	5.9	ns
Female	121.4	5.6	120.0	7.1	ns
Both	121.3	6.2	120.5	6.6	ns

Result:

No significant difference exist in the Gn-tgo-Ar angle between Filipinos and Germans.

VARIABLE 7
Nordeval angle (°)

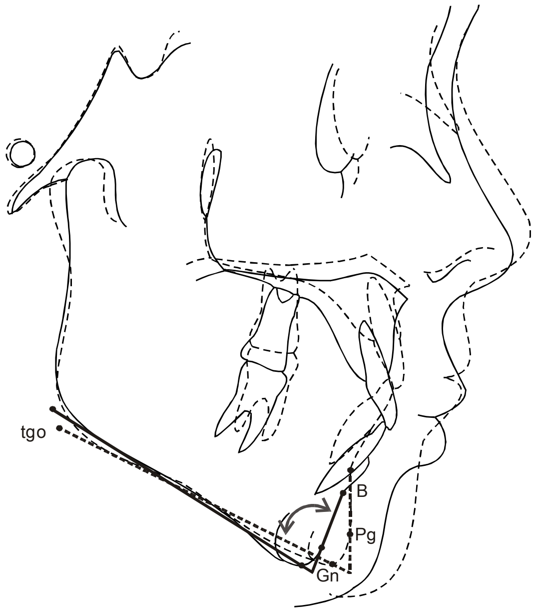


Fig. 63. Superimposition of Nordeval angle of Filipinos (-) and Germans (--)

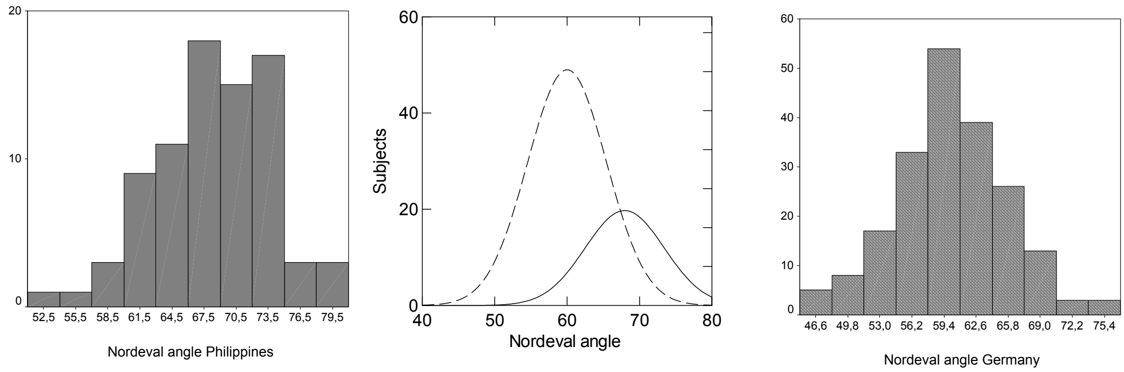


Fig. 64–66. Normal distribution and normal curve comparison of the Nordeval angle between Filipinos (-) and Germans (--)

Table. 8. Comparison of the Nordeval angle between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	68.4	6.1	59.2	5.2	***
Female	69.2	4.8	60.9	5.6	***
Both	68.4	5.5	60.2	5.5	***

Result:

The Nordeval angle of the Filipinos is significantly larger than that of the Germans.

VARIABLE 8
Pg - NB (mm)

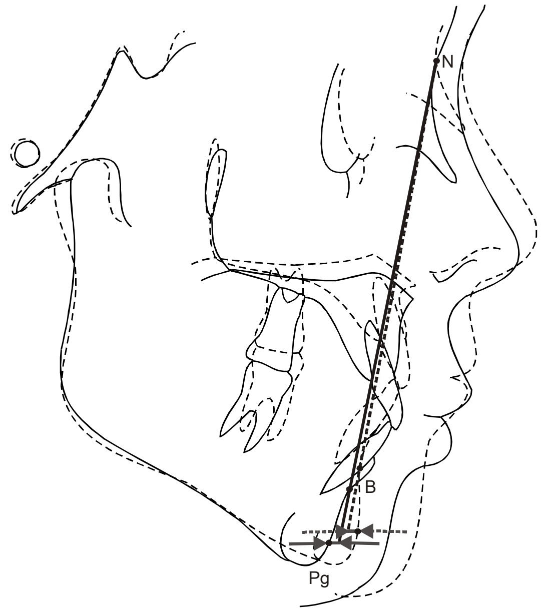


Fig. 67. Superimposition of Pg-NB of Filipinos (-) and Germans (--)

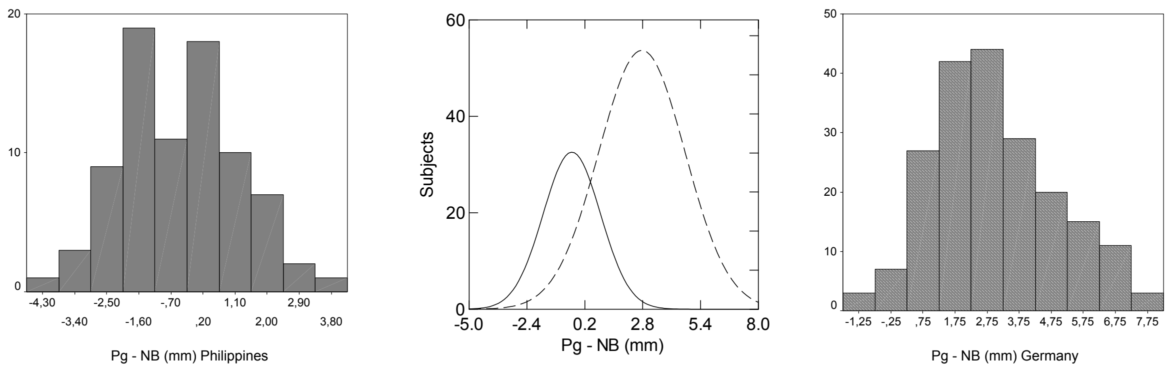


Fig. 68–70. Normal distribution and normal curve comparison of the Pg-NB value between Filipinos (-) and Germans (--)

Table. 9. Comparison of the Pg-NB between Filipinos (n=81) and Germans (n=201)

Gender	Filipinos		Germans		P sig.
	Mean	S. D.	Mean	S. D.	
Male	-0.1	1.6	2.8	1.7	***
Female	-0.8	1.7	3.2	2.1	***
Both	-0.4	1.6	3.0	1.9	***

Result:

The Filipinos show a significantly lower Pg-NB values when compared to the Germans.

VARIABLE 9
NL – NSL (°)

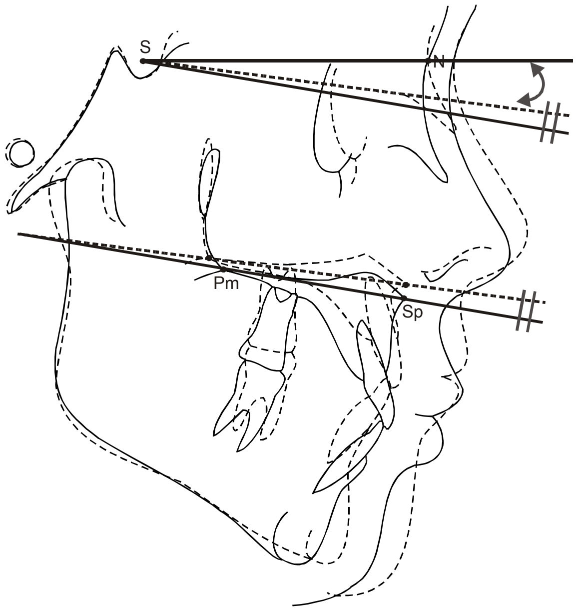


Fig. 71. Superimposition of NL-NSL of Filipinos (-) and Germans (--)

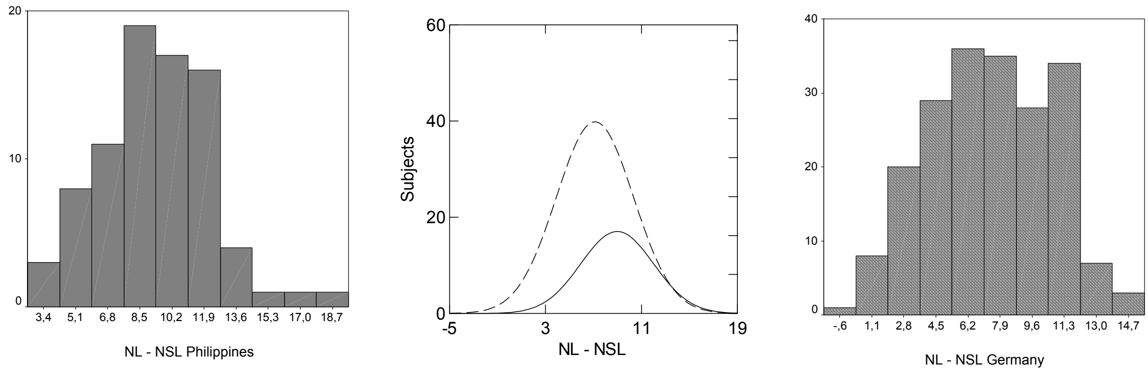


Fig. 72-74. Normal distribution and normal curve comparison of the NL-NSL value between Filipinos (-) and Germans (--)

Table. 10. Comparison of the NL-NSL between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	8.7	2.5	7.7	3.1	**
Female	10.3	3.3	7.2	3.3	***
Both	9.4	3.0	7.4	3.2	***

Result:

The Filipinos show a significantly larger NL-NSL angle, when compared to the Germans.

VARIABLE 10
ML – NSL (°)

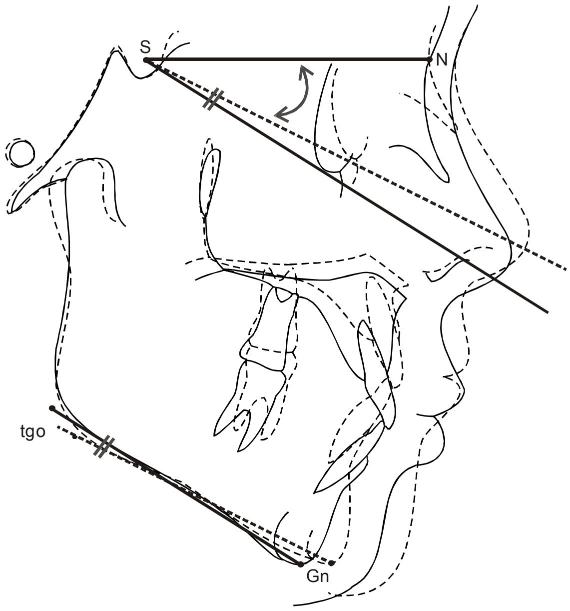


Fig. 75. Superimposition of ML-NSL of Filipinos (-) and Germans (--)

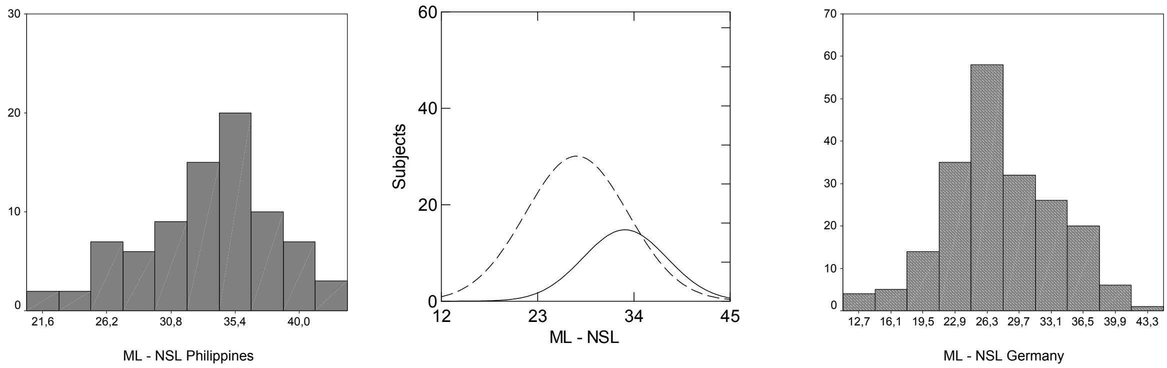


Fig. 76-78. Normal distribution and normal curve comparison of the ML-NSL value between Filipinos (-) and Germans (--)

Table. 11. Comparison of the ML-NSL between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	32.0	5.0	29.8	5.2	***
Female	34.4	3.7	26.4	5.9	***
Both	33.4	4.8	27.7	5.9	***

Result:

The ML-NSL angle of the Filipinos are significantly larger than that of the Germans.

VARIABLE 11
ML – NL (°)

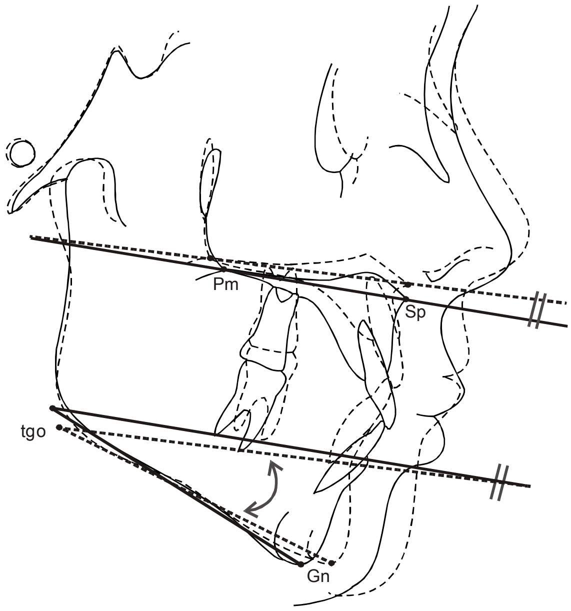


Fig. 79. Superimposition of ML-NL of Filipinos (-) and Germans (--)

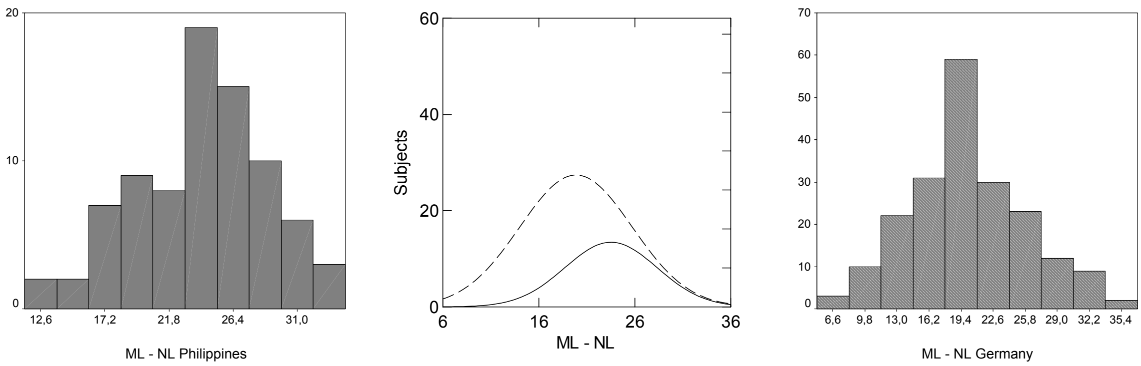


Fig. 80-82. Normal distribution and normal curve comparison of the ML-NL value between Filipinos (-) and Germans (--)

Table. 12. Comparison of the ML-NL between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	23.2	4.9	22.0	5.8	ns
Female	24.0	4.4	19.0	5.5	***
Both	24.0	4.8	20.1	5.8	***

Result:

The Filipinos exhibit a significantly larger ML-NL angle when compared to the Germans. However, this difference is not so significant among the male samples.

