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A CEPHALOMETRIC STUDY OF KOREAN ADULTS

BY

In-Chool Park, D.D.S.

A Thesis Submitted to the Faculty of the Graduate School
of Loyola University of Chicago in Partial Fulfillment
of the Requirements for the Degree of
Master of Science

August

1982

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DEDICATION

To my parents, wife, daughter and son,
whose many sacrifices and encouragements
made my education possible.

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VITA

The author, In-Chool Park, was born on May 22, 1952, in Busan, Korea.

He graduated from Seoul High School in February, 1971.

In March, 1971, he entered Seoul National University College of Liberal Arts and Science for pre-dental education. After finishing pre-dental education, he entered Seoul National University College of Dentistry in March, 1973 and graduated with the degree of Doctor of Dental Surgery in February, 1977. In the senior year of Dental College, he was awarded the "Encouragement Award" at the first National Medical, Dental, Pharmacology and Veterinary Student Thesis Contest from the Education Ministry of Korea.

Upon completing the dental education, he entered the Korean Air Force as a dental officer in February, 1977 and was discharged in May, 1980.

In July, 1980, he began graduate studies in Oral Biology and post-graduate studies in Orthodontics at Loyola University of Chicago School of Dentistry. During the second year of graduate studies he was involved in teaching as a teaching assistant in the Physiology/Pharmacology Department of Loyola University School of Dentistry.

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CHAPTER I

INTRODUCTION

The study of craniofacial relationships and their variations in man has long been a subject of investigation in physical anthropology. Since its development, roentgenographic cephalometry has been used in the study of growth and development and in the clinical practice of orthodontics. Clinically it has been a valuable tool in growth prediction, diagnosis, treatment planning, case prognosis, and evaluating treatment results.

Orthodontists have studied cephalofacial relationships in many population samples for the purpose of diagnosis using various methods of analysis but without much concern for differences in the face between groups of different ethnic origin. However, a number of investigators (Ahn, 1961; Altemas, 1968; Chan, 1975; Choy, 1969; Cotton and et al. 1951; Craven, 1958; Drummond, 1968; Enlow, 1982; Garcia, 1975; Mitani, 1980; Nanda, 1969; Taylor and Hitchcock, 1966) noticed the variation in the craniofacial morphology between different ethnic groups. Richardson (1980) defined the term "ethnic group" as "a nation or population with a common bond such as a geographical boundary, a culture or language, or being racially or historically related".

Cephalometric studies of many different ethnic groups are now available, including Downs' study of Caucasians (1948), Suh's study of Koreans (1967), Mitani's study of Japanese (1980), Chan's study of Chinese (1975) Nanda's study of North Indians (1969), Garcia's study of Mexican Americans

(1975), and Drummond's study of Negroes (1968). All these investigators stated that normal measurements of one group should not be considered normal for other racial groups. Different racial groups have to be treated according to their own individual characteristics.

The purposes of this study are:

1. to establish the cephalometric norms for Koreans using the Downs, Steiner, Ricketts, and Vertical analyses,
2. to investigate the sexual differences between Korean males and Korean females,
3. to investigate the racial differences between Koreans and Caucasians, and
4. to compare the results of this study with previous Korean studies.

CHAPTER II

REVIEW OF LITERATURE

A. AMERICAN STUDIES

Broadbent (1931) published "A New X-Ray Technique and Its Application to Orthodontics". In this article he introduced new methods to record and measure the changes in the jaw in relation to the rest of the head by application of a standardized cephalometric technique. It was possible to make accurate determinations of changes in the living head that may be due to developmental growth or orthodontic treatment by means of a head holder and a standardized roentgenogrpahic technique introduced by Broadbent.

Broadbent (1937) discussed the patterns of growth and development of the normal child face in his article, "The Face of the Normal Child". Broadbent introduced point R, the distance midway on the perpendicular from the Bolton-Nasion plane to Sella Turcica, as the registration point for registering tracings of subsequent pictures of the same individual and of different individuals as well. Broadbent showed developmental growth patterns of the skeletal structures of the face and the dentition of the normal child. He also showed the movements of incisors and canines during the so called "Ugly Duckling" stage.

Brodie (1941) in his article entitled "On the Growth Pattern of the Human Head," described the growth pattern of various parts of the human head by using serial roentgenology. The material consisted of

fourteen sets of serial head plates taken on twenty-one children, and extended from 3 months to 8 years of life.

Brodie, in this study, made an effort to complement the work of Broadbent by: (1) breaking down the human head into its various parts and studying each as a separate entity, and (2) by employing absolute instead of comparative measurements. The most important single finding was that the morphogenetic pattern of the head was established by the third month of postnatal life, or perhaps earlier, and that once attained it did not change.

Brodie summarized his findings as follows: (1) The anterior nasal spine follows a steady downward and forward course, while the posterior nasal spine and pterygomaxillary tissue are shown to progress straight downward after 1 year. (2) The occlusal plane, established by the eruption of the second deciduous molar at about 2 years, maintains a stable angular relation with the floor of the nose from this time on. (3) The chin point comes forward quite rapidly until 3½ or 4 years, but after this the lines representing the growth of its body remain parallel. (4) Nasal floor remains stable in its angular relation throughout the entire growth period studied, and that the occlusal plane and the lower border of the mandible do likewise after occlusion of the teeth is once established. (5) The lower six-year molar is strikingly constant in its relation to the mandible and (6) The upper first permanent molar pursues an almost straight downward course until it meets its antagonist in occlusion.

Wylie (1947) presented his analysis assessing the anteroposterior dysplasia by projecting several landmarks to Frankfort horizontal plane. His method of assessment was made based upon some of the possible generalizations. He wrote, "We may say that each of the following factors, when greater than average in size, dispose toward a Class II relationship: the length of the cranial base between the glenoid fossa of the temporal bone and the tuberosity of the maxilla, the overall length of the maxilla, and the position of the maxillary first permanent molar as measured forward from the tuberosity of the maxilla. The only other factor involving absolute size which is to be considered is the overall length of the mandible, which of course predispose to the Class II relationship when it is undersized."

He further stated, "The assessment of anteroposterior dysplasia serves this very valuable function because it is not based upon the relative position of facial parts in either centric or rest, but instead takes each part independently and assesses them with respect to their relative size. It permits the localization of this dysplasia in one or more five different areas."

Björk (1947) analyzed the nature of prognathism and investigated the problems connected therewith, and in particular those which concern the bite. The investigation was carried out on two age groups, with the object of determining the normal range of variation in the facial skeleton in the Swedish population, and of finding out the growth changes in the build of the face. The material for the investigation included 322

twelve-year-old boys and 281 Swedish Army conscripts in the ages 21 and 22 years.

The theoretical possibilities of the causes of prognathism were first examined, before entering upon an empirical analysis of the various problems met within this investigation. The effects of the possible causes were illustrated by means of a series of diagrams. For the purpose of demonstrating the configuration of the facial build, these diagrams were drawn as closed figures, consisting of lines joining the following points and features: facial profile - nasion - sella turcica - the joint angle - the jaw angle - the point of the chin.

In summary, Björk stated, "The analysis of the nature of maxillary prognathism shows good agreement between the two age groups. It indicates that the degree of prognathism is only determined to a lesser extent by increases in the jaw length, the most influential changes being those which take place in the shape of the facial skeleton and the shape and size of the cranial base. Maxillary and mandibular prognathism occur simultaneously, on the average, this condition being known as total prognathism." Björk also pointed out that the shape and the facial profile is not determined by the degree of maxillary prognathism, but depends upon the relation between the prognathism of the jaws. This investigation showed that a relative reduction, or increase in mandibular prognathism, is affected by the relative sizes of the jaws, as well as by the changes in the shape of the facial skeleton and in the shape and size of the cranial base; the various changes combine differently in different individuals.

Downs (1948) introduced his analysis and norms for Caucasians, to determine the range of the facial and dental pattern within which one might expect to find the normal, and further to discover whether any usable correlations existed in such normals. Downs used 20 living individuals, ranging in age from 12 to 17 years and about equally divided as to sex. All individuals possessed clinically excellent occlusions. Downs introduced five skeletal measurements and five dental measurements in his analysis.

Downs compared the Frankfort Horizontal plane with the SN and the Bolton planes in order to test the validity of the Frankfort plane, as a substitute for strictly cranial planes, in the appraisal of the lateral profile X-rays. He found out that the Frankfort plane is a more logical choice for a study of relationships involving only the face, because the Frankfort plane cuts across the face, while both SN and Bolton planes constitute dividing lines between face and cranium and therefore are measures of craniofacial relations.