VARIABLE 12
N – Sp' (mm)

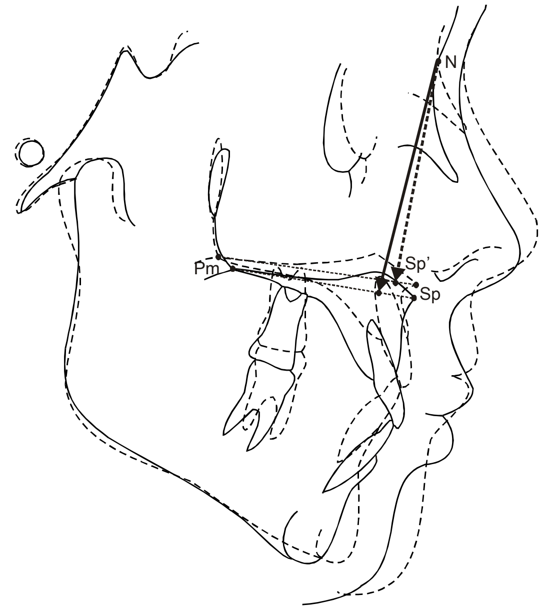


Fig. 83. Superimposition of N-Sp' of Filipinos (-) and Germans (--)

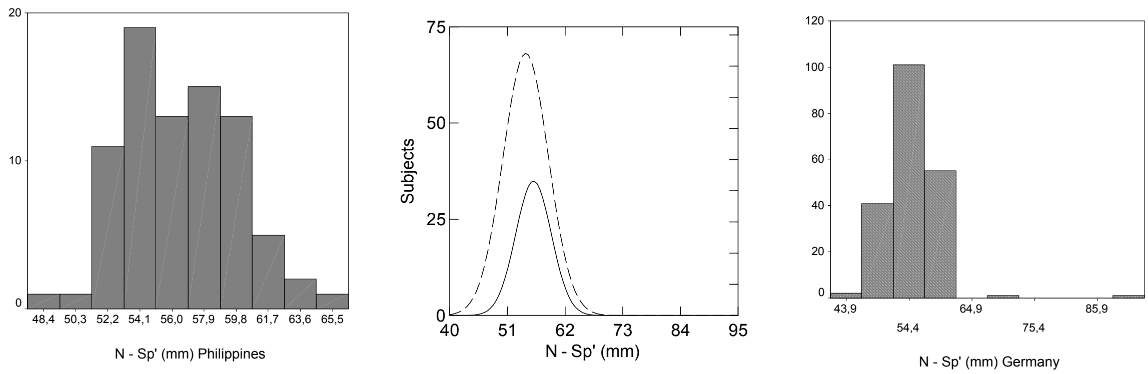


Fig. 84-86. Normal distribution and normal curve comparison of the N-Sp' value between Filipinos (-) and Germans (--)

Table. 13. Comparison of the N-Sp' between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	57.9	3.1	53.9	5.7	***
Female	54.5	2.6	55.4	3.0	**
Both	56.4	3.4	54.8	4.3	***

Result:

The Filipinos show a significantly longer N-Sp' measurement, when compared with the Germans. However, the Filipino females show a shorter N-Sp' measurement , when compared with the German females.

VARIABLE 13
Sp' - Gn (mm)

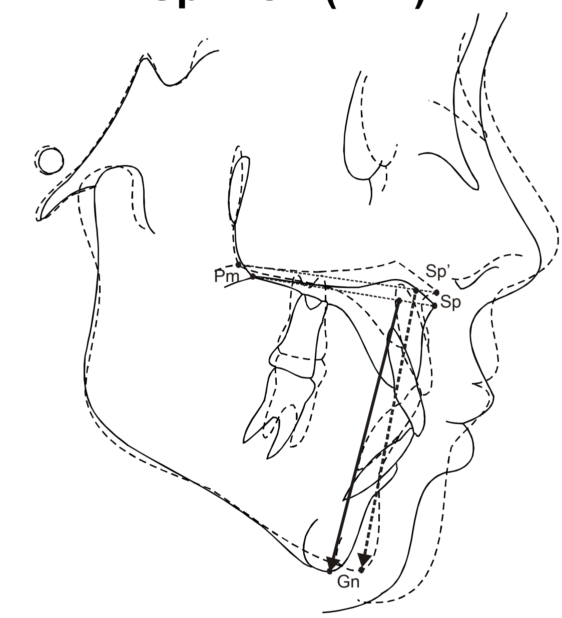


Fig. 87. Superimposition of Sp'-Gn of Filipinos (-) and Germans (--)

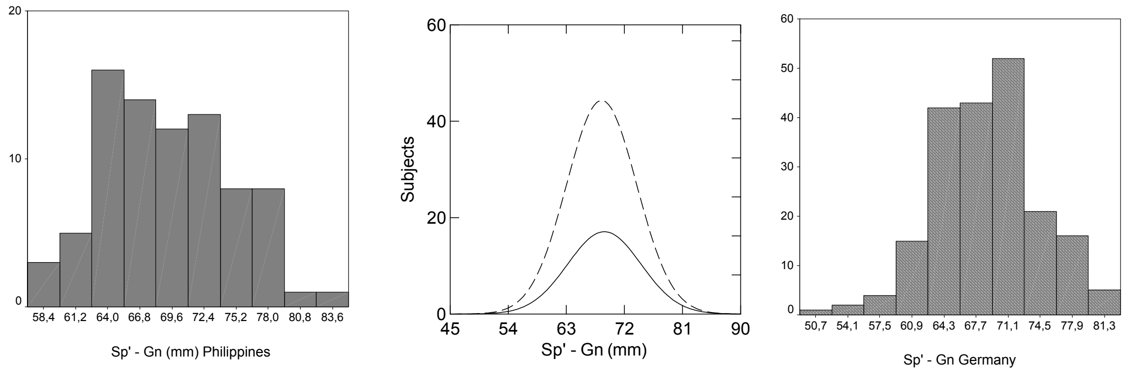


Fig. 88-90. Normal distribution and normal curve comparison of the Sp'-Gn value between Filipinos (-) and Germans (--)

Table. 14. Comparison of the Sp'-Gn between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	71.3	5.5	67.3	5.9	***
Female	66.5	4.5	69.6	4.9	***
Both	69.3	5.7	68.7	5.4	ns

Result:

In general, no significant difference exists between the Sp'-Gn measurements of both Filipinos and Germans. However, the Filipino males show a significantly greater Sp'-Gn, while the Filipino females show a lesser Sp'-Gn when compared to their German counterparts.

VARIABLE 14
Index (%)

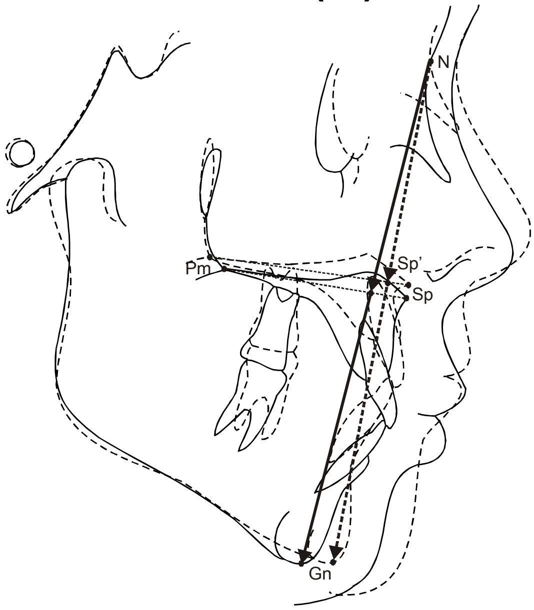


Fig. 91. Superimposition of Index of Filipinos (-) and Germans (--)

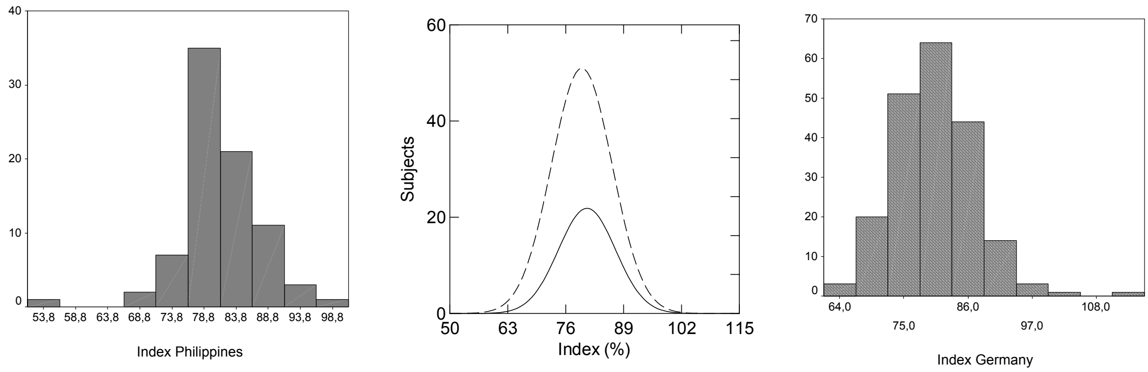


Fig. 92-94. Normal distribution and normal curve comparison of the Index value between Filipinos (-) and Germans (--)

Table. 15. Comparison of the Index between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	81.4	4.8	80.5	8.4	ns
Female	81.1	8.1	79.7	5.6	ns
Both	81.2	6.4	80.0	6.8	*

Result:

A significant difference exists between the Index value of Filipinos and Germans.

VARIABLE 15
OK1 – NA (°)

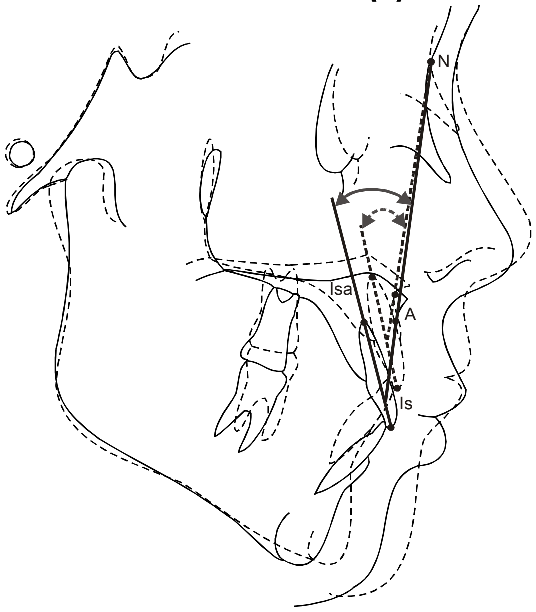


Fig. 95. Superimposition of OK1-NA of Filipinos (-) and Germans (--)

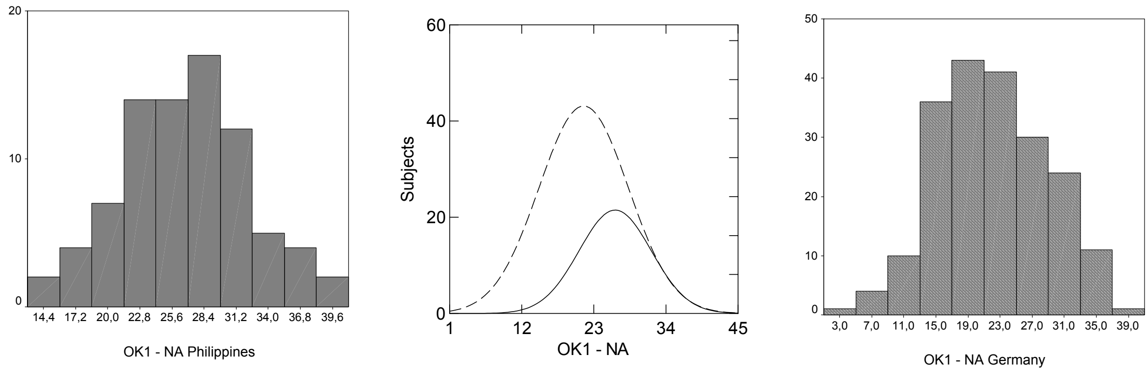


Fig. 96-98. Normal distribution and normal curve comparison of the OK1-NA value between Filipinos (-) and Germans (--)

Table. 16. Comparison of the OK1-NA between Filipinos (n=81) and Germans (n=201)

Gender	Filipinos		Germans		P sig.
	Mean	S. D.	Mean	S. D.	
Male	26.7	6.1	20.0	6.7	***
Female	26.6	4.8	22.9	6.6	***
Both	26.6	5.5	21.7	6.8	***

Result:

The Filipinos exhibit a significantly larger OK1-NA angle, when compared to the Germans.