Baum (1951) discussed the problem of establishing a range of normality in orthodontic diagnosis. Baum stated, "It is apparent that changes do occur in the skeletal and denture pattern of a growing individual. It is necessary then, to establish a series of progressive normals, one for each age group throughout the entire life span of the individual." Baum attempted to establish the normal skeletal and denture patterns of children possessing excellent occlusions during the ages when orthodontic treatment is usually undertaken. Baum used 62 children with

excellent occlusion equally divided as to sex. He compared with Downs norms and found some significant differences and he thought that was due to the different age groups.

Krogman (1951) published the article to present a historical survey of many planes which had been devised or adapted to elucidate type-similarities and type-differences in direct comparison. He classified the various methods into four main groups as follows: (1) Resting horizontal planes. (2) Planes using various craniometric points. (3) Planes centering upon the External Auditory Meatus (4) Roentgenographic cephalometric planes.

Krogman stated, "It is urged upon the cephalometrician that no one dimension, no one angle, no difference of a few millimeters or of a few degrees in an angle, can assume a type-difference that is of absolute diagnostic value. Roentgenographic cephalometry is a natural heritor of craniometry, and it has gone far ahead, as it should. It is three dimensional; it penetrates into the very depth of growth, as it were; and it truly is time-linked in the sense that it is an auto-repetitive technique. As a research tool in the growth of head and face it has no peer. Conclusions must be relative to the growth-stage of each individual child. Dimension, angle, and ratio are each interpretable only in relation to one another in the individual complex. The essence, therefore, of the roentgenographic cephalometric method is its ability to capture moments of growth and then, on a serial basis, to link them meaningfully in terms of individual growth progress."

Graber (1952) discussed some of misconceptions regarding cephalometrics and strongly suggested its use in clinical orthodontics. He divided malocclusions into three groups for the purpose of cephalometric analysis: (1) Skeletal dysplasias, (2) Dental dysplasias, and (3) Skeleto-dental dysplasias. Graber introduced the concept of extraction of teeth only in the maxillary arch in a Class II case with a high apical base difference and marked protrusion of the maxillary anterior segment, with no spaces.

In summary, Graber stated, "Cephalometrics is not a panacea for all our troubles. There is no substitute for clinical experience and judgment, but cephalometrics will help a great deal. It offers valuable assistance in growth and development appraisal, in picking up abnormalities, in studying facial type, and in arriving at a functional analysis. Its use as a diagnostic criterion is its most valuable contribution to clinical orthodontics, delineating the possibilities and limitations of therapy. Its use as a progress report and in the study of completed cases provides a means of objective appraisal of therapeutic success and permits us to raise, or lower, our sights on a little sharper horizon."

Wylie and Johnson (1952) evaluated Wylie's earlier paper published in 1947. They discussed many suggestions made by others and accepted the idea of using "point A" of Downs instead of anterior nasal spine in measuring the maxillary length. They also discussed the advantages and disadvantages of angular and linear measurements in cephalometric analysis. They used 171 lateral head-films taken with the teeth in occlusion prior to

orthodontic treatment in an age group of 11 to 13 years. These head-films were segregated into 57 "good", 61 "fair", and 53 "poor", using subjective appraisal only. On each film measurements of facial height at the profile, length of the mandibular body and the mandibular ramus were made. The gonial angle was measured and the vertical placement of the glenoid fossa of the temporal bone was determined: differences between means were evaluated for statistical significance.

Wylie and Johnson made a set of transparencies for the assessment of vertical dysplasia from lateral films, so that each individual may be placed in relation to the rest of the population without tracings and without actual measurements being required.

Margolis (1953) published the second part of his article, "Basic Facial Pattern and Its Application in Clinical Orthodontics". In this study, Margolis reviewed the maxillo-facial triangle as a reference from which to orient the dentition and other anatomic structures. Margolis stated, "The Frankfort Horizontal plane cannot be obtained on the cephalic roentgenogram because Porion is not discernible. Further, Orbitale grows downward at a different rate than does Porion. Therefore, in roentgen cephalographies a plane constructed by cranial landmarks is preferred as a reference plane." Margolis also studied other races and found out that there is a significant similarity of maxillo-facial triangles in all races of modern man when the facial skeletons are well developed in balance and harmony. Margolis also stated that occlusion of the teeth is influenced not only by the development of the craniofacial skeleton but also by the

excursions of the mandible in function, resulting from neuromuscular activity.

Steiner (1953) discussed the reference plane and suggested the use of S-N plane instead of the Frankfort Horizontal plane because of the difficulty in locating the Porion points. Steiner tried to simplify tracings and to use methods that give direct readings in the areas to be judged for clinicians directly dealing with the patients. Steiner introduced his analysis and norms, but he did not explain where his norms came from. Steiner was greatly interested in the difference of the angles SNA and SNB because the lines NA and NB are related to the same thing and the difference in their relationship gives a direct reading of the relationship of the chin to other structures of the face.

Graber (1954) discussed the norm concept of cephalometrics. Graber stated, "There is no doubt that the initial use of cephalometric radiographs as diagnostic criteria had an institutional character. The need for cephalometric standard on which to base our case analyses and therapeutic goals, cannot be challenged. The actual creation of this norm concept has been most difficult. Attempts to reduce anatomic and functional relations to angles and numbers and changing a three dimensional phenomenon into a two dimension linear diagram, has led some of us astray. To accept a mean as an absolute treatment goal, is to ignore a majority of populace. To arbitrarily select one or two convenient measurements as prognostic or therapeutic clues, is to overlook the independence of multiple individual characheristics, which are unrecognizable in

cross-sectional grouping of so called normals. Our goal must be, then, an individualized norm, using group standards only as a guide."

Coben (1955) tried to obtain a better understanding of the conformation and growth adjustments of the individual facial pattern in his study. His investigation was based upon serial lateral cephalometric roentgenograms of a group of forty-seven Caucasians, composed of twenty-five males and twenty-two females, none of whom received orthodontic treatment. To correlate facial form and the postural position of the head, the Frankfort horizontal plane was employed as a plane of orientation. The Sella-nasion plane was selected as a cranial reference plane. The findings were divided into two major phases: (1) statistical appraisal of the morphology and growth of the total sample, and (2) Analysis of individual patterns.

In discussion, Coben stated, "To comprehand variation of facial types and differences in the growth behavior of faces, it is not sufficient to study any single variance alone, for the significance of each characteristic lies in its integration in the total facial morphology. What may seem to be a harmoniously formed mandible in one face may be unharmonious in another." He stressed the importance of the role of the cranial base by saying, "Little has been said of the role of the cranial base. Although anatomically it is convenient to separate the cranial base from the dentofacial complex, in reality there is no such division. Abnormal variation in the configuration and growth behavior of the cranial base may result in severe dentofacial disharmonies. The superimposed

tracings registered on basion, with sella-nasion planes parallel, graphically illustrate the mechanism by which growth of the cranial base carries the upper face forward and upward away from the vertebral column, leaving the mandible behind."

Sassouni (1955) presented his analysis based, in principle, upon the assumption that, in an individual person, cephalofacial proportionality is achieved by a balance between certain growth loci or segments. His findings were based upon 100 lateral headplates on file at the Philadelphia Center for Research in Child Growth. Of those, fifty had normal occlusion, twenty had Class I malocclusion, twenty had Class II, and ten had Class III malocclusion.

Sassouni used four main horizontal planes of reference, each centering in an area of growth-adjustment, and two arcs. As a conclusion of his Facial Study, he stated, "In a well-proportioned face, the anterior arc intersects, from above down, the frontoethmoid junction, nasion, anterior nasal spine, incisal edge of the upper central incisor, and pogonion. Similarly, the posterior arc intersects to posterior wall of sella turcica and gonion." He also stated, "It may be a dangerous mistake to try to correct malocclusions by referring to absolute norms. And it will be a mistake and a source of failure if consideration is not given to the particular facial pattern of each of our patients. In this way of thinking, the proportional analysis that we have studied takes its full meaning."

Hixon (1956) discussed the norm concept in cephalometrics. In

discussion of some uses and limitations of norms, he stated, "It is most important to distinguish betwen describing growth and evaluating growth. It can be seen that the proper use of a norm is for description and not for evaluation. Since any norm that is employed in the practice of orthodontics will be used to describe a wide variety of patients, it is necessary to inquire into the sample size, age, race, and sex of the subjects used in constructing the norm." He concluded, "In spite of the limitations outlined, those data available do provide reference frames that are definite aids. These yardsticks may be a bit elastic at present, but are far better than no yardstick."