VARIABLE 16
OK1 – NA (mm)

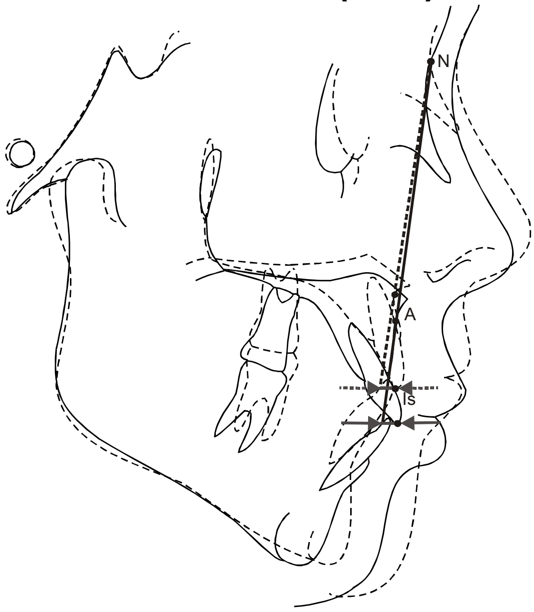


Fig. 99. Superimposition of OK1-NA of Filipinos (-) and Germans (--)

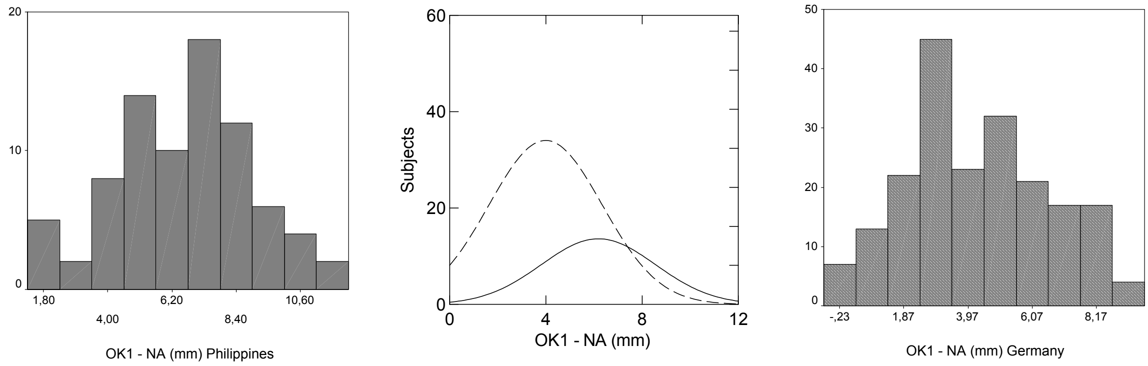


Fig. 100-102. Normal distribution and normal curve comparison of the OK1-NA value between Filipinos (-) and Germans (--)

Table. 17. Comparison of the OK1-NA between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	6.6	2.4	3.8	2.4	***
Female	6.7	2.4	4.6	2.2	***
Both	6.6	2.4	4.3	2.3	***

Result:

The Filipinos exhibit a significantly larger OK1-NA measurement, when compared to the Germans.

VARIABLE 17
UK1 – NB (°)

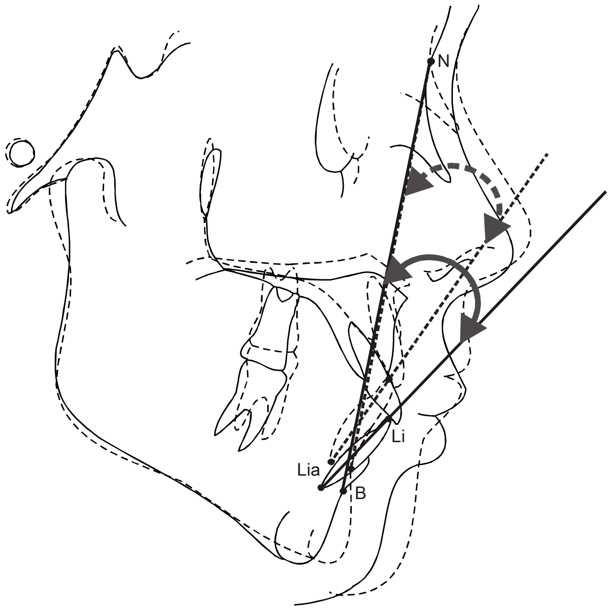


Fig. 103. Superimposition of UK1-NB of Filipinos (-) and Germans (--)

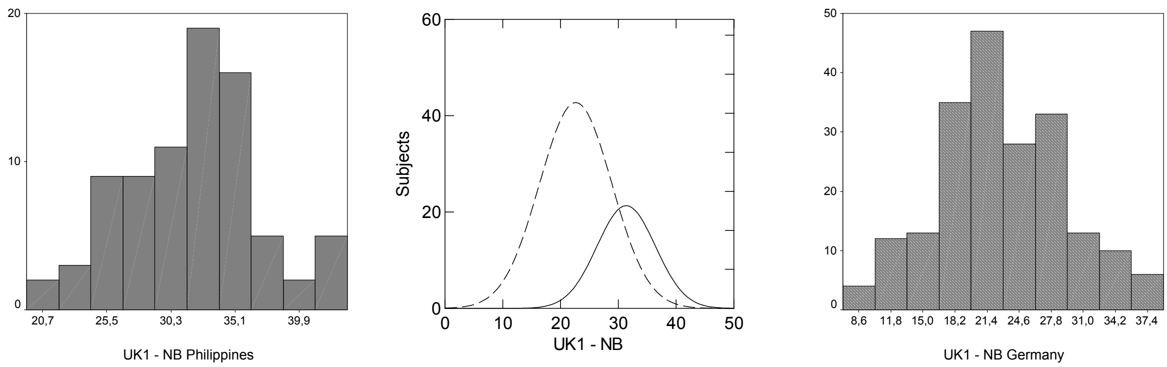


Fig. 104-106. Normal distribution and normal curve comparison of the UK1-NB value between Filipinos (-) and Germans (--)

Table. 18. Comparison of the UK1-NB between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	31.1	5.0	22.9	6.6	***
Female	32.8	5.0	22.9	6.1	***
Both	31.8	5.0	22.9	6.3	***

Result:

The Filipinos show a significantly larger UK1-NB angle, when compared to the Germans.

VARIABLE 18
UK1 – NB (mm)

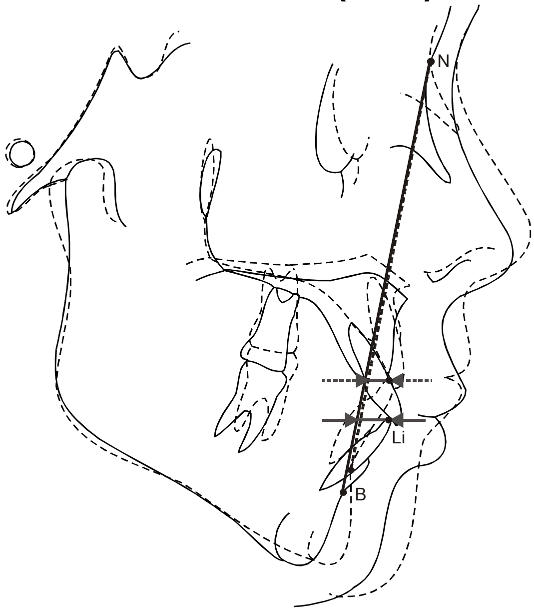


Fig. 107. Superimposition of UK1-NB of Filipinos (-) and Germans (--)

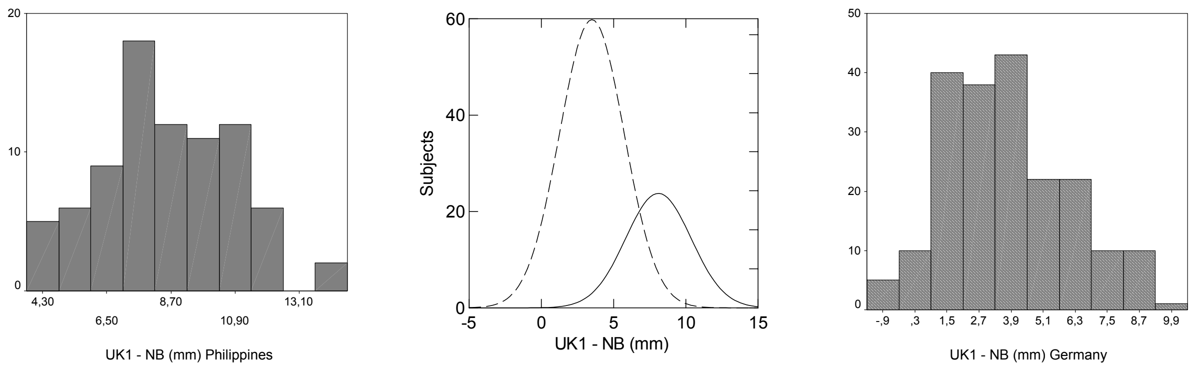


Fig. 108-110. Normal distribution and normal curve comparison of the UK1-NB value between Filipinos (-) and Germans (--)

Table. 19. Comparison of the UK1-NB between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	8.6	2.5	3.8	2.5	***
Female	8.6	2.0	3.8	2.1	***
Both	8.6	2.2	3.8	2.3	***

Result:

The Filipinos exhibit a significantly larger readings of UK1-NB, when compared with the Germans.

VARIABLE 19
OK1 – UK1 (°)

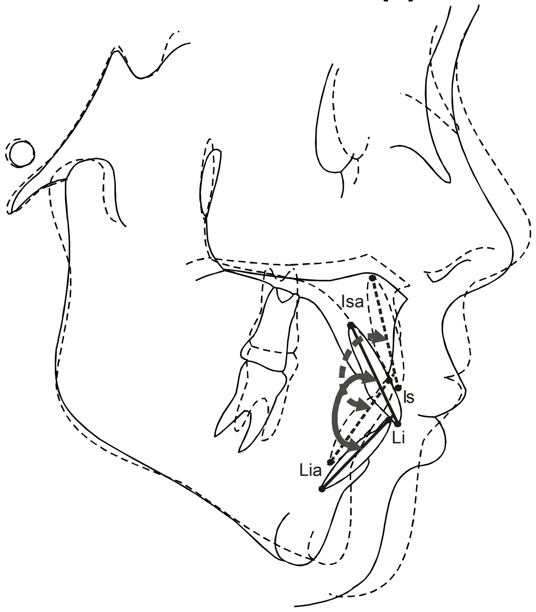


Fig. 111. Superimposition of OK1-UK1 of Filipinos (-) and Germans (--)

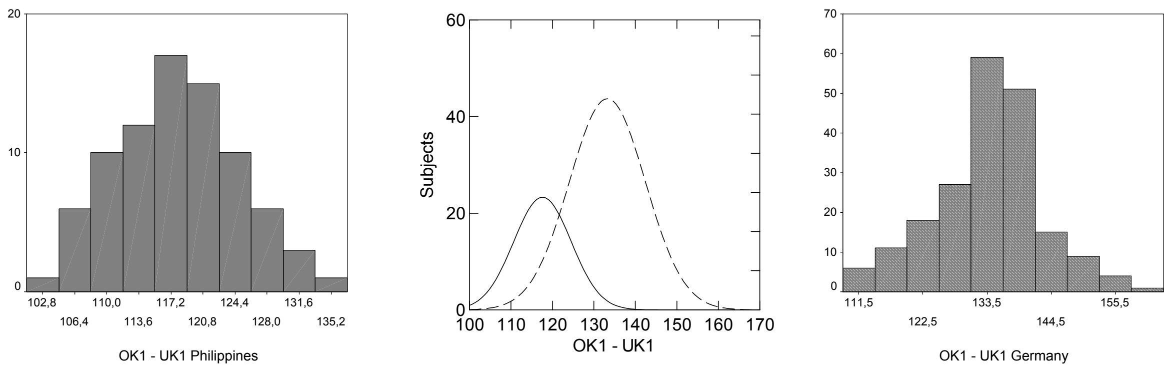


Fig. 112-114. Normal distribution and normal curve comparison of the OK1-UK1 value between Filipinos (-) and Germans (--)

Table. 20. Comparison of the OK1-UK1 between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	118.8	7.5	135.2	9.7	***
Female	117.0	6.2	132.6	8.6	***
Both	118.0	7.0	133.6	9.1	***

Result:

The Filipinos exhibit a significantly smaller OK1-UK1 angle, when compared to the Germans.

VARIABLE 20
Holdaway angle (°)

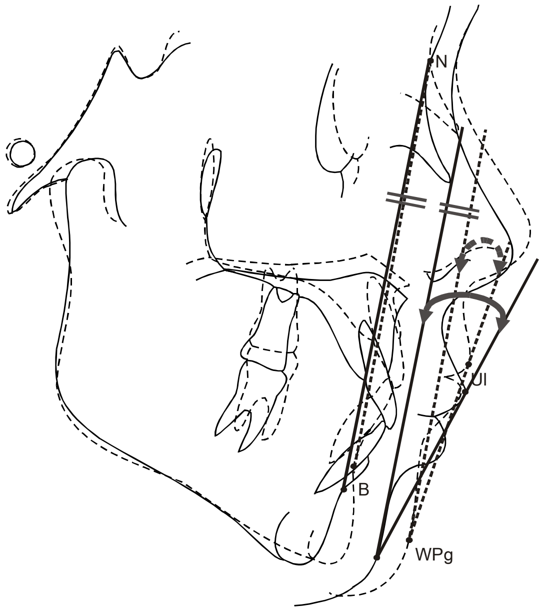
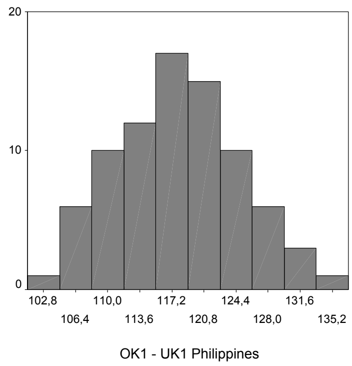
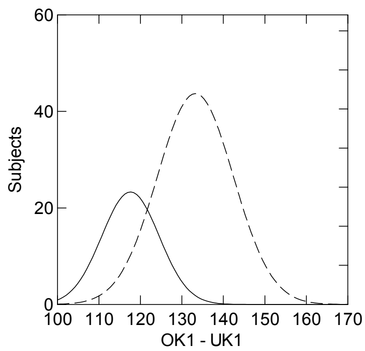


Fig. 115. Superimposition of Holdaway angle of Filipinos (-) and Germans (--)





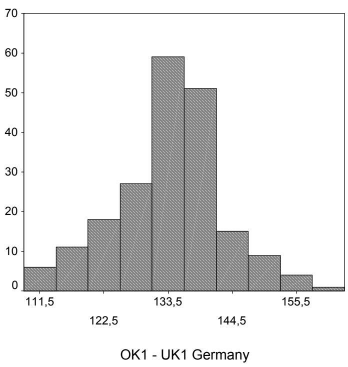


Fig. 116-118. Normal distribution and normal curve comparison of the Holdaway angle between Filipinos (-) and Germans (--)

Table. 21. Comparison of the Holdaway angle between Filipinos (n=81) and Germans (n=201)

Gender	**Filipinos**		**Germans**		P sig.
	Mean	S. D.	Mean	S. D.	
Male	15.5	3.9	7.2	4.7	***
Female	15.2	3.6	8.1	4.4	***
Both	15.4	3.8	7.7	4.5	***

Result:

The Filipinos show a significantly larger Holdaway angle compared to the Germans.