Hatton and Grainger (1958) discussed the reliability of measurements from cephalograms. This study attempted to define the efficiency and reliability of the method for studying anatomic variations. The method was to compute the error variances involved in the radiographic and tracing technic with data derived from duplicate radiograms and duplicate tracings of 15 3-year-old children. They found that by far the greatest source of distribution variation is due to the real difference between children and that from the point of view of economical production of data for creating norms and permitting comparisons, the best experimental procedure is to use a sufficient number of children rather than to attempt to reduce technical error further by duplicating measurement.

Ricketts (1960) discussed the value of the cephalometric roentgenogram based on the findings on 1,000 clinical cases with a usual orthodontic problem. A system of five measurements from X-ray tracings was

designed to provide a sensible method of informing the orthodontist of facial form and denture position. These angles and measurements proved to be indicators of facial depth, facial height, and profile contour. Ricketts measured the teeth from the denture bases rather than to points outside the dental areas. The position of the lower incisor in relation to the APo plane was thought to be the key communication of the problems with the anterior teeth. A system for deep structural analysis was proposed for those cases in which more detailed information was desired. As a conclusion, Ricketts stressed the need for the concept that a survey or analysis was for the purpose of describing and understanding skeletal proportion and form.

Ricketts (1960) discussed the dynamic synthesis of cephalometrics according to the growth and change in the relationship of part. Ricketts stressed the need for more understanding of the application of cephalometrics in treatment planning. Ricketts studied 1000 clinical cases to obtain information on the morphologic variation. Means, ranges of variation, and standard deviations were established for facial height, depth and convexity. These data were divided into age groups and studied for suggestions on growth. Ricketts thought the A-Pog plane was of greatest usefulness because it represented a reciprocal relationship of the denture bases to which the anterior must be related functionally. Ricketts presented the sequence of steps as a simple approach to estimating growth and desired treatment changes in the dynamic synthesis.

Ricketts (1964) discussed the chin, point B, and the lower incisor

as a triad in the first part of his article, "The keystone Triad". He stressed the understanding of the systematic totality of the behavior of the triad which is the keystone of the lower jaw. He showed serious objections to the common interpretations of point B, particularly to the use of NB as a reference for the lower incisors. Ricketts stated that probably the biggest error ever to appear on the orthodontic scene, and one which affected the course of orthodontics for many years, is the mistaken notion that the angle or axis of the lower incisor is a measure of its forward or backward position in the mandible or to the face.

Ricketts (1964) reviewed growth findings together with treatment changes and attempted to transpose them into clinical understanding in the second part of his article. He employed the APo plane as the most useful clinical reference in order to describe the labiolingual location of the lower incisor. Ricketts stated, "A critical interpretation was gained by relating only the lower incisor and forgetting about point B. The lower incisor studied in relation to the APo plane automatically considers the facial pattern of the individual and also is useful at his state of growth and development." In actual practice, and in the prognosis of a treatment, Ricketts tried to hold to the principles of accepting a range of variation within the confines of one standard deviation from the mean of the anteroposterior position of the lower incisor to the APo plane.

Altemus (1968) demonstrated the variety in cephalofacial relationships. He presented a few examples of the range of cephalofaical

relationships between members of different racial and ethnic groups using Downs', Steine's and Ricketts' cephalometric analyses. He tried to progress from thinking of people in groups, either racial or ethnic groups, with attendent use of norms and standards to the consideration of the individual. Altemus demonstrated that norms and standards cannot be used rigidly because of the vast differences in the sizes and shapes of individuals. He stated, "The rigid use of norms and standards conceived and developed from the basic concept of the health and beauty of the orthognathic face is confusing to the orthodontist treating patients whose physiognomy and dentition are not naturally orthognathic. This value judgement is best made considering individuals as they relate to their racial, ethnic, family and sometimes the artistic sensitivity of the orthodontist."

Baumrind and Frantz (1971) discussed the reliability of head film measurements. They classified the sources of measurement error into two: (1) Errors of projection (2) Errors of identification. The findings of their study were as follows: (1) Even when one is replicating assessments of the same head film, errors in landmark identification are too great to be ignored. (2) The magnitude of error varies greatly from landmark to landmark. (3) The distribution of error for most landmarks is not random, but is, rather, systematic.

Riolo, Moyers, McNamara, and Hunter (1974) published "An Atlas of Craniofacial Growth" based on their extensive longitudinal study. The sample of this study consisted of 47 males and 36 females, with continuous

attendence at the University school over the period ranging from their sixth to sixteenth birthdays.

This monograph was published for several purposes as follows: 1) to provide a statistical description of a large segment of the craniofacial data for the University Elementary and Secondary school study; 2) to provide a ready reference to a large serial sample of craniofacial data for those persons in laboratories who do not have access to such data; 3) to permit comparisons of their data with other similar longitudinal growth data; 4) to inform other workers of the potential uses of their data set and to offer them the opportunity for cooperative and comparative analyses.

Biggerstaff, et al. (1977) reported a Vertical Cephalometric Analysis which consisted of dimensional and proportional analyses. The purpose of their report was to (1) define the biologic base for measurements which can pinpoint areas of skeletal or dental disharmony in the vertical plane of space, (2) describe the comparative data base for diagnosing specific vertical dysplasias, and (3) describe the utility of the vertical analysis. In discussion, they stated, "Vertical dimension problems have been ignored too long. Clinicians have recognized the importance of these problems but have not been able to analyze them effectively." Their approach to analyzing vertical problems was based on assessment of the manifest growth of biologic areas.

B. KOREAN STUDIES

Ahn (1961) published the cephalometric standards for Koreans according to Downs, Graber, and Broadbent's methods of analysis using five age groups of 5, 10, 15, 20, and 23 year olds. Each group consisted of twenty-five males and twenty-five females except 23 year-old group which comprised of fifty males and fifty females. He made comparisons between different age groups, Korean male and Korean female, Korean and Caucasian, and Korean and Japanese. Ahn didn't find any significant difference between Korean males and females in different age groups according to Downs and Graber analyses. In convexity and Y-axis measurements, there was a significant difference between Koreans and Caucasians. He also reported Koreans have similar skeletal and dental patterns to Japanese.

Employing Steiner analysis, Suh (1967), established the cephalometric standards of Korean males and females of the age groups of 5, 10, 15, 20, and 23 year olds. He made the tables of standard deviation of each age group of Korean males and females, and obtained the ANB range values and ideal acceptable compromise. His study showed that the incisor teeth of maxilla and mandible of the Korean have labial inclination, and the mandible of the Korean is retruded in some degrees compared to the Caucasian standards.

Joo (1970) established the cephalometric standards of ten-year old children (25 males and 25 females) and twenty-three-year old adults (56 males and 50 females) with clinically normal occlusions by using Bjork, Downs, Wylie, Steiner, Graber and Tweed analyses. The results of this study were as follows: 1) The ratio of mandibular body to anterior

cranial base was about 1:1.1, 2) Holdaway ratio was about 4.2:1, 3) The angles of Tweed triangle were 32°, 52° and 96°, 4) Korean has posterior position of mentale portion compared with Caucasian, and 5) Korean has larger labial inclination of maxillary and mandibular incisors compared to Caucasian.

Kim, Yang and Cho (1970) published a cephalometric study of the Korean using the Holdaway ratio. They measured and obtained the Holdaway ratio of 104 adults with normal occlusion and 75 adults with malocclusion. The results of their study were as follows: 1) The Holdaway ratio was 4.41:1 in male and 11.66:1 in female. In female, labial inclination of the lower central incisor was severe and convexity of the pogonion was less than in male.

Yang (1974) analyzed sixty-four Korean males and sixty-five Korean females with normal occlusion from the childhood to the juvenile period cephalometrically. His study was confined to the linear measurements using the palatal plane and the mandibular plane as the reference planes in the maxilla and the mandible. The following conclusions were obtained from his study: 1) The order of growth increments were mandibular, maxillary, and cranial base length in both sexes. 2) In both sexes, the growth of the anterior face was more rapid than that of the posterior face, and the lower facial growth was greater than the upper facial growth of the anterior and posterior face. 3) The maxillo-facial height growth was more rapid than that of the depth in both sexes.

Yang stated that linear analyses are very helpful in describing the

shapes of structures and locating abnormalities when used together with angular analyses.

Lee (1975) conducted a cephalometric investigation to establish the cephalometric standards of Hellman dental age IIIB groups of the Korean. The subjects consisted of twenty-five males and twenty-five females with normal occlusion and acceptable profile. The facial convexity of Korean children in this study was larger than that of the Caucasian. The labial inclination of the lower central incisors in male was a little greater than that in female.

Son (1975) did a cephalometric study of Korean adults using the Jarabak analysis. The subjects consisted of forty-two males and forty-two females aged from seventeen to twenty years with normal occlusion and acceptable facial appearance. All the linear skeletal measurements of the male were greater than those of the female. In relationship of the upper lip to the esthetic line, the lip of the female was more behind than that of the male. The ratio of the mandibular body to the anterior cranial base was about 1:1.1.

Yoo (1976) established the cephalometric standards, using lateral cephalometric roentgenograms of 48 male and 53 female Korean adults with normal occlusion and acceptable profile. Coben's method was used. The following conclusions were obtained: 1) Cranial base depth of the male was greater than that of the female. 2) The proportional depth of the middle face was greater in the female than in the male. 3) The proportional total anterior face height was greater in the male than in the

female; and, it was greater in the Korean than in the Caucasian.

Chang (1976) presented the cephalometric standards of the Korean children. The subjects consisted of twelve-year olds (33 males and 33 females) with the normal occlusion and acceptable profile. Their linear and angular measurements were performed by Jarabak's method. Chang obtained the following results: 1) Each linear measurement of the skull was greater in males than in females. 2) The maxillary basal bones were more protrusive in Korean children than in Caucasian children. 3) The degree of the facial convexity was larger in Korean children than in Caucasian children. 4) The labial inclination of the upper and lower incisors was greater in Korean children than in Caucasian children.

Chang and et al. (1976) investigated the facial configuration of Korean children. They used the anterior vertical line as a reference in order to compare the facial configuration of the Korean child with that of the Caucasian child. They obtained the following conclusions: 1) The relatively vertical inclination of the nasal bone and flat contour of the frontal bone contribute to the flattening of the upper face. 2) Slight lack of the chin prominence characterizes the lower face while procumbent incisors and their alveolar bone dominate the middle face. 3) A caudal skull base inclination is probably the most specific feature for the Korean.

Kang (1976) conducted a cephalometric study to define the differences that existed between the Korean male and Korean female on the dentoskeletal framework and the soft tissue profile around the mouth.

The results of his study were as follows: 1) Among the angles formed by the long axes of the maxillary and mandibular anterior teeth, the maxillary and mandibular anterior alveolar bone, and the lower and upper lips, only the angle formed by the lips was more accute in males than in females. The males have a more rounded profile, and the females have a flatter profile in the lower third of the face. 2) The occlusal plane was related to the anterior tooth inclination, anterior alveolar bone profile, and the lip contour. Only the angle related to the lower lip was significantly different between the two sexes. 3) The angles formed by the lips, incisors, and alveolar bone with the Frankfort horizontal plane in the maxilla and the mandibular plane in the mandible were investigated. The angles related to the upper and lower lips showed a significant difference between the male and female. The angles formed by the facial plane and the mandibular plane with the esthetic plane were tested. The angle related to the mandibular plane angle showed a significant difference between the two sexes. This difference may be due to the profile contour of the nose.

Lee (1978) published his longitudinal cephalometric study based on thirty-two Korean children from seven to eleven years of age. The purpose of this study was to investigate the growth changes in craniofacial depth and height. The Coben's coordinate system was used in this study .

The findings from his study were as follows: 1) Among the craniofacial depth increments the lower facial depth dimension increased the

most, mid-facial depth dimension increased less, and cranial depth dimension increased the least. 2) In spite of the increasing depth dimensions, the mid-facial depth proportion had a tendency to remain stable. 3) The degree of overbite increased markedly from seven to eleven years of age. 4) Increment in the total anterior facial height dimension was larger than that in the total posterior facial height, and the upper anterior facial increased more than the lower anterior facial height. 5) The lower facial depth proportion increased markedly, and the convexity of the face was reduced significantly. 6) The posterior facial height tended to show small proportional changes. 7) The growth increments in craniofacial complex were larger in the facial height than in the facial depth.

Lee (1979) established the cephalometric standards of Hellman dental age IV A group of the Korean. The subjects consisted of forty males and forty-four females with normal occlusion and acceptable profile. All linear measurements were greater in male than in female. Females exhibited more convex profile than male.

C. STUDIES OF DIFFERENT ETHNIC GROUPS

Employing Downs' analysis, Cotton, Takano, and Wong (1951) compared the American Negro, the American Japanese, and the American Chinese to the means and ranges compiled by Downs on the white American. Wylie in this article discussed the concept of "normal occlusion" and pointed out that Cotton's view of "normal" was apparently the opposite of that of Downs', for he said, "All individuals did not possess clinically excellent occlusions, but all possess more or less normal occlusions." One of

Takano's major conclusions was that it is fallacious to apply morphological standards derived in one ethnic group to individuals of another.

Craven (1958) studied fifty-six lateral cephalometric radiographs of Central Australian aboriginals. In this study, Craven compared the facial and cranial structures of Central Australian aborginals with those of other living races. Inter-racial variation was studied and individual variations of the face and cranium examined. Some of the conclusions he made in this study were: 1) The Australian aboriginal has a greater degree of alveolar prognathism than the Swede or Bantu. 2) Growth changes in the Australian aboriginal facial profile are similar to those of the North American White, Swede and Bantu. 3) In contrast to the North American white, Swede and Bantu, alveolar prognathism in the Australian aboriginal increases with age.

Drummond (1968) performed a cephalometric study of the American Negro to determine a mean and range of normal for each lateral cephalometric measurement in the American Negro. His sample consisted of forty American Negro patients with clinically acceptable occlusion and Angle Class I molar relation. The primary difference between the American Negro and the Caucasian was the bimaxillary dental protrusion, the steep mandibular plane, and the anterior placement of the maxilla in the American Negro population.

Using Downs analysis, Nanda (1969) established the cephalometric norms of North Indians and compared these norms to three other ethnic groups, namely, Negroes, Chinese and Japanese. The requirements of the

sample were a full complement of permanent teeth in proper intercuspation with no rotations and no crowding of maxillary and mandibular incisors, and a good balance and harmony of dentofacial structures. The skeletal norms obtained in this study were almost similar to the American White, but were retrusive when compared with the Chinese, Negro and Japanese. The dental pattern of this sample was more protrusive than the American White; it was retrusive as compared with the Chinese and the Negro. Nanda stated, "The present study serves to highlight the fact that the excellence of dentofacial pattern is peculiar to its racial group. The objectives to be persued in orthodontic treatment will naturally need to be amended accordingly.".

Choy (1969) conducted a cephalometric investigation of the Hawaiian using Bjork, Downs, Steiner and Tweed analyses. Forty-three adult skulls of Hawaiian origin were used in this study. Choy drew the following conclusions by comparing the Hawaiian with other ethnic groups which included the Bantu of Africa, the Australian Aboriginal, the American Negro, the American Japanese, the American Chinese, and the Japanese: 1) Of all the non-white ethnic groups the Hawaiian was found to be least protrusive. 2) The Hawaiian exhibited greater alveolar prognathism than did members of the White groups of this study. 3) The Hawaiian records very flat mandibular and occlusal planes, even more so than in the White groups compared in this study.

Chan (1972) established the cephalometric standards of Chinese male adult (Cantonese) and compared Chinese with other ethnic groups

including Caucasian, American-Japanese, Australian aborigines and Negroes. His findings were: 1) The Chinese has the most retrognathic mandible. 2) In denture pattern, the Chinese has the largest occlusal plane angle when compared to other ethnic groups. 3) All measurements of his study, except the A-B plane, were significantly different from Caucasian standards in Downs analysis. As a conclusion, Chan stated, "It is evident that to evaluate any Chinese orthodontic patient, Chinese standards, and not Caucasian standards, must be used a a yardstick.".

Enlow (1975) in his book, "Handbook of Facial Growth", wrote that the cranium of the Orientals tends to be brachycephalic and the cranial base is more closed, while that of Whites is more closed in the brachycephalic group and more open in the dolicocephalic group. Furthermore, the cranium of Blacks tends to be dolicocephalic and the cranial base in Blacks tends to be more open. Enlow also described a greater tendency for a Class II type of malocclusion and a prognathic mandible of the Oriental.

Garcia (1975) investigated the dento-facial characteristics of Mexican Americans using the Downs and Steiner analyses. He found that all of the measurements in the Mexican American sample were significantly different from the Caucasian norms. The following clinically significant differences were demonstrated in the Mexican American sample as compared to the Caucasian sample: 1) Skeletally, the Mexican American sample was more protrusive than the Caucasian sample. 2) The lower incisor of the Mexican American sample was more labially inclined than that of the

Caucasian sample. 3) The upper incisor of the Mexican American sample was more procumbent than that of the Caucasian sample. 4) The interincisal angle of the Mexican American sample was more acute than that of the Caucasian sample.