4.2 Summary and comparison of the cephalometric measurements and tracings

Table 22. Comparison of the cephalometric measurements between Filipinos (n=81) and Germans (n=201)

Variable	Filipinos		Germans		P sig.
	Mean	S.D.	Mean	S.D.	
SNA	83.3	3.3	82.4	3.5	***
SNB	79.9	2.8	80.8	3.4	***
ANB	3.5	2.0	1.6	2.1	***
SN-Pg	79.6	2.9	82.2	3.5	***
NSBa	130.6	4.9	130.9	4.9	ns
Gn-tgo-Ar	121.3	6.2	120.5	6.6	ns
Nordeval angle	68.4	5.5	60.2	5.5	***
Pg-NB (mm)	-0.4	1.6	3.0	1.9	***
NL-NSL	9.4	3.0	7.4	3.2	***
ML-NSL	33.4	4.8	27.7	5.9	***
ML-NL	24.0	4.8	20.1	5.8	***
N-Sp' (mm)	56.4	3.4	54.8	4.3	***
Sp'-Gn (mm)	69.3	5.7	68.7	5.4	ns
Index	81.2	6.4	80.0	6.8	*
OK1-NA	26.6	5.5	21.7	6.8	***
OK1-NA (mm)	6.6	2.4	4.3	2.3	***
UK1-NB	31.8	5.0	22.9	6.3	***
UK1-NB (mm)	8.6	2.2	3.8	2.3	***
OK1-UK1	118.0	7.0	133.6	9.1	***
Holdaway angle	15.4	3.8	7.7	4.5	***

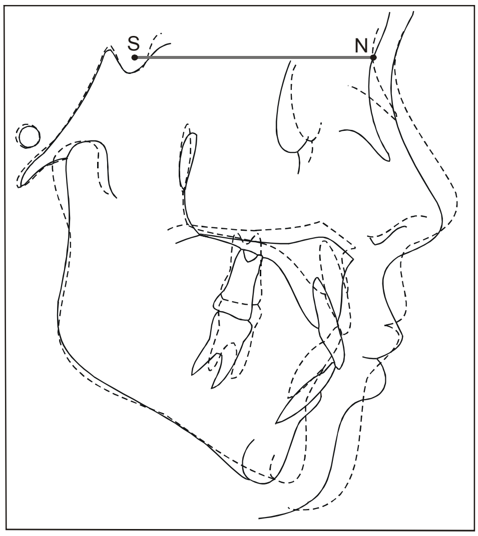


Fig. 119. Cephalometric superimposition of Filipinos (-) and Germans (--)

Results:

Of the 20 cephalometric parameters, 17 showed significant differences in measurements between the Filipinos and Germans.

Table 23. Comparison of the cephalometric measurements between Filipino male (n=44) and German male (n=78)

Variable	Filipinos		Germans		P sig.
	Mean	S.D.	Mean	S.D.	
SNA	83.4	3.2	81.6	3.5	***
SNB	80.1	2.8	79.8	3.2	ns
ANB	3.3	2.1	1.8	2.1	***
SN-Pg	80.0	3.1	81.2	3.1	**
NSBa	129.4	4.6	131.5	3.9	***
Gn-tgo-Ar	120.5	6.4	121.3	5.9	ns
Nordeval angle	68.4	6.1	59.2	5.2	***
Pg-NB (mm)	-0.1	1.6	2.8	1.7	***
NL-NSL	8.7	2.5	7.7	3.1	**
ML-NSL	32.0	5.0	29.8	5.2	***
ML-NL	23.2	4.9	22.0	5.8	ns
N-Sp' (mm)	57.9	3.1	53.9	5.7	***
Sp'-Gn (mm)	71.3	5.5	67.3	5.9	***
Index	81.4	4.8	80.5	8.4	ns
OK1-NA	26.7	6.1	20.0	6.7	***
OK1-NA (mm)	6.6	2.4	3.8	2.4	***
UK1-NB	31.1	5.0	22.9	6.6	***
UK1-NB (mm)	8.6	2.5	3.8	2.5	***
OK1-UK1	118.8	7.5	135.2	9.7	***
Holdaway angle	15.5	3.9	7.2	4.7	***

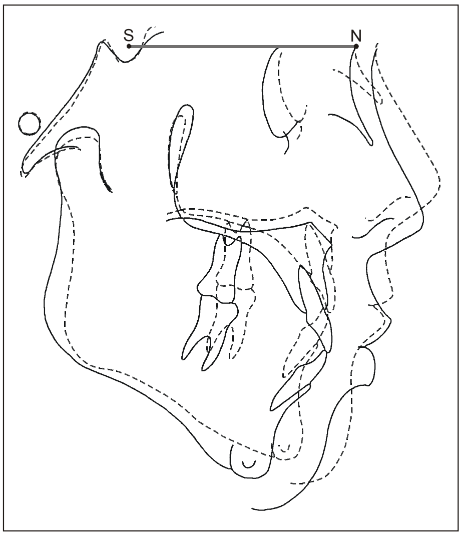


Fig.120. Cephalometric superimposition of Filipino (-) and German (--) male

Results:

Among the male subjects, 16 cephalometric parameters exhibit significant differences in measurements between Filipinos and Germans.

Table 24. Comparison of the cephalometric measurements between Filipino female (n=37) and German female (n=123)

Variable	Filipinos		Germans		P sig.
	Mean	S.D.	Mean	S.D.	
SNA	83.3	3.5	82.9	3.4	ns
SNB	79.6	2.8	81.4	3.4	***
ANB	3.6	1.9	1.5	2.1	***
SN-Pg	79.2	2.8	82.9	3.6	***
NSBa	132.1	4.8	130.4	5.3	**
Gn-tgo-Ar	121.4	5.6	120.0	7.1	ns
Nordeval angle	69.2	4.8	60.9	5.6	***
Pg-NB (mm)	-0.8	1.7	3.2	2.1	***
NL-NSL	10.3	3.3	7.2	3.3	***
ML-NSL	34.4	3.7	26.4	5.9	***
ML-NL	24.0	4.4	19.0	5.5	***
N-Sp' (mm)	54.5	2.6	55.4	3.0	**
Sp'-Gn (mm)	66.5	4.5	69.6	4.9	***
Index	81.1	8.1	79.7	5.6	ns
OK1-NA	26.6	4.8	22.9	6.6	***
OK1-NA (mm)	6.7	2.4	4.6	2.2	***
UK1-NB	32.8	5.0	22.9	6.1	***
UK1-NB (mm)	8.6	2.0	3.8	2.1	***
OK1-UK1	117.0	6.2	132.6	8.6	***
Holdaway angle	15.2	3.6	8.1	4.4	***

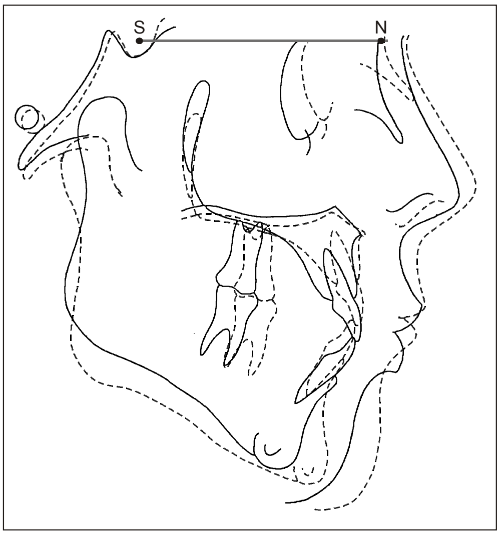


Fig.121. Cephalometric superimposition of Filipino (-) and German (--) female

Results:

Among the female subjects, 17 cephalometric parameters show significant differences in measurements among Filipinos and Germans.

4.3 Linear correlation coefficients

Table 25. Linear correlation coefficients (r) between SNA, NL-NSL, NSBa, ML-NSL and SNB of Filipinos (n=81)

Variable	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***

Table 26. Linear correlation coefficients (r) between SNA, NL-NSL, NSBa, ML-NSL and SNB of Germans (n=201)

Variable	NL-NSL	NSBa	ML-NSL	SNB
SNA	-0.38***	-0.39***	-0.34***	0.81***
NL-NSL		0.50***	0.31***	-0.45***
NSBa			0.27***	-0.48***
ML-NSL				-0.57***

4.4 Linear regression

Table 27. Linear regressions with corresponding r^2 and standard error of the estimate (SE) of Filipinos (n=81)

Variable	Regression equation	R^2	*S.E.*
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 28**.** Linear regressions with corresponding r^2 and standard error of the estimate (SE) of Germans (n=201)

Variable	Regression equation	R^2	*S.E.*
NL-NSL	= -0.35 SNA + 36.54	0.14	3.01
NSBa	= -0.54 SNA + 175.39	0.15	4.49
ML-NSL	= -0.58 SNA + 75.84	0.12	5.54
SNB	= 0.80 SNA + 15.27	0.66	1.98
SNA	= -0.27 NSBa + 118.30	0.15	3.20
SNB	= -0.33 NSBa + 124.30	0.23	2.99
ML-NSL	= -0.98 SNB + 106.99	0.32	4.86

4.5 Standard error of the estimate

Table 29. Standard errors of the estimate when predicting one of the variables SNA, NL-NSL, NSBa, ML-NSL, and SNB from the other four by means of a multiple regression analysis of Filipinos (n=81)

Variable	*R*	R^2	*S.E.*
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

Table 30. Standard errors of the estimate when predicting one of the variables SNA, NL-NSL, NSBa, ML-NSL, and SNB from the other four by means of a multiple regression analysis of Germans (n=201)

Variable	*R*	R^2	*S.E.*
SNA	0.88	0.77	1.68
NL-NSL	0.60	0.36	2.64
NSBa	0.63	0.40	3.60
ML-NSL	0.65	0.42	3.64
SNB	0.91	0.83	1.33

4.6 Harmony box and schema

Regression results are represented in a graphical box-like form, with SNA as the independent variable and NL-NSL, NSBa, ML-NSL, and SNB each as the dependent variable. The harmony schema is drawn based on the standard error of the estimate (SE) derived from the multiple regression analysis.

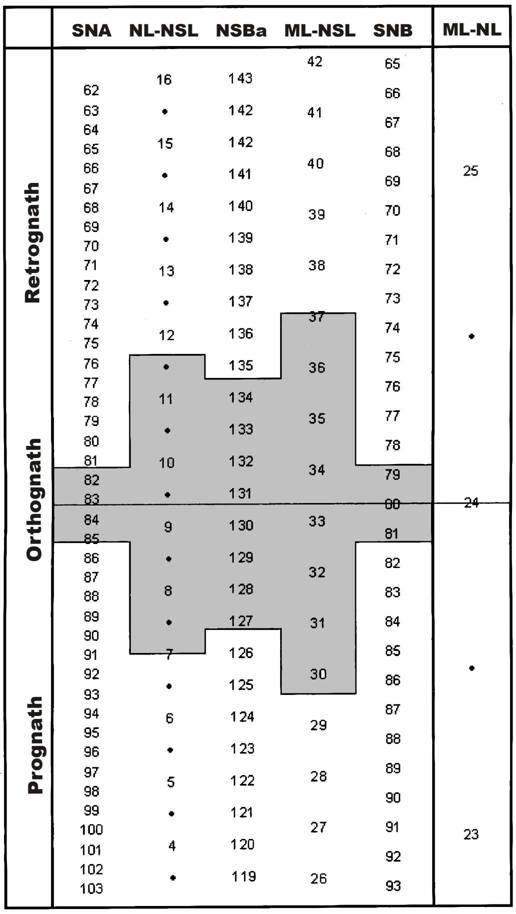


Fig. 133. Graphical box of Filipinos with the harmony line and schema

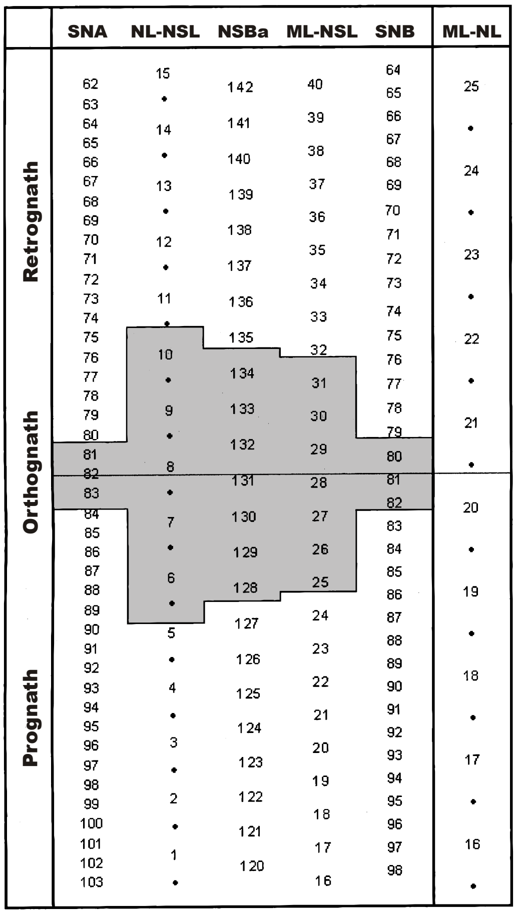


Fig. 134. Graphical box of Germans with the harmony line and schema

5. DISCUSSION

In the study by Richardson, "ethnic group" was defined as a nation or population with a common bond such as a geographical boundary, a culture or language, or being racially or historically related[5,63]. This study is the first to compare the Filipino craniofacial morphology to German caucasians. Since both groups belong to different races and ethnic groups, clear understanding of each morphology was achieved by means of statistical comparisons, cephalometric superimpositions and the harmony box.

5.1 *The Harmony box*

The harmony box is constructed based on the five cephalometric variables which were found to have a certain correlation pattern to one another. These variables are SNA, which represents maxillary prognathism, SNB, which represents mandibular prognathism, NL-NSL, which represents maxillary inclination, ML-NSL, which represents mandibular inclination, and NSBa, which represents the cranial base angle. The inter-maxillary angle (ML-NL) is calculated as the difference between ML-NSL and NL-NSL [69]. It should be noted that the sella-nasion line is shared by all the measurements, thus enhancing the power of the mathematical correlation among the five variables [72].

Table 25 and 26 show the linear correlation coefficients (r) between the five cephalometric variables among the Filipinos and the Germans. The correlation coefficient values range between 0.23 and 0.81 and all are highly significant. The linear correlation coefficient (r) reveals the intensity of correlation between the five variables. The higher the value, the higher the correlation. The maximum value of (r) is 1, and a value of 0 means no correlation. The intensity of correlation between the cephalometric variables among the Germans is higher in comparison with the Filipinos with the exception of SNA/NSBa, NL-NSL/NSBa, and NL-NSL/SNB. The correlation between SNA and SNB is highest in both groups, while the NSBa and ML-NSL showed the lowest correlation. A positive correlation means, that as the value of one variable increases, the other value also increases. A negative correlation means, that as the value of one variable increases, the other decreases.

Among the five variables, the NSBa revealed a positive correlation with NL-NSL and ML-NSL, and a negative correlation with the SNA and SNB. It means that when the maxilla and the mandible are retruded in position in relation to the anterior cranial base, they tend to be more posteriorly inclined, and the cranial base angle tends to be larger. However, if the maxilla and the mandible are protruded in position in relation to the anterior cranial base, they tend to be more anteriorly inclined, and the cranial base angle tends to be smaller.