Mitani (1980) presented the cephalometric standards of seventeen-year old Japanese in his Master's Thesis. He obtained the following results by comparing his Japanese standards with Caucasian standards: 1) The Japanese have a retrusive profile or retrusive jaws relating to the cranial base. 2) The Japanese have different vertical ratios of the anterior and posterior facial structures from the Caucasians. 3) Japanese incisors are more anteriorly oriented than those of caucasians.

CHAPTER III

MATERIAL AND METHOD

A. MATERIAL

The material* for this study consisted of standardized lateral head roentgenograms of 80 eighteen-year old Koreans (35 males and 45 females), selected from the freshman class of Yonsei University in Seoul, Korea. These roentgenograms were originally taken for the purpose of the cross-sectional cephalometric study of Korean adults in the Orthodontic Department of Yonsei University Dental College.

The criteria for the selection of the sample were: 1) acceptable profile, 2) full complement of permanent teeth in proper intercuspation, 3) abscence of remarkably large overjet or overbite, and 4) no history of previous orthodontic treatment.

B. METHOD

The cephalograms were traced on translucent acetate tracing papers. Angular and linear measurements were made by the author with a Unitek cephalometric protractor and a transparent metric ruler. All the measurements were taken to the nearest 0.5 degree or 0.5 millimeter. The analyses utilized were those of Downs, Steiner, Ricketts, and Vertical (Biggerstaff).

* The material was provided by courtesy of Dr. Young-Kyu Yoo, chairman of the orthodontic department of Yonsei University Dental College.

Statistical calculations performed included means, standard deviations, and "t" tests. Statistical comparisons were made by means of the "t" test except in the Ricketts analysis. The Ricketts norms were based on 8.5 year-olds and computed yearly changes, consequently it was not considered appropriate to make a "t" test. Instead of a "t" test, the difference of the means between the two groups were divided by Rickets "clinical deviation".

The anode to film distance of the cephalometric machine used for this study was 150 cm and the distance between the center of a subject and the X-ray tube was 15 cm. There is a slight difference between the Korean and American standard orientation of cephalometric radiography. The anode to film distance of American cephalometric machines is 5 feet (152.4 cm). But this difference appears on the film surface as less than 0.5% difference in linear measurements and no difference in angular measurements. This is comparable to the error due to rounding measurements upward or downward to the nearest 0.5 mm.

To determine the error involved in the tracing of cephalograms, picking the landmarks, and measuring; nine cephalograms (every tenth cephalogram) were retraced after all the originals were completed. A "t" test was used to compare the results of the first and second tracing. Seventy out of seventy-five measurements showed no significant difference. A significant difference was found in five measurements.

C. POINTS AND PLANES

The definitions of points and planes were from the ATLAS OF CRANIOFACIAL GROWTH (Riolo and et al. 1979), the ROCKY MOUNTAIN DATA SYSTEMS

MANUAL (Ricketts and et al.), and the SYLLABUS IN ROENTGENOGRAPHIC CEPHALOMETRY (Krogman and Sassouni, 1957).

POINTS (Fig. 1)

1) N Nasion - The junction of the frontonasal suture at the most posterior point on the curve at the bridge of the nose.

2) S Sella - The center of the pituitary fossa of the sphenoid bone.

3) P Porion - A point located at the most superior point of the external auditory meatus (left).

4) Ba Basion - The most inferior, posterior point on the anterior margin of foramen magnum.

5) Ar Articulare - The point of intersection of the inferior surface of the cranial base and the averaged posterior surfaces of the mandibular condyles.

6) O Orbitale - The lowest point on the average of the right and left borders of the bony orbit.

7) SE Ethmoid Registration Point - Intersection of sphenoidal plane with the averaged greater sphenoid wing.

8) Pt Pterygoid Point - Intersection of inferior border of foramen rotundum with posterior wall of pterygo-maxillary fossa.

9) CF Intersection of Frankfort and Pterygoid Vertical plane.

10) CC Intersection of Ba-N plane and facial axis.

11) DC A point selected in the center of the condyle neck on the Ba-N plane (left).

12) XI The centermost point (Ricketts) of the mandibular ramus.

13) Go Gonion - The midpoint of the angle of the mandible. Found by bisecting the angle formed by the mandibular plane and the plane through Articulare, Posterior and along the portion of the mandibular ramus inferior to it.

14) GoI Gonial Intersection - The intersection of the mandibular plane with the plane through Articulare, Posterior, and along the portion of the mandibular ramus inferior to it.

15) ANS Anterior Nasal Spine - The tip of the median, sharp bony process of the maxilla at the lower margin of the anterior nasal opening.

16) PNS Posterior Nasal Spine - The most posterior point at the sagittal plane on the bony hard palate.

17) A A Point - The most posterior point on the curve of the maxilla between the anterior nasal spine and supradentale.

18) B B Point - The point most posterior to the line from Infradentale to Pogonion on the anterior surface of the symphyseal outline of the mandible.

19) Po Pogonion - The most anterior point on the contour of the bony chin. Determined by a tangent through Nasion.

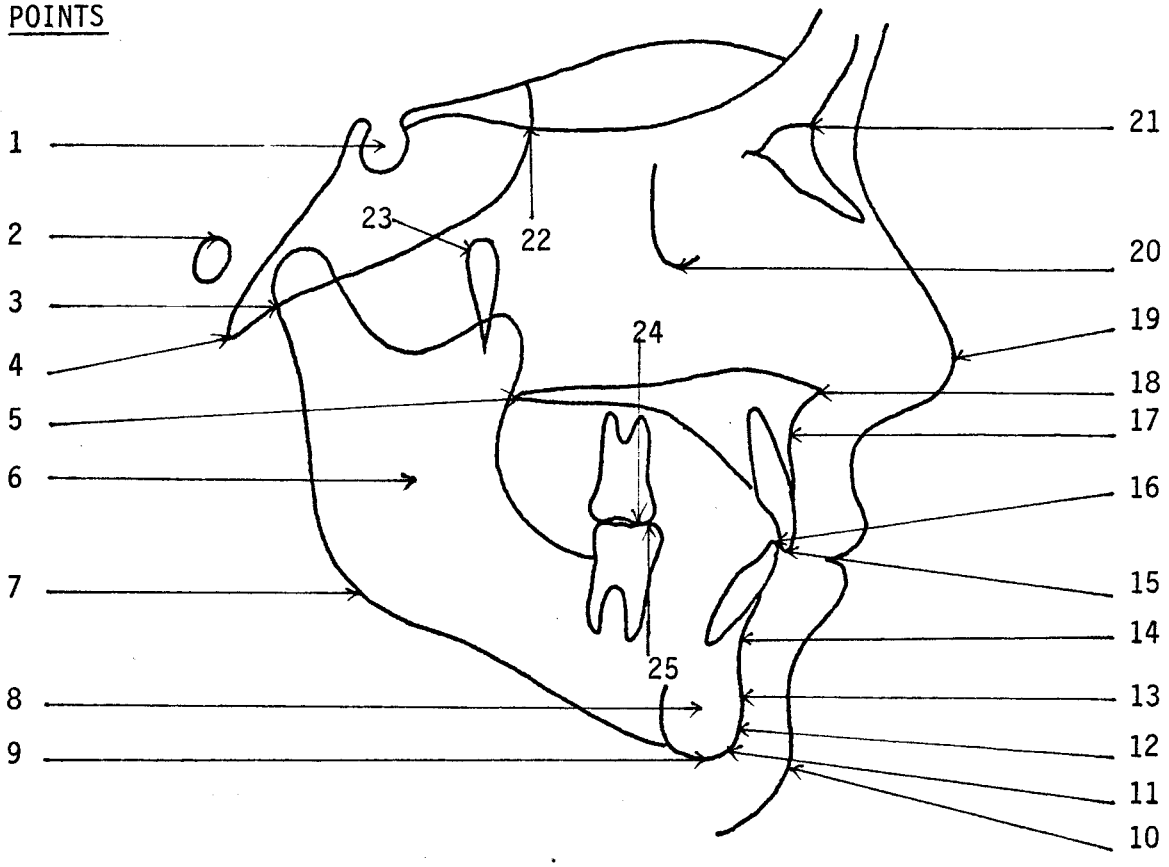
20) PM Supra Pogonion - Point selected at the anterior border of the symphysis between point B and Pogonion where the curvature changes from concave to convex.

21) Me Menton - The most inferior point on the symphyseal outline.

22) Gn Gnathion - The most anterior - inferior point on the contour of the bony chin symphysis. Determined by bisecting the angle

FIGURE 1

POINTS



1.	S	10.	DT	19.	EN
2.	P	11.	Gn	20.	O
3.	Ar	12.	Po	21.	N
4.	Ba	13.	PM	22.	SE
5.	PNS	14.	B	23.	Pt
6.	XI	15.	UIE	24.	UMT
7.	Go	16.	LIE	25.	LMT
8.	D	17.	A		
9.	Me	18.	ANS		

the angle formed by the mandibular plane and the line through Pogonion and Nasion.