The linear regressions with corresponding r^2 and the standard error of the estimate are shown in Table 27 and 28. The harmony boxes of the Filipinos and Germans (Figure 122, 123) are constructed based on these regressions, with SNA as the independent variable and NL-NSL, ML-NSL, NSBA and SNB each as the dependent variable, according to the method of SEGNER [69]. The central line found at the middle of the box represents the mean values of the five cephalometric variables. The upper and the lower borders beyond the central line are determined by the standard error of the estimate from the multiple regression analysis when one of the five variables is taken (Table 29,30). This is called the *harmony schema* [71]. In the harmony schema (Figure 124,125), the range is narrower for SNA and SNB angles and wider for NL-NSL, ML-NSL and NSBa. It means that the last three variables display a much higher standard error of the estimate in a regression, thus allowing a higher range of variability among these variables. The harmony schema of the Filipinos is bigger, particularly in the ML-NSL region, in comparison with the Germans. This means that the mandibular inclination (ML-NSL) among the Filipinos show more variation than the Germans.

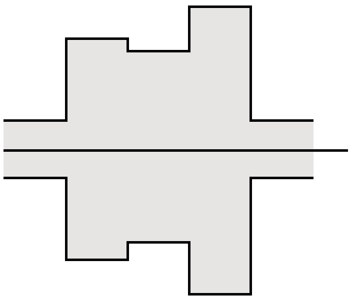


Fig. 124. Filipino harmony schema

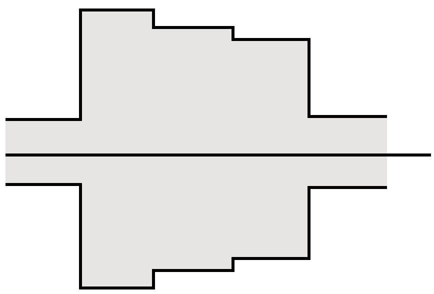


Fig. 125. German harmony schema

A harmonious combination of variables from a correlation point of view, would not necessarily require the values to lie on a perfectly straight horizontal line[69]. Any horizontal line connecting the values of the five variables inside the harmony schema is considered to be a line expressing a harmonious craniofacial pattern (Figure 126). This is called floating norms. A disharmonious combination of variables shows that the values do not lie within the harmony schema, but instead, they lie in the different zones of the harmony box (Figure 127).

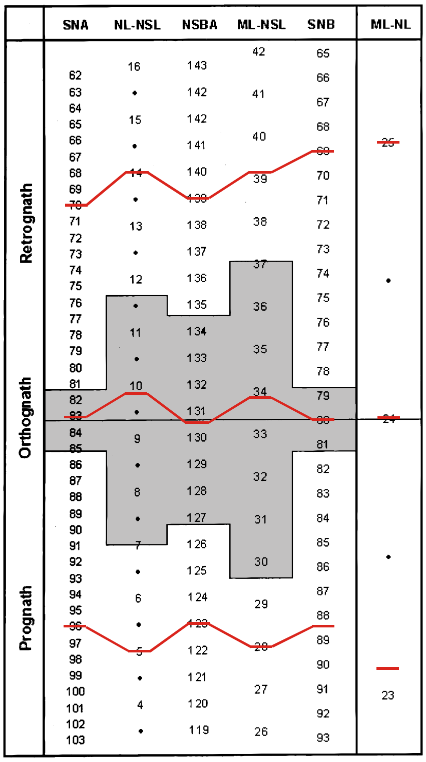


Fig. 126. Harmonious combinations

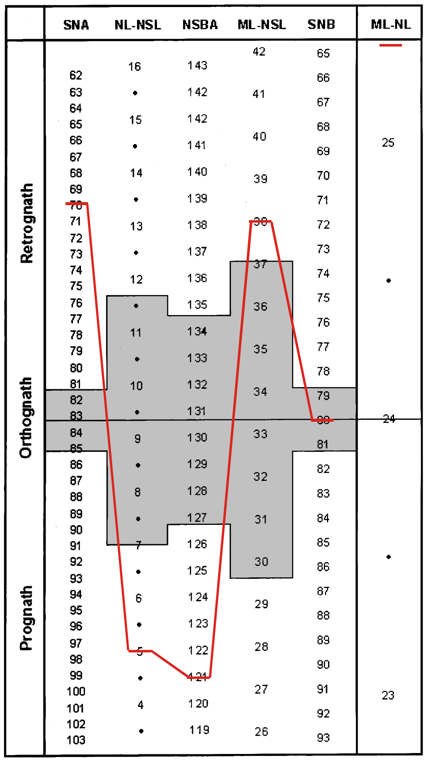


Fig. 127. Disharmonious combinations

5.2 *Facial Type*

Cephalometric radiographs reveal data in two dimensions, the sagittal (SNA,SNB,NSBa) and the vertical (NL-NSL,ML-NSL). Ideally, a diagnostic analysis of the craniofacial complex is performed in three dimensions[37]. This is best accomplished by combining a lateral cephalometric radiograph with a radiograph taken in the frontal view, a submentovertex view, to create a comprehensive analysis[48]. However, since most of the craniofacial anomalies encountered by both orthodontists and maxillofacial surgeons deal with problems relating to the sagittal and the vertical planes, knowledge of the two dimensional cephalometric analysis is equally important.

BROADBENT[12], NANDA and GHOSH[54] stated that although cephalometric norms for each race and ethnic group have been established, individual variation still exist. 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[31]. Sagittally, the facial type is described by the degree of maxillary (SNA) and mandibular (SNB) prognathism in relation to the anterior cranial base. Thus, an individual may be described as retrognathic, orthognathic or prognathic. Among the Filipinos, an SNA value of 80° to 87° corresponds to an orthognathic face. A value of less than 80° corresponds to a retrognathic face and a value greater than 87° corresponds to a prognathic face. Among the Germans, an SNA value of 79° to 86° corresponds to an orthognathic face. An SNA value of less than 79° is considered retrognathic and a value of more than 86° is considered to be prognathic.

The sagittal relation of the maxilla and the mandible in relation to the anterior cranial base is described as mesial, neutral and distal, depending on the ANB angle. In an orthognathic face, an ANB angle of 2° to 6° among the Filipinos, and –1° to 4° among the Germans, is considered to be in neutral relation. A lesser value is considered to be in mesial relation and a greater value is considered to be in distal relation.

In a retrognathic face, an ANB angle of 0º to 4º among the Filipinos, and -3° to 2° among the Germans, is considered neutral. A lesser value is considered to be in mesial relation and a greater value is considered to be in distal relation.

In a prognathic face, an ANB angle of 4° to 8° among the Filipinos, and 1° to 6° among the Germans, is considered neutral. A lesser value is considered to be in mesial relation and a greater value is considered to be in distal relation.

Vertically, the facial type is determined by the degree of inclination of the maxilla (NL-NSL) and the mandible (ML-NSL) in relation to the anterior cranial base. Thus, an individual may be characterized as having an "offen" (obtuse) skeletal pattern, "neutral" (normal) skeletal pattern, or "tief" (acute) skeletal pattern, in relation to the index value. An index value of 75% to 88% among the Filipinos, and 73% to 87% among the Germans, is considered to be a "neutral" vertical relationship. A lower than neutral index value signifies an "offen" vertical relationship, while a higher than neutral value signifies a "tief" vertical relationship.

The harmony schema is used as a guide in classifying the vertical interbasal relationship (Figure 128). The "neutral" zone (2) corresponds to the column of the ML-NSL inside the harmony schema. In the same column above the schema is the "offen" zone (1) and below the schema lies the "tief" zone (3).

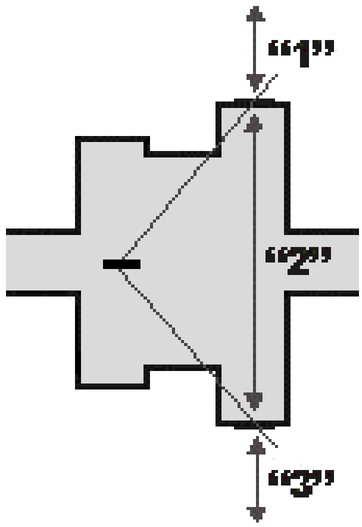


Fig. 128. Classification of interbasal angle using the harmony schema

5.3 *The harmony concept*

DI PAOLO et. al.[20] emphasized that a cephalometric analysis should be able not only to detect, but to locate the area of the skeletal dysplasia. The harmony box is an adjunctive tool to detect and locate the skeletal dysplasia in the craniofacial complex. Any horizontal line connecting the values of the different variables inside the box has to be considered as a line expressing a harmonious skeletal pattern. If the line corresponds to the center of the box, the subject is classified as harmonious and orthognathic. However, if the line lies on the upper part of the box, the subject, though still harmonious, is classified as retrognathic. On the other hand, if the line lies in the lower part of the box, the subject, though still harmonious, is classified as prognathic. An individual whose cephalometric values fall within the range of the harmony schema is considered to have a harmonious skeletal relationship. This same subject is classified further as orthognathic, retrognathic or prognathic according to the zone of the box where his cephalometric values fall after the individual horizontal harmony line is marked among each of the cephalometric variables.

The harmony schema may be moved upon the box so that all the cephalometric values of the subject lie within its borders. If at least one value lies outside the harmony schema, that indicates a deviation from a harmonious facial pattern. In Figure 129a, the facial type is retrognathic. However, the SNA value lies outside the harmony schema, which suggests that the maxilla (SNA) is the jaw at fault because it is positioned too far anteriorly from the mandible (SNB). The problem is the sagittal position of the maxilla. In Figure 129b, the facial type is orthognathic. However, the NL-NSL and the ML-NSL values lie outside the harmony schema. The maxilla (NL-NSL) is rotated posteriorly and the mandible (ML-NSL) is rotated anteriorly resulting in a skeletal deep bite. In Figure 129c, the facial type is prognathic, however, the ML-NSL value lies outside the harmony schema. It shows that the mandible (ML-NSL) is rotated posteriorly, resulting to a skeletal open bite. Using this method, the cephalometric variable/s responsible for an unbalanced skeletal pattern is readily detected and located[25]. It should be noted that the description of craniofacial morphology using the harmony box is not based on any single cephalometric norm, but rather, it is based on the harmonious relationships of these variables to one another.

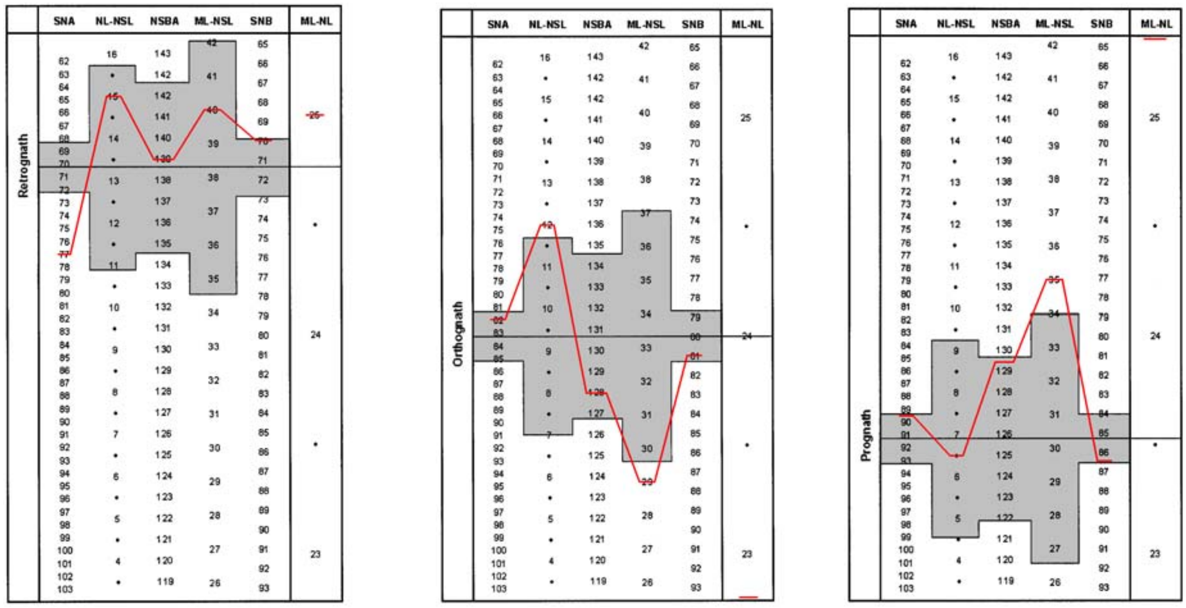


Fig. 129. Disharmonious combinations in a: a) retrognathic face, b) orthognathic face, and c) prognathic face

5.4 Comparison of the skeletal morphology of the Filipinos and Germans

The comparison of the craniofacial morphologies of the Filipinos and Germans is described by means of statistics (student's *t*-test), cephalometric superimposition and the harmony box. Since sexual dimorphism is essential in establishing cephalometric standards, separate values for male and female are presented.

5.4.1 Statistical comparison

Significant differences were seen among 17 cephalometric variables between Filipinos and Germans (Table 22). Highly significant differences were seen in the SN-Pg, Nordeval angle, and Pg-NB (mm) values, revealing that the Filipinos possess less pronounced chins in comparison with the Germans. The Filipino apical bases are more posteriorly inclined compared to the Germans whose apical bases are more anteriorly inclined. The dental statistical comparisons showed that the Filipinos exhibit a bimaxillary dental protrusion with an OK1-UK1 of 118° compared to the Germans' 133.6°. The higher Holdaway angle value among the Filipinos (15.4) demonstrated that the soft tissue profile of the Filipinos is more convex compared to the Germans (7.7).

Among the male samples, 16 out of the twenty cephalometric variables displayed significant differences (Table 23). The facial height (N-Sp', Sp'-Gn) of the Filipino male is significantly longer compared to the German male. The more posterior inclination of the Filipino male's apical bases compared to the German male further demonstrated the characteristic longer face. The large Nordeval angle among the Filipino male (68°) revealed a more ventrally positioned chin in relation to pogonion, displaying a profile convexity. The upper and lower incisors of the Filipino male are inclined and positioned more labially compared to the Germans. Thus, the Filipino male exhibits an acute dental pattern (OK1-UK1 118.8°) due to bimaxillary dental protrusion. The German male, however, displayed an obtuse dental pattern due to more upright upper and lower incisors (Ok1-UK1 135.2°). The Holdaway angle among the Filipino male is significantly higher (15.5°) compared to the Germans (7.2°) revealing a profile convexity among the Filipino male.

Among the female samples, 17 out of the twenty cephalometric parameters displayed significant differences (Table 24). The parameters describing the chin position, the inclination of the maxillary and mandibular apical bases, the dental parameters and the Holdaway angle, revealed that the Filipino female displays a less prominent chin, more posteriorly inclined apical bases, and exhibits a bimaxillary dental protrusion resulting to a more convex profile in comparison to the German female, who displays a longer facial height.

5.4.2 Comparison by cephalometric superimposition

The differences in craniofacial morphology are presented by superimposing the Filipino and German tracings on the sella and the SN lines. The Filipinos displayed a more anteriorly positioned maxilla and a more posteriorly positioned mandible, compared to the Germans (Figure 119). No differences were found in the cranial base flexure and the gonial angle. The Filipino chin is more posteriorly positioned (SN-Pg) with a significantly larger Nordeval angle, revealing a less pronounced chin compared to the Germans. The Filipinos displayed longer facial heights and more posteriorly inclined maxilla and mandible than the Germans.

Among the male samples (Figure 120), the sagittal position of the mandible (SNB), and the gonial angle are the same. However, the sagittal position of the maxilla is more anteriorly positioned among the Filipino males compared to the German males. The cranial base flexure is lesser among the Filipino male than the German male. A less prominent chin is also seen among the Filipino male due to a more posteriorly positioned SN-Pg and greater Nordeval angle. The facial height of the Filipino male is longer than the German male.

The sagittal position of the maxilla (SNA) among the female groups is the same, but the mandible is more posteriorly positioned among the Filipino female than the German female (Figure 121). The cranial base flexure is greater among the Filipino female. The SN-Pg is more posteriorly positioned with a greater Nordeval angle, displaying a less prominent chin among the Filipino female compared to the German female. Although the Filipino female exhibited more posteriorly inclined maxilla and mandible, the German female revealed a longer facial height.

5.4.3 Comparison using the harmony box

5.4.3.1 Filipinos and Germans

The Filipino and the German harmony boxes and schemas are presented in Figure 130 and 131. The mean values of the five cephalometric variables of each race are represented by the central lines in the middle of the harmony box. The broken lines in the Filipino harmony box represent the mean values of the five cephalometric variables of the Germans. The solid lines in the German harmony box represent the mean values of the Filipino cephalometric variables. Both displayed disharmonious orthognathic facial types with a neutral sagittal relation. No difference in the NSBa angle was observed. Vertically, the Filipinos showed an "offen" tendency or O1 type, due to the more posteriorly inclined mandible (ML-NSL). On the other hand, when the German mean values are plotted on the Filipino harmony box, it showed a rather "tief" tendency or T3 type, due to a more anteriorly inclined mandible (ML-NSL). Thus, both groups revealed a disharmonious orthognathic facial type due to the ML-NSL values which lie outside the harmony schema.

Table 31. Mean of the 5 German cephalometric variables

Variable	Mean
SNA	82.4
NL-NSL	7.4
NSBa	130.9
ML-NSL	27.7
SNB	80.8
ML-NL	20.1

Table 32. Mean of the 5 Filipino cephalometric variables

Variable	Mean
SNA	83.3
NL-NSL	9.4
NSBa	130.6
ML-NSL	33.4
SNB	79.9
ML-NL	24.0

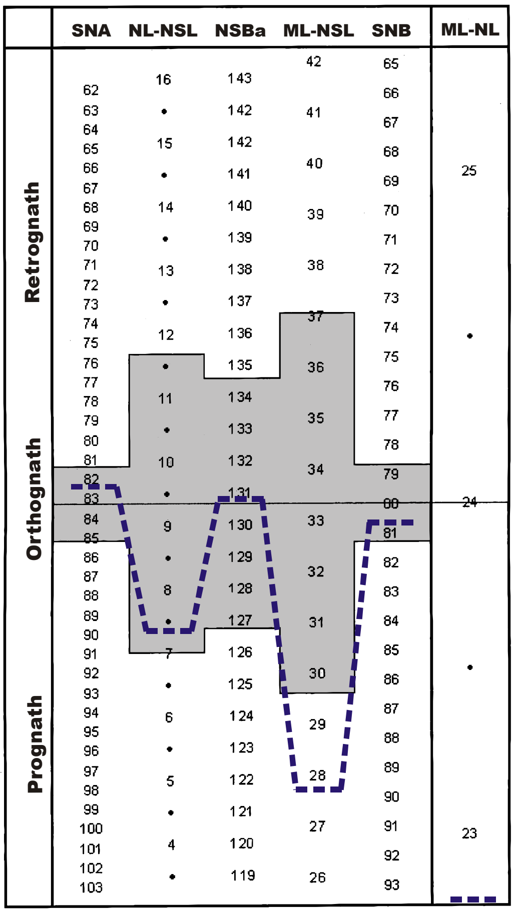


Fig. 130. Filipino harmony box and schema with the German cephalometric values (--)

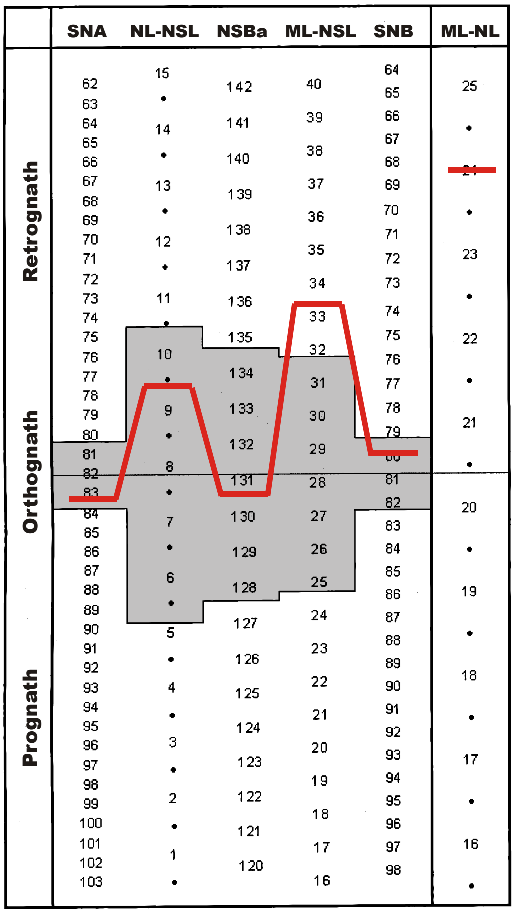


Fig. 131. German harmony box and schema with the Filipino cephalometric mean values (-)

5.4.3.2 Filipino and German male

The Filipino and the German male harmony boxes and schemas are presented in Figure 132 and 133. The mean values of the five cephalometric variables of each race are represented by the central lines in the middle of the harmony box. The broken lines in the Filipino harmony box represent the mean values of the five cephalometric variables of the German male. The solid lines in the German harmony box represent the mean values of the Filipino male cephalometric variables. Both are harmonious orthognathic with a neutral sagittal relation. The NSBa angle of the German male is higher compared to the Filipino male. Vertically, both are in "neutral" zone or N2 type. No difference in the index value was observed. However, when the Filipino male mean values were plotted on the German harmony box, the maxilla and the mandible are described as being more posteriorly inclined compared to the Germans. When the German male mean values were plotted on the Filipino harmony box, the maxilla and the mandible are described as being anteriorly inclined.

5.4.3.3 Filipino and German female

The Filipino and the German female harmony boxes and schemas are presented in Figure 134 and 135. The mean values of the five cephalometric variables of each race are represented by the central lines in the middle of the harmony box. The broken lines in the Filipino harmony box represent the mean values of the five cephalometric variables of the German female. The solid lines in the German harmony box represent the mean values of the Filipino female cephalometric variables. Both revealed a disharmonious orthognathic facial type with a neutral sagittal relation. The NSBa angle of the Filipino female is greater than the German female. Vertically, the Filipino female showed an "offen" tendency or O1 type, due to the more posteriorly inclined mandible (ML-NSL). On the other hand, when the German female mean values are plotted on the Filipino harmony box, it showed a rather "tief" tendency or T3 type, due to a more anteriorly inclined mandible (ML-NSL). Thus, both groups revealed a disharmonious orthognathic facial type due to the ML-NSL values which lie outside the harmony schema. The index value of the Filipino female is slightly higher than the German female. The German female exhibited a longer middle (N-Sp') and lower (Sp'-Gn) facial heights compared to the Filipino female.

Table 33. Mean of the 5 Filipino male cephalometric variables

Variable	Mean
SNA	83.4
NL-NSL	8.7
NSBa	129.4
ML-NSL	32.0
SNB	80.1
ML-NL	23.2

Table 34. Mean of the 5 German male cephalometric variables

Variable	Mean
SNA	81.6
NL-NSL	7.7
NSBa	131.5
ML-NSL	29.8
SNB	79.8
ML-NL	22.0

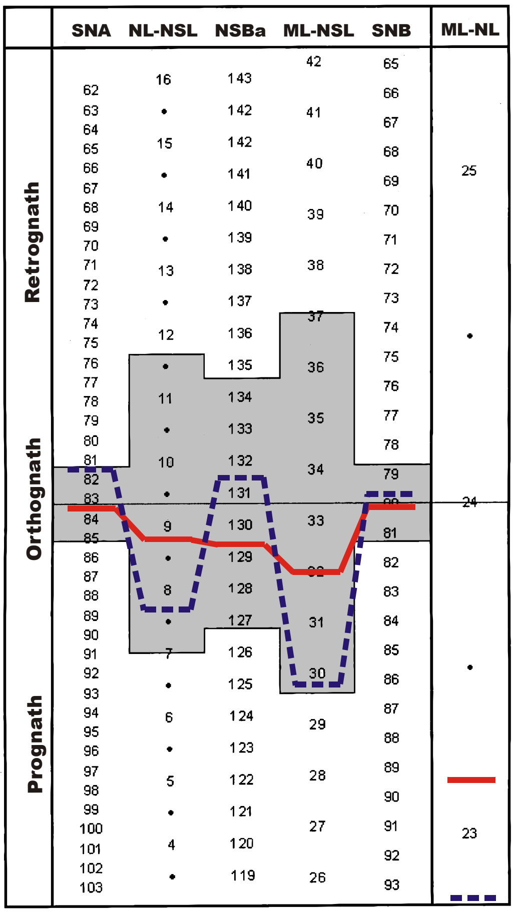


Fig. 132. Filipino harmony box and schema with the German male cephalometric mean values (--)

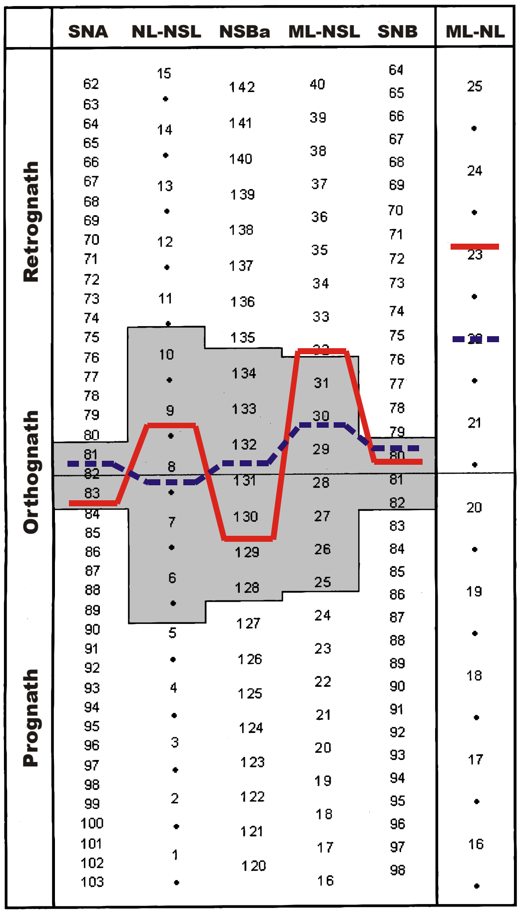


Fig. 133. German harmony box and schema with the Filipino male cephalometric mean values (-)

Table 35. Mean of the 5 Filipino female cephalometric variables

Variable	Mean
SNA	83.3
NL-NSL	10.3
NSBa	132.1
ML-NSL	34.4
SNB	79.6
ML-NL	24.0

Table 36. Mean of the 5 German female cephalometric variables

Variable	Mean
SNA	82.9
NL-NSL	7.2
NSBa	130.4
ML-NSL	26.4
SNB	81.4
ML-NL	19.0

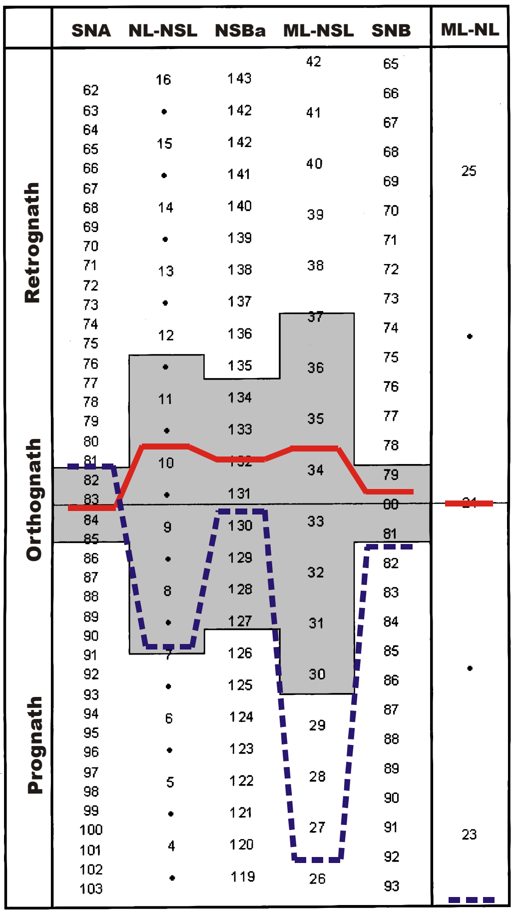


Fig. 134. Filipino harmony box and schema with the German female cephalometric mean values (--)

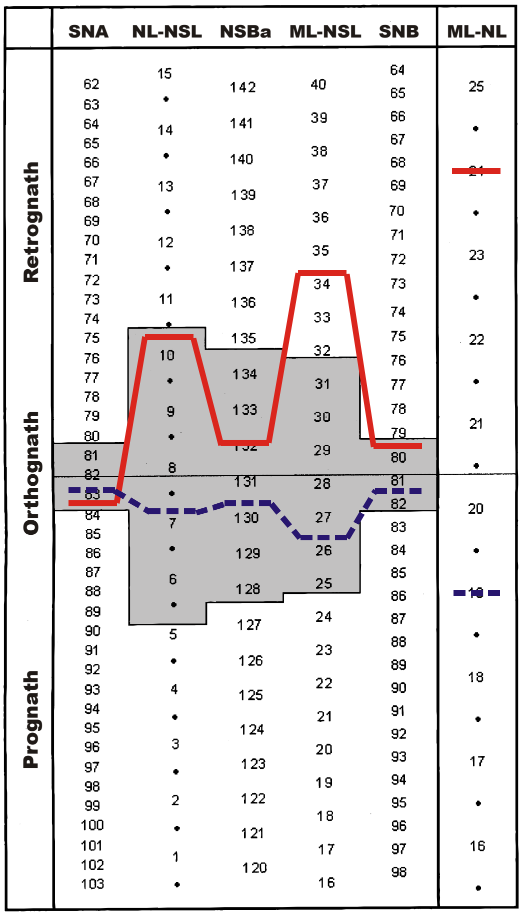


Fig. 135. German harmony box and schema with the Filipino female cephalometric mean values (-)

5.5 Comparison of the dentoalveolar morphology of the Filipinos and Germans

The difference in dentoalveolar morphology among the Filipinos and Germans is presented by means of statistical comparison (student's *t*-test) and cephalometric superimposition. No sexual dimorphism were found among the dentoalveolar variables, which strongly agrees with the study of URSI, TROTMAN, MCNAMARA and BEHRENTS[77].