23) D Point D - A point located at the center of the cross-section of the body of the symphysis.

24) LIE Lower Incisor Incisal Edge - The incisal tip of the mandibular central incisor.

25) UIE Upper Incisor Incisal Edge - The incisal tip of the maxillary central incisor.

26) LMT Lower Molar Mesial Cusp Tip - The anterior cusp tip of the mandibular first molar.

27) UMT Upper Molar Mesial Cusp Tip - The anterior cusp tip of the maxillary first molar.

28) EN Tip of the nose tangent to the esthetic plane.

29) DT The point on the anterior curve of the soft tissue chin, tangent to the esthetic plane.

PLANES (Fig. 2)

1) S-N Plane: Sella - Nasion

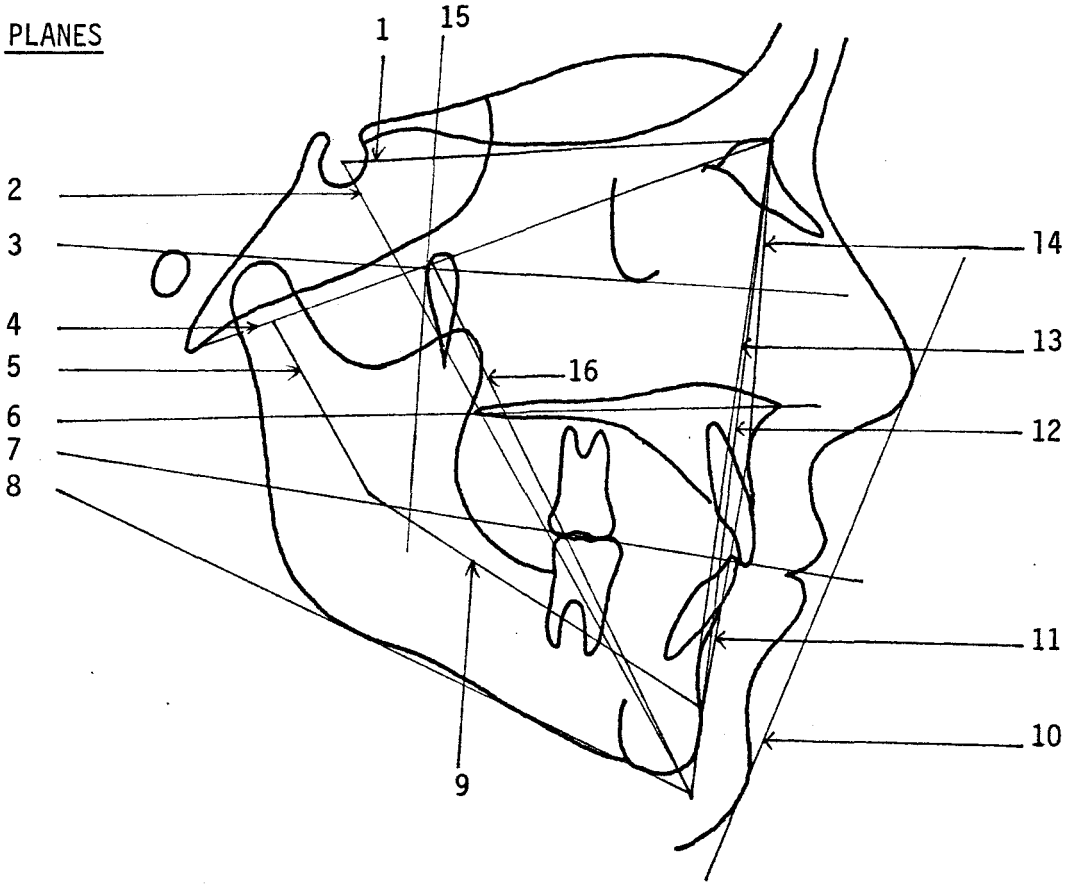
2) Frankfort Plane: Porion - Orbitale

3) Palatal Plane: Anterior nasal spine - Posterior nasal spine

4) Occlusal Plane: A line bisecting the occlusion of the first molars and central incisors.

5) Functional Occlusal Plane: A line bisecting the occlusion of the first molars and bicuspids.

FIGURE 2



1. S-N Plane
2. Y-axis
3. Frankfort Plane
4. Ba-N Plane
5. Condylar Axis
6. Palatal Plane
7. Occlusal Plane
8. Mandibular Plane
9. Corpus Axis
10. Esthetic Plane
11. A-Po Plane
12. Facial Plane
13. N-B Plane
14. N-A Plane
15. Pterygoid Vertical Plane
16. Facial Axis

6) Mandibular Plane: 1) Menton to the lower border of the mandible. (Downs, Ricketts) 2) Go - Gn (Steiner)

7) Ba - N Plane: Basion - Nasion

8) N - A Plane: Nasion - A point

9) N - B Plane: Nasion - B point

10) Facial Plane: Nasion - Pogonion

11) A - Po Plane: A point - Pogonion

12) Facial Axis: Pt - Gn

13) Y - Axis: Sella - Gn

14) Corpus Axis: XI - PM

15) Condylar Axis: XI - DC

16) Pterygoid Vertical Plane: A line perpendicular to Frankfort plane through the distal of pterygopalatine fossa.

17) Esthetic Plane: EN - DT

D. ANALYSES

DOWNS ANALYSIS (Fig. 3)

1) Facial Angle - The inferior inside angle of the Frankfort plane and facial plane.

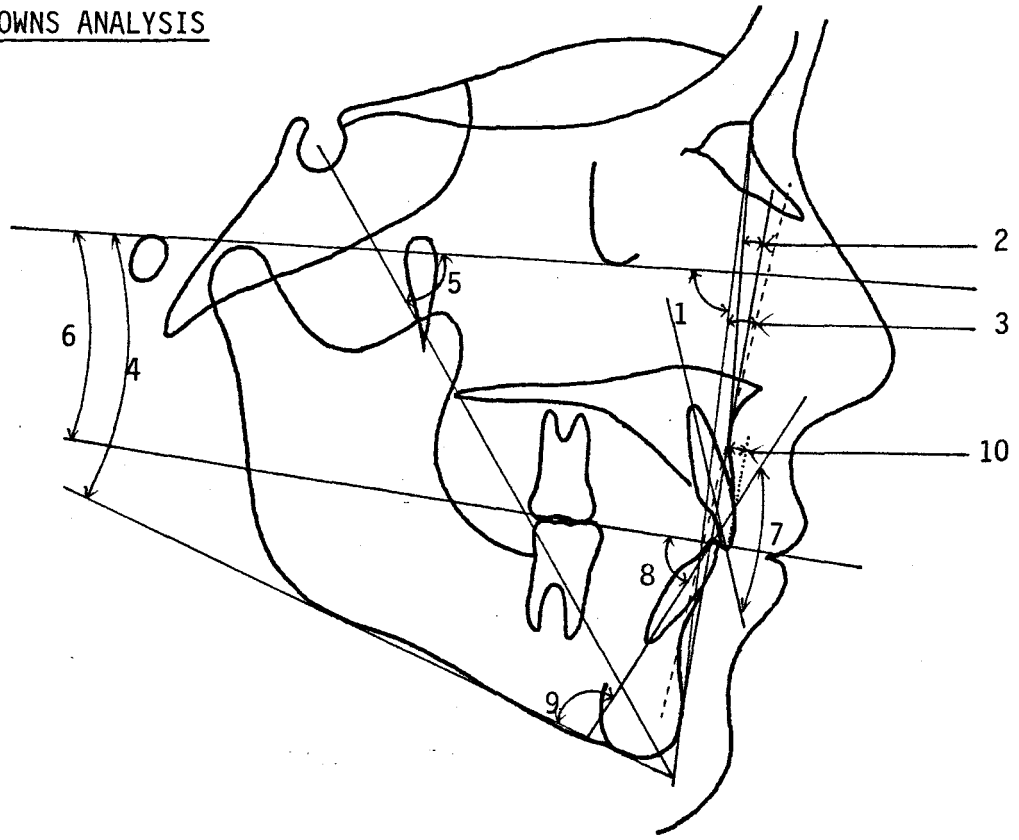
2) Angle of Convexity - The angle formed by the intersection of a line from the Nasion to point A with a line from point A to Pogonion.

3) A-B Plane - The angle formed by the A-B plane and facial plane.

4) Mandibular Plane Angle - The angle formed by the Frankfort plane and mandibular plane.