5.5.1 Statistical comparison

Significant differences in all dentoalveolar variables were found among the Filipinos and Germans (Table 22-24).

5.5.2 Cephalometric superimposition

Sructurally, the maxilla is bordered by the palate on one side and the nasal cavity on the other. The middle part of this structure in an anteroposterior direction is used as the area of registration during cephalometric superimposition of the maxillary base (Figure 136).

For the investigation of differences in the position of the lower teeth, the area of pogonion and the mandibular plane (ML) are used as the bases for registration during cephalometric superimposition (Figure 136).

Superimpositions revealed that the Filipinos exhibit bimaxillary dental protrusion resulting to an acute dental pattern (OK1-UK1). The upper (OK1) and lower (UK1) incisors of the Filipinos are more labially positioned and more labially inclined compared to the Germans. The upper and lower incisors of the Germans are more upright resulting to an obtuse dental pattern (OK1-UK1).

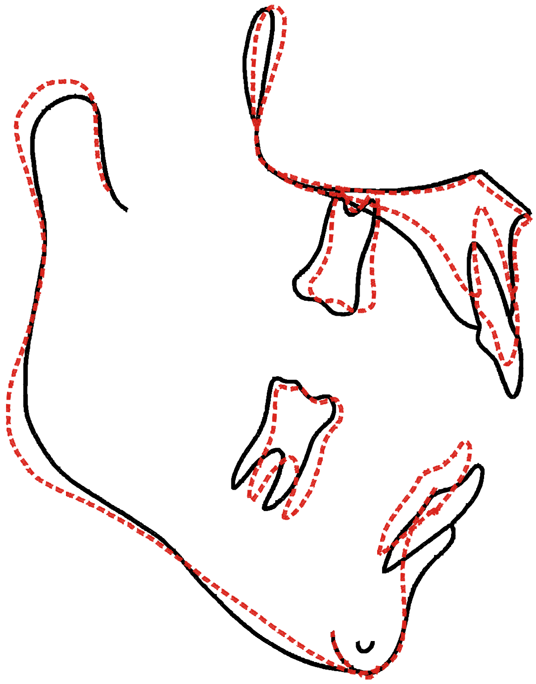


Fig. 136. Superimposition of the maxilla and mandible of the Filipinos (-) and Germans (--)

A study by CHUNG et.al[14] revealed that the bimaxillary dental protrusion seen among Asians is due to an imbalance of tooth dimension to the alveolar bone. In the present study, the distance between the maxillary and the mandibular apical bases among the Filipinos is rather wide compared to the Germans. Due to a greater ANB angle (3.5°), a tendency toward labial inclination of the mandibular incisors and dental compensation occur. The Germans exhibit more upright upper and lower incisors due to a lesser ANB angle (1.6°).

5.6 Comparison of the soft tissue profile of the Filipinos and Germans

5.6.1 Statistical comparison

A significant difference exists in the soft tissue profile among the Filipinos and the Germans. Sexual dimorphism was not evident in the Holdaway angle measurements.

5.6.2 Cephalometric superimposition

The Filipinos display a more convex profile due to a significantly greater Holdaway angle (15.4°) compared to the Germans (7.7°). Skeletally, the Filipinos exhibit a larger ANB angle, allowing the lower incisors to incline more labially in relation to the NB line as a result of dental compensation. The SN-Pg of the Filipinos is more posteriorly positioned and the Nordeval angle is greater compared to the Germans, resulting to a less prominent chin. Dentally, the Filipinos are characterized by having bimaxillary dental protrusion, which contributed to the profile convexity and lip protrusion (Figure 137).

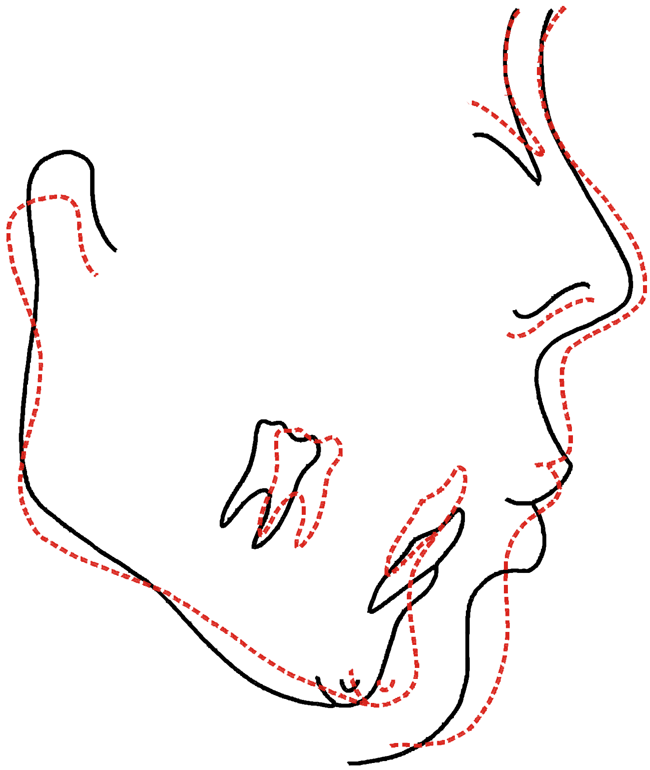


Fig. 137. Superimposition of soft tissue profile of Filipinos (-) and Germans (--)

5.7 Summarized discussion

5.7.1 Skeletal relationships

The larger ANB readings among the Filipinos suggested a tendency toward lower incisal proclination and dental compensation. The smaller SN-Pg angle, Pg-NB (mm) measurement and greater Nordeval angle showed that the Filipinos have less prominent chins than the Germans. They also exhibited greater posterior rotation of the maxilla and mandible. Filipino males exhibited longer facial heights compared to the Germans due to longer N-Sp' (mm) and Sp'-Gn (mm) as well as posteriorly rotated apical bases (maxilla and mandible). Although the Filipino females revealed a more posteriorly inclined apical base, their N-Sp’ (mm) and Sp’-Gn values were shorter compared to the Germans who displayed longer facial heights.

5.7.2 Dental relationships

The characteristic bimaxillary dental protrusion seen among other Asians were also observed among the Filipino samples.[14,43,47,49,53,59,76,82] They displayed more procumbent upper and lower incisors in relation to both the NA and NB planes resulting in an acute interincisal angle of 118° as compared to135° found among the Germans. This present finding agrees with ENLOW’S reported perception of the oriental facial pattern[23] and it agrees with studies reporting that those facial parameters closer to the dentoalveolar areas show the greatest differences among ethnic and racial groups.[4,42,63]

5.7.3 Soft tissue profile

Compared to the Germans, the Filipino’s Holdaway angle was significantly greater thus exhibiting more lip protrusion. Due to an acute interincisal angle, less prominent chin and posteriorly positioned mandible, the Filipinos revealed a convexity in the facial profile. The Germans displayed a straight profile, a characteristic feature found among Caucasians. These findings correspond with JOSON’S[39] study on the soft tissue profile of Filipinos with normal occlusion.

5.7.4 Methodology

The population from which the subjects for this investigation are drawn are clearly defined and described. All Filipino subjects are chosen from one university in Manila, the capital of the Philippines. The subjects are interviewed to assure their ethnic composition and the average chronologic age of all subjects is 18 years old.

The German subjects served as the control group and are drawn from two key cities in Germany, namely Munich and Hamburg. The average chronologic age of these subjects is also 18 years old. Both groups are selected based on established criteria and the number of subjects are sufficient to reach statistical significance.

The cephalograms of the Filipino subjects are taken using only one cephalometric x-ray machine and by the same technician. All cephalograms are traced and digitized at the University of Munich. Although the German cephalograms are taken from a different x-ray machine, the choice of radiographic landmarks and the analysis performed were the same. The method of statistical analysis was determined before starting the study to ensure that data was collected in an appropriate way to facilitate the analysis. Similar to other cephalometric studies, the means and standard deviations are used for presenting the descriptive information on the variability within the samples. Student's *t*-test is performed to compare the cephalometric parameters in both ethnic groups.

In this study, a harmony box is also constructed in order to further describe the craniofacial morphology of each group. Previous studies on harmony boxes have used SNA as the independent variable in the regression analysis. Only FRANCHI[25] used SNB as the independent variable in the regression analysis, to construct the harmony box. He emphasized that SNB serves as an independent variable because it correlates with the highest significance with all other variables and shows the highest R^2 value in the multiple regression analysis. In the studies by SEGNER[69], TOLLARO[75], and NGARMPRASERTCHAI[55], as well as in the present study, SNB showed the highest correlation with all other variables as well, with the highest R^2 value in the multiple regression analysis. However, SNA was consistently used as the independent variable in the linear regression equation to construct the harmony box. During the course of the investigation, an attempt was made to use SNA and

SNB each as the independent variable. As a result, the harmony boxes appeared so different from one another. Further studies is recommended to find out whether SNA or SNB is more appropriate to use as the independent variable in the construction of the harmony of the box.

5.7.5 Results

The results of the present study offers orthodontic practitioners normative cephalometric standards for Filipino patients which are specific for each gender. As a result, clinicians could use these standards to diagnose orthodontic patients in a more meaningful way, than using one standard for both sexes and for all ethnic and racial groups. However, the study is also confronted with the question regarding treatment objective. Should one treat to what is natural for each race, or to an “ideal occlusion”, which according to Tweed, is the “ultimate” in balance and harmony of facial esthetics?

6. CONCLUSION

From the present results, it can be concluded that differences in craniofacial morphology exist between the two ethnic groups. The difference between the facial pattern of Filipinos and Germans is due primarily to the protruded upper and lower incisors and to the posteriorly inclined maxilla and mandible seen among the Filipinos as compared with the Germans. Facial convexity due to bimaxillary dental protrusion is the naturally occurring facial characteristic of the Filipinos.

The mean cephalometric values are useful diagnostic aids, but they should not be used as treatment goals for individual patients. The objective of treatment must be to obtain tooth relationships, which are in harmony with the individual facial and dental morphology.

The cephalometric norms and harmony box derived from the study are drawn from an adult population. Therefore, it serves to provide as guide to determine the location and the severity of existing dentofacial discrepancies among this age group. Yet, it is recommended that further studies be undertaken among other age groups of Filipinos and Germans with well-balanced faces and Angle Class one occlusion, particularly for children within the orthodontic treatment age range, in order to provide a more complete picture of the malocclusion. Thus, orthodontic problems may be effectively resolved.

The present study suggests the need to treat patients from different ethnic groups differently using cephalometric norms specific to each group.

"every man should be judged by measures within him…"

Aristotle

7. SUMMARY

The purpose of this study was (1) to establish cephalometric norms for soft tissue, skeletal and dental relationships among Filipino adults with Angle Class 1 occlusion; (2) to establish the Filipino harmony box; and (3) to compare these norms with the accepted German standards.

Eighty-one Filipino subjects, 44 men and 37 women, were selected from the student population of the Manila Central University on the basis of the following criteria: (1) natural-born ethnic Filipino, traced up to their great-grandparent’s generation; (2) good facial aesthetics; (3) Angle Class I occlusion with no crowding; (4) all teeth present (third molars may or may not be present); and (5) no previous history of orthodontic treatment. Clinical examinations and interviews were conducted to ensure that the established criteria were observed properly. The German subjects, 78 men and 123 women, were selected from Hamburg and Munich on the basis of the same criteria. The average age for both groups is 18 years old.

Each lateral headfilm was traced by one investigator using the acetate tracing paper. All cephalometric reference points were marked and identified according to Hasund’s analysis. All the relevant linear and angular measurements were identified using the computer program, DiagnoseFix (Dr. Jörg Wingberg, Diagnostik Wingberg GmbH, Buxtehude, Germany).

Differences between the cephalometric measurements of the two groups were compared by means of the harmony box, the student’s *t*-test and cephalometric superimpositions. Significant differences between the two groups were seen predominantly in the lower third of the face.

Skeletally, the Filipinos showed more posteriorly inclined apical bases and a less prominent chin. Dentally, they exhibited a bimaxillary dental protrusion resulting in an acute dental pattern and a convexity of the soft tissue profile.

These findings suggest that ethnic differences in facial traits exist and awareness of the dentofacial pattern of each ethnic group will ensure better success of treatment in establishing optimal facial harmony.

7. ZUSAMMENFASSUNG

Die Aufgaben den vorliegenden Studie sind: 1) Bestimmung der kephalometrischen Normen der philippinischen Probanden mit Angle-Klasse-1-Okklusion in bleibenden Gebiss, 2) Herstellung der philippinischen Harmoniebox, 3) Vergleich der philippinischen Harmoniebox und dortige Normen mit bestehenden deutschen.

81 philippinische Probanden, von denen 44 männlich und 37 weiblich, wurden von den Studenten der Universität Manila Central nach folgenden Kriterien ausgewählt: 1) 100% philippinische Abstammung, bis zu Generation der Ur-Großeltern nachvollziehbar, 2) akzeptables Gesichtsprofil und Gesichtssymmetrie, 3) Angle-Klasse-1 Okklusion ohne Engstand, 4) alle Zähne ohne Berücksichtigung der Weisheitszähne angelegt, 5) keine kieferorthopädische Vorbehandlung. Klinische Untersuchung und Interview wurden durchgeführt, um sicher zu sein, dass alle Kriterien erfüllt wurden. Die deutschen Probanden, 78 männlich und 123 weiblich wurden aus Hamburg und München ausgewählt. Das Durchschnittsalter beider Gruppen betrug 18 Jahre.

Die Fernröntgenseitenbilder wurden von einer Person auf Acetatfolie mit einem Bleistift durchgezeichnet. Alle kephalometrischen Referenzpunkte wurden nach Hasunds[31] Methode identifiziert und markiert. Alle relevanten Winkel und Strecken wurden mit dem Computerauswertungsprogramm, DiagnoseFix (Dr. Jörg Wingberg, Diagnostik Wingberg GmbH, Buxtehude, Germany) gemessen. Diese Daten wurden mit bestehenden deutschen Normen verglichen.

Die vergleichende Untersuchung erfolgte durch Darstellung der Hauptmesswerte in dafür neu erstellten Harmonieboxen, die auf der Basis der Harmoniebox von Segner und Hasund[71] entwickelt wurden, desgleichen die statische Auswertung (student's *t*-test), und die kephalometrische Überlagerung.

Ein hoch signifikanter Unterschied zwischen den beiden Gruppen wurde für das untere Gesichtsdrittel gefunden.

Die skelettale Morphologie bei philippinischen Probanden wurde charakterisiert durch die posteriore Inklination der apikale Basis mit einem kleineren Kinn.

Die dentale Morphologie bei philippinischen Probanden wurde charakterisiert durch die bimaxilläre Protrusion der Incisivi.

Das Gesichtsprofil bei philippinischen Probanden zeigt eine Konvexität im Vergleich mit den deutschen Probanden.

Die vorangegangenen Befunde lassen vermuten, dass ein ethnischer Unterschied bei den Gesichtsstrukturen existiert. Diese Entdeckungen zeigen, dass die zusammengesetzten kephalometrischen Normen aus einer ethnischen Gruppe kein korrektes Gesichtsmuster für eine andere Rasse erbringen.

8. REFERENCES

[1] Al-Jasser, N.M.:
Cephalometric evaluation of craniofacial variation in normal Saudi population according to Steiner analysis.
Saudi Med J 2000;21(8):746-750.

[2] Angle, E.H.:
Classification of malocclusion.
Dental Cosmos 1899;41:248-264.

[3] Argyropoulos, E., Sassouni, V.:
Comparison of the dentofacial patterns for native Greek and American-Caucasian adolescents.
Am J Orthod 1989;95(3):238-249.

[4] Bacon, W., Girardin, P., Turlot, J.C.:
A comparison of cephalometric norms for the African Bantu and a caucasoid population.
Eur J Orthod 1983;5:233-240.

[5] Barnhart, CL.:
The American College Dictionary.
Random House, New York, NY 1953.

[6] Ben-Bassat,Y., Dinte,A., Brin, I.,Koyoumdjisky-Kaye, E.:
Cephalometric pattern of Jewish East European adolescents with clinically acceptable occlusion.
Am J Orthod 1992;102(5):443-448.

[7] Beyer, O.:
The prehistory of the Philippines.
Annual Report of the Smithsonian Institution.
Washington DC 1942.

[8] Bishara, S.E., Fernandez, A.G.:
Cephalometric comparisons of the dentofacial relationships of two adolescent populations from Iowa and Northern Mexico.
Am J Orthod 1985;88(4):315-322

[9] Bishara, S.E., Abdalla, E.M., Hoppens, B.J.:
Cephalometric comparisons of dentofacial parameters between Egyptian and North American adolescents.
Am J Orthod 1990;97(5):413-421.

[10] Björk, A.:
The face in profile.
Svensk Tandläk Tidskr 1947;40:Suppl 5B):55-66.

[11] Broadbent, B.H.:
A new X-ray technique and its application to orthodontia.
Angle Orthod 1931;1:45-66.

[12] Broadbent, B.H., Enlow, D.H.:
Facial Growth.
3rd ed, WB Saunders, Philadelphia 1990:222-228.

[13] Cerci, V., Martins, J.E., de Oliveira, M.A.:
Cephalometric standards for white Brazilians.
Int J Adult Orthod Orthog Surg 1993;8(4):287-292.

[14] Chung, C.S., Kau, M.C., Walker, G.F.:
Racial variation of cephalometric measurements in Hawaii.
J Craniofac Genet Dev Biol 1982;2(2):99-106.

[15] Cooke, M.S., Wei, S.H.:
A comparative study of southern Chinese and British Caucasian cephalometric standards.
Angle Orthod 1989;59(2):131-138.

[16] Cooke, M.S., Wei, S.H.Y.:
Cephalometric standards for the southern Chinese.
Eur J Orthod 1988;10:264-272.

[17] Daskalogiannakis, J.:
Glossary of Orthodontic Terms
Quintessence Publishing Co., Inc., Berlin 2000.

[18] Davoody, P.R., Sassouni, V.:
Dentofacial pattern differences between Iranians and American Caucasians.
Am J Orthod 1978;73(6):667-675.

[19] Dawson – Saunders, B., Trapp, R.G.:
Basic and clinical biostatistics
Prentice Hall International, Inc., Connecticut 1990.

[20] Di Paolo, R.J., Philip, C., Maganzini A.L.,Hirce, J.D.:
The quadrilateral analysis: an individualized skeletal assessment.
Am J Orthod 1983;83(1):19-32.

[21] Drummond, R.A.:
A determination of cephalometric norms for the Negro race.
Am J Orthod 1968;54(9):670-682.

[22] El-Batouti, A., Øgaard, B., Bishara, S.E.:
Longitudinal cephalometric standards for Norwegians between the ages of 6 and 18 years.
Eur J Orthod 1994;501-509.

[23] Enlow, D.H.:
Facial Growth.
3rd ed. WB Saunders, Philadelphia 1990.

[24] Fonseca, R.J., Klein, W.D.:
A cephalometric evaluation of American Negro women.
Am J Orthod 1978;73(2):152-160.

[25] Franchi, L., Baccetti, T., McNamara, J.A.:
Cephalometric floating norms for North American adults.
Angle Orthod 1998;68(6):497-502.

[26] Galen:
De Placititis Hippocratis et Platonis V.
The Art of Greece, 1400-31 B.C. Sources and Documents in the History of Art Series.
J.J. Pollitt (Ed.), Prentice-Hall, Inc., New Jersey 1965.

[27] Garcia, C.J.:
Cephalometric evaluation of Mexican Americans using the Downs and Steiner analyses.
Am J Orthod 1975;68(1):67-74.

[28] Gleis, R., Brezniak, N., Lieberman, M.:
Israeli cephalometric standards compared to Downs and Steiner analyses.
Angle Orthod 1990;60(1):35-40.

[29] Grewal, H., Sidhu, S.S., Kharbanda, O.P.:
A cephalometric appraisal of dento-facial and soft tissue pattern in Indo-Aryans.
J Pierre Fauchard Acad 1994;8(3):87-96.

[30] Haralabakis, B., Spirou, V., Kalokithas, G.:
Dentofacial cephalometric analysis in Adult Greeks with normal occlusion.
Eur J Orthod 1983;5:241-243.

[31] Hasund, A.:
Clinical Cephalometry for the Bergen-Technique.
University of Bergen
Bergen, Norway 1977.

[32] Hellman, N.
The face in its developmental career.
Dental Cosm 1935;77:1-25.

[33] Hofrath, H.:
Bedeutung der Röntgenfern und Abstands Aufnahme für die Diagnostik der Kieferanomalien.
Fortschr der Orthod 1931;1:231-258.

[34] Huang, W., Taylor, R., Dasanayake, A.:
Determining cephalometric norms for Caucasians and African Americans in Birmingham.
Angle Orthod 1998;68:503-511.

[35] Huntley, H. E.:
The Divine Proportion, A Study in Mathematics and Beauty.
Dover Publications, New York 1970.

[36] Iversen, E., Shibata, Y.:
Canon and Propostions in Egyptian Art.
2nd ed., Aris and Philips, Warminster, England 1975.

[37] Jacobson, R.L., Jacobson, A.:
Radiographic cephalometry: From basics to videoimaging.
Quintessence Publishing Co. Inc., Illinois 1995.

[38] Jacobson, A.:
Radiographic cephalometry: From basics to videoimaging.
Quintessence Publishing Co. Inc., Illinois 1995.

[39] Joson, C.A.:
The soft tissue profile of selected young adult Filipinos with normal occlusion.
The Phil Dent Ass J 2001;53(2):4-10.

[40] Korkhaus, G.:
Gebiss- Kiefer- und Gesichtsorthopädie.
Bruhn C. Handbuch der Zahnheilkunde, Vol.4
Verlag von JF Bergmann, Munich 1939.

[41] Kowalski, C.J., Nasjleti, C.E., Walker, G.F.:
Differential diagnosis of adult male Black and White Populations. Angle Orthod 1974;44(4):247-349.

[42] Lamberton, C.M., Reichart, P.A., Triratananimit, P.:
Bimaxillary protrusion as a pathologic problem in the Thai.
Am J Orthod 1980;77(3):320-329.

[43] Lew, K.K.:
Cephalometric ideals in Chinese, Malay and Indian ethnic groups.
Asian J Aesth Dent 1994;2(1):35-38.

[44] Lim, J.V.:
Steiner's cephalometric analysis of Filipino students aged 16-25. The Phil J Orthod 2000;1:23-24.

[45] Martin, R., Saller, K.:
Lehrbuch der Anthropologie.
3rd ed., Gustav Fischer Verlag, Stuttgart 1955.

[46] Miura, F., Inoue, N., Suzuki, K.:
Cephalometric standards for Japanese according to Steiner analysis.
Am J Orthod 1965;51(4):289-295.

[47] Miyajima,T., et.al.:
Craniofacial structure of Japanese and European-American adults with normal occlusions and well-balanced faces.
Am J Orthod 1996;110(4):431-438.

[48] Miyashita, K.:
An Atlas of Roentgen Anatomy and Cephalometric Analyses [Japanese].
Quintessence, Tokyo 1986.

[49] Moate, S.J., Darendeliler, M.A.:
Cephalometric norms for the Chinese:a compilation of existing data.
Aust Orthod J 2002;18(1):19-26.

[50] Moorrees, C.F.A., Jacobson, A.:
Radiographic Cephalometry, From Basics to Videoimaging.
Quintessence Publishing Co., Inc., Illinois 1995.

[51] Moyers, R. E., McNamara Jr., J.A.:
Esthetics and the treatment of Facial Form.
Vol. 28 Craniofacial Growth Series,
Center for Human Growth and Development
The University of Michigan, Ann Arbor 1993

[52] Müller, H. W.:
Der Kanon in der ägyptischen Kunst. In: Der vermessene Mensch – Anthropometrie in Kunst und Wissenschaft.
Heinz Moos Verlag, München;1973:9-31.

[53] Munandar, S., Snow, M.D.:
Cephalometric analysis of Deutero-Malay Indonesians.
Aust Dent J 1995;40(6):381-388.

[54] Nanda, R.S., Ghosh, J.:
Facial soft tissue harmony and growth in orthodontic treatment.
Semin Orthod 1995;1(2):67-81.

[55] Ngarmprasertchai, S.:
Vergleich der dento-kraniofazialen Morphologie zweier ethnisher Gruppen mit eugnathem Gebiss im Fernröntgenseitenbild.
Doctoral dissertation.
Ludwig-Maximilian-University, Munich, Germany, 2002.

[56] Olds, C., McNamara Jr., J.A.:
Esthetics and the Treatment of Facial Form.
Vol. 28 Craniofacial Growth Series,
Center for Human Growth and Development
The University of Michigan, Ann Arbor 1993.

[57] Pacioli Fra Luca.:
Divina Proporzione. Constantin Winterberg (trans.) In: Die Lehre vom Goldenen Schnitt, vol. 2. Quellenschriften für Kunstgeschichte und Kunsttechnik von Mittelalters und der Neuzeit. Nach der Venezianischen Ausgabe vom Jahre 1509.
Verlag Carl Greaser, Wien 1889.

[58] Panofsky, E.:
Meaning in the Visual Arts.
The Overlook Press, New York 1974;61-65, 103-105.

[59] Park, I.C., Bowman, D., Klapper, L.:
A Cephalometric study of Korean adults.
Am J Orthod 1989;96(1):54-59.

[60] Peck and Leena Peck:
Selected Aspects of the Art and Science of Facial Aesthetics.
Seminars in Orthod 1995;1:105-26.

[61] Philo, M.:
Syntaxis. See: The Art of Greece, 1400 B.C.
Sources and Dokuments in the History of Art Series.
J.J. Pollitt (Ed.) Prentice-Hall, Inc., New Jersey 1965.

[62] Quejada, J.G.:
A study on the cephalometric characteristics of 19-24 year-old Filipinos exhibiting facial balance and harmony.
Seminar paper, University of the Philippines, 1980.

[63] Richardson; E:R.:
Racial differences in dimensional traits of the human face.
Angle Orthod 1980;50(4):301-311.

[64] Ricketts, R.M.:
The biologic significance of the divine proportion and Fibonacci series.
Am J Orthod 1982;81:351-370.

[65] Ricketts, R.M.:
Divine proportion in facial esthetics.
Clin Plast Surg 1982;9:401-422.

[66] Rudzki-Janson, I., Hasund, A.:
Indikation und Grenzen der Funktionskieferorthopädie in der täglichen Praxis.
Deutscher Zahnärztekalender. 1979;112-130.

[67] Sabater, E.L.:
A cephalometric appraisal for dental, skeletal and dentofacial patterns in Adults from the Philippines.
Master's thesis, Graduate school of Georgetown University, Washington D.C., 1969

[68] Schäfer, H.:
Von ägyptischer Kunst.
4. Aufl. Wiesbaden: Otto Harrassowitz; 1963.

[69] Segner, D.:
Floating norms as a means to describe individual skeletal patterns.
Eur J Orthod 1989;11(3):214-20.

[70] Segner, D.:
Stability of the craniofacial pattern during growth.
Franklin Printing and Publishing House Ltd., Hungary 1993.

[71] Segner, D., Hasund, A.:
Individualisierte Kephalometrie, 2. Aufl.
Franklin Printing and Publishing House Ltd., Hamburg 1994.

[72] Solow, B.:
The pattern of the craniofacial associations. A morphological and methodological correlation and factor analysis study on young adults.
Acta Odont Scan 1966;24:Supplement 46.

[73] Spix, J.B.:
Cephalo Genesis.
Hübsch Mannii Verlag, Munich 1815.

[74] Swlerenga, D., Oesterle, L.J., Messersmith, M.L.:
Cephalometric values for adult-Mexican Americans.
Am J Orthod 1994;106(2):146-155.

[75] Tollaro, I., Tiziano, B., Franchi, L.:
Floating norms for the assessment of craniofacial pattern in the deciduous dentition.
Eur J Orthod 1996;18:359-365.

[76] Uesato, G. et.al.:
Steiner cephalometric norms for Japanese and Japanese-Americans.
Am J Orthod 1978;73(3):321-327.

[77] Ursi, W.J., Trotman, C.A., McNamara J.A., Behrents, R.G.:
Sexual dimorphism in normal craniofacial growth.
Angle Orthod 1993;63(1):47-56.

[78] Welcker, H.:
Untersuchungen über Wachstum und Bau des Menschlichen Schädels.
Part 1, Verlag Wilhelm Engelmann, Leipzig 1862.

[79] Welcker, H.:
Kraniologische Mitteilungen.
Arch Anthrop 1866;1:89.

[80] Wolfe, S.A., Lin Hu, Berkowitz, S.:
In search of the harmonious face: Apollo revisited, with an examination of the indications for retrograde maxillary displacement.
Plast Reconstr Surg 1997;99:261-272.

[81] Zeising, A.:
Neue Lehre von der Proportionen des menschlichen Körpers, aus einem bisher unerkannt gebliebenen, die ganze Natur und Kunst durchdringenden morphologischen Grundgesetze.
Rudolph Weigel, Leipzig 1854.

[82] Zeng, X.L., Forsberg, C.M., Linder-Aronson, S.:
Craniofacial morphology in Chinese and Swedish children with Angle Class I and Class II occlusal relations.
Aust Ortho J 1998;15(3):168-176.

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