FIGURE 3

DOWNS ANALYSIS



1. Facial Angle
2. Convexity
3. A-B Plane
4. Mandibular Plane Angle
5. Y-axis
6. Occlusal Plane
7. Interincisal Angle
8. $\overline{1}$ to Occlusal Plane
9. $\overline{1}$ to Mandibular Plane
10. $\underline{1}$ to A-Po

5) Y Axis - The angle formed by the Frankfort plane and a line from Sella to Nasion.

6) Cant of Occlusal Plane - The angle formed by the occlusal plane and Frankfort plane.

7) Interincisal Angle - The angle formed by the long axes of the maxillary central incisor and mandibular central incisor.

8) $\overline{1}$ to Occlusal Plane - The angle formed by the long axis of mandibular central incisor and the occlusal plane.

9) $\overline{1}$ to Mandibular Plane - The angle formed by the long axis of mandibular central incisor and the mandibular plane.

10) $\underline{1}$ to A-Po - The distance from the A-Po plane to the tip of the maxillary central incisor.

STEINER ANALYSIS (Fig. 4)

1) SNA - The angle formed by the S-N plane and N-A plane.

2) SNB - The angle formed by the S-N plane and N-B plane.

3) ANB - The angle formed by the N-A plane and N-B plane.

4) SND - The angle formed by the S-N plane and N-D plane.

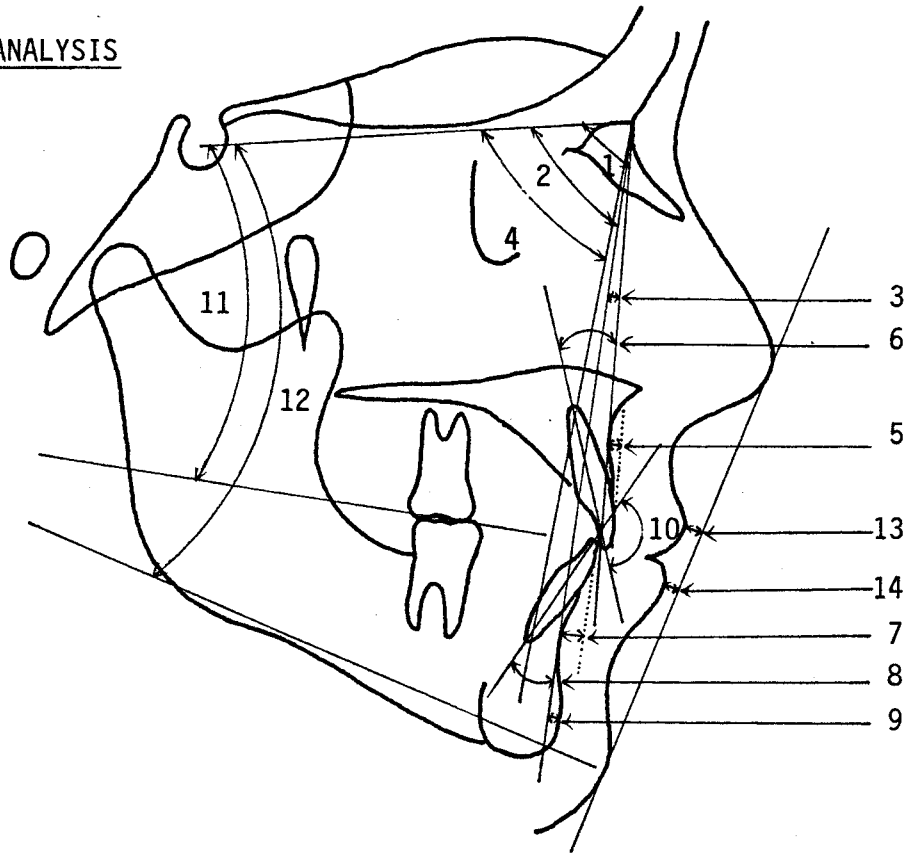
5) $\underline{1}$ to NA (mm) - The distance from the N-A plane to the most labial point of the maxillary central incisor crown.

6) $\underline{1}$ to NA (degree) - The angle formed by the long axis of the maxillary central incisor to N-A plane.

7) $\overline{1}$ to NB (mm) - The distance from the N-B plane to the most labial point of the maxillary central incisor crown.

FIGURE 4

STEINER ANALYSIS



1. SNA
2. SNB
3. ANB
4. SND
5. $\underline{1}$ to NA (mm)
6. $\underline{1}$ to NA (degree)
7. $\overline{1}$ to NB (mm)
8. $\overline{1}$ to NB (degree)
9. Po to NB
10. Interincisal Angle
11. Occlusal Plane to SN
12. GoGn to SN
13. Upper Lip Protrusion
14. Lower Lip Protrusion

8) $\overline{I}$ to NB (degree) - The angle formed by the long axis of the mandibular central incisor to N-B plane.

9) Po to NB - The distance between the N-B plane to Pogonion.

10) Occlusal Plane to SN - The angle between the occlusal plane and S-N plane.

11) GoGn - SN - The angle formed by the Go-Gn plane and S-N plane.

12) Upper Lip Protrusion - The distance between the upper lip and the esthetic plane.

13) Lower Lip Protrusion - The distance between the lower lip and the esthetic plane.

RICKETTS ANALYSIS (Fig. 5, 6, and 7)

1) Molar Relation - The distance between the distal surface of the lower and upper molars measured along the occlusal plane.

2) Canine Relation - The distance between the tips of the lower and upper canines measured along the occlusal plane.

3) Incisor Overjet - The distance between the incisal tips of the upper and lower incisors measured along the occlusal plane.

4) Incisor Overbite - The distance between the tips of the lower and upper incisors measured perpendicular to the occlusal plane.

5) Lower Incisor Extrusion - The distance between the tip of the lower incisor and the occlusal plane.

6) Interincisal Angle - The angle formed by the long axes of the central incisors.

7) Convexity - The distance between point A and the facial plane.

8) Lower Face Height - The angle from anterior nasal spine to the center of the ramus (XI) to PM.

9) Upper Molar Position - The distance from the pterygoid vertical to the distal of the upper first molar.

10) Mandibular Incisor Protrusion - The distance from the tip of the lower incisor to the A-Po plane.

11) Maxillary Incisor Protrusion - The distance from the tip of the upper incisor to the A-Po plane.

12) Mandibular Incisor Inclination - The angle between the long axis of the lower incisor and the A-Po plane.

13) Maxillary Incisor Inclination - The angle between the long axis of the upper incisor and the A-Po plane.

14) Occlusal Plane to Ramus - The distance between the occlusal plane and the XI point.

15) Occlusal Plane Inclination - The angle between the corpus axis and the occlusal plane.

16) Lip Protrusion - The distance between the lower lip and the esthetic plane.

17) Upper Lip Length - The distance between anterior nasal spine and the embrasure of the lips.

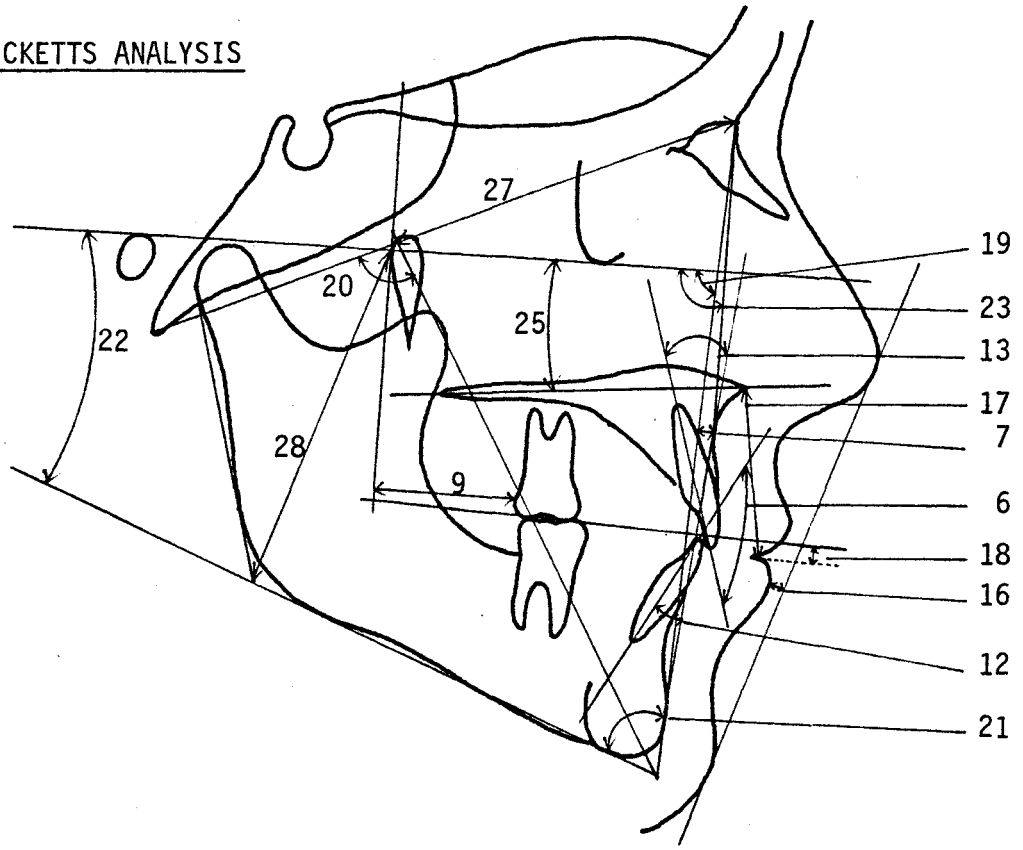
18) Lip Embrasure to Occlusal Plane - The distance between the embrasure of the lips and the occlusal plane.

19) Facial Depth - The angle between the facial plane and Frankfort plane.

20) Facial Axis - The angle between the facial axis and Ba-N plane.

FIGURE 5

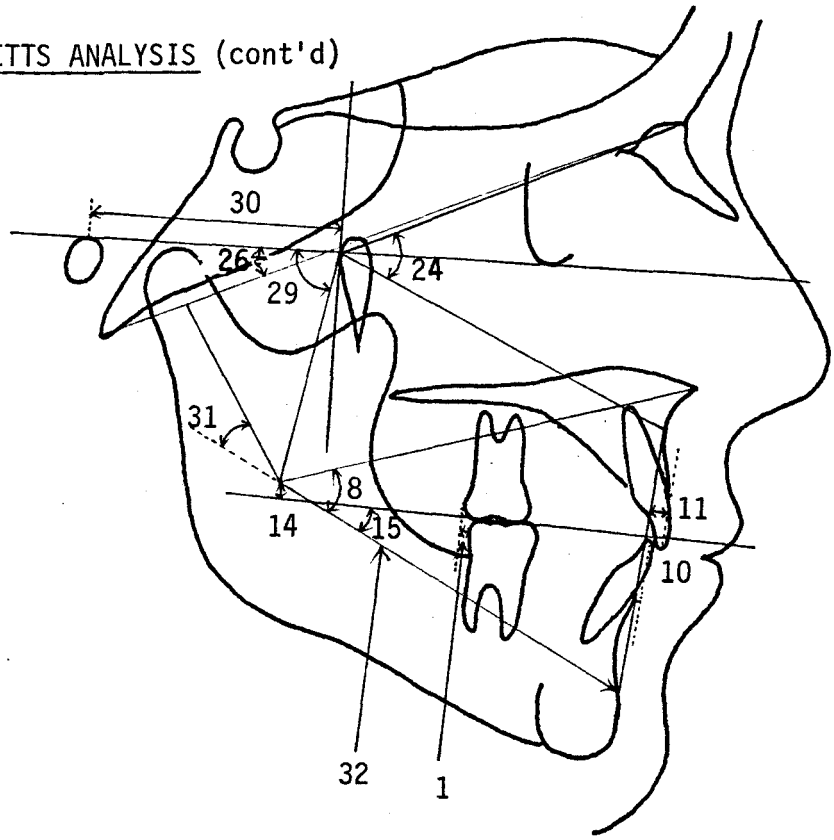
RICKETTS ANALYSIS



6. Interincisal Angle
7. Convexity
9. Upper Molar Position
12. Mandibular Incisor Inclination
13. Maxillary Incisor Inclination
16. Lip Protrusion
17. Upper Lip Length
18. Lip Embrasure to Occlusal Plane
19. Facial Depth
20. Facial Axis
21. Facial Taper
22. Mandibular Plane Angle
23. Maxillary Depth
25. Palatal Plane
27. Cranial Length
28. Posterior Facial Height

FIGURE 6

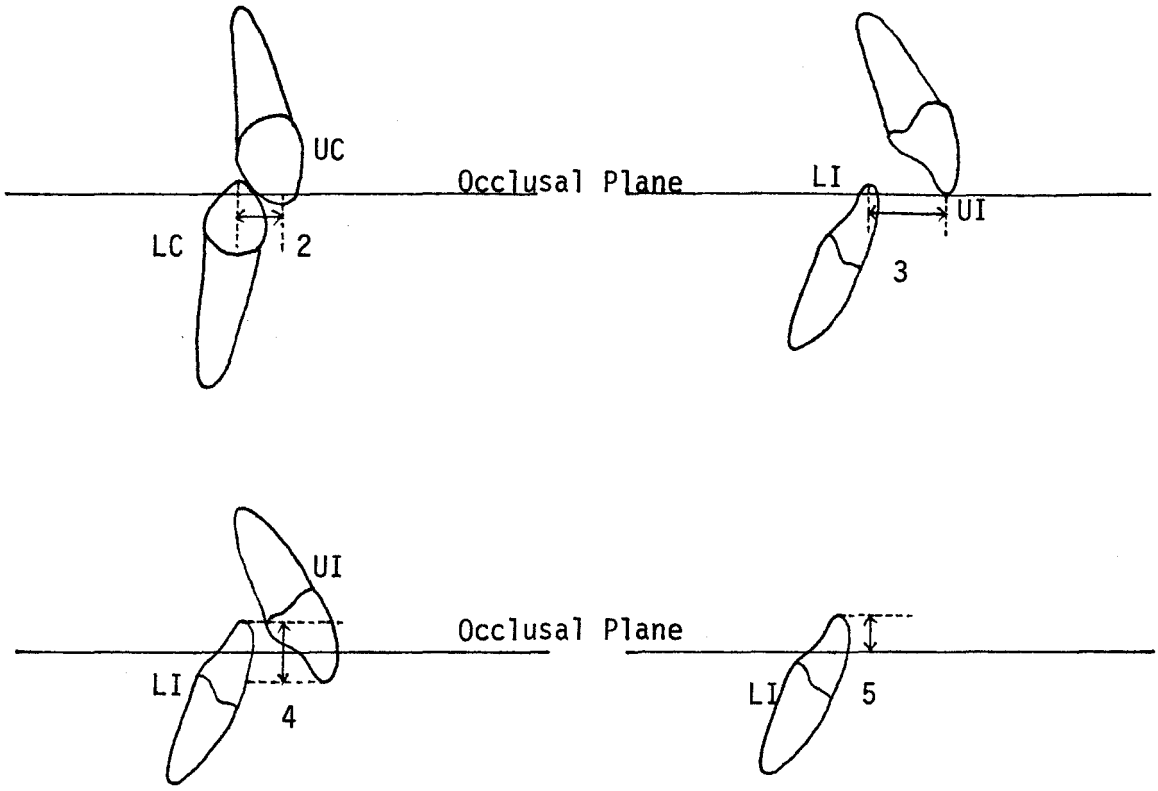
RICKETTS ANALYSIS (cont'd)



1. Molar Relation
8. Lower Face Height
10. Mandibular Incisor Protrusion
11. Maxillary Incisor Protrusion
14. Occlusal Plane to Ramus
15. Occlusal Plane Inclination
24. Maxillary Height
26. Cranial Deflection
29. Ramus Position
30. Porion Location
31. Mandibular Arc
32. Corpus Length

FIGURE 7

RICKETTS ANALYSIS (cont'd)



2. Canine Relation
3. Incisor Overjet
4. Incisor Overbite
5. Lower Incisor Extrusion

21) Facial Taper - The mandibular plane measured to the facial plane.

22) Mandibular Plane Angle - The angle formed by the mandibular plane and Frankfort plane.

23) Maxillary Depth - The angle formed by the Frankfort plane and the plane from Nasion to point A.

24) Maxillary Height - The angle formed by the points Nasion, CF and A point.

25) Palatal Plane - The angle between Frankfort plane and the palatal plane.

26) Cranial Deflection - The angle between the Ba-N and Frankfort planes.

27) Cranial Length - Anterior - The distance between CC point and Nasion.

28) Posterior Facial Height - The distance between Gonion and CF point.

29) Ramus Position - The angle between the Frankfort plane and the CF-XI plane.

30) Porion Location - The distance between Porion and the PTV.

31) Mandibular Arc - The angle between the corpus and condyle axes.

32) Corpus Length - The distance between XI and PM.

VERTICAL ANALYSIS (Fig. 8)

1) Upper Posterior Facial Height - SE to PNS

2) Upper Anterior Facial Height - Nasion to ANS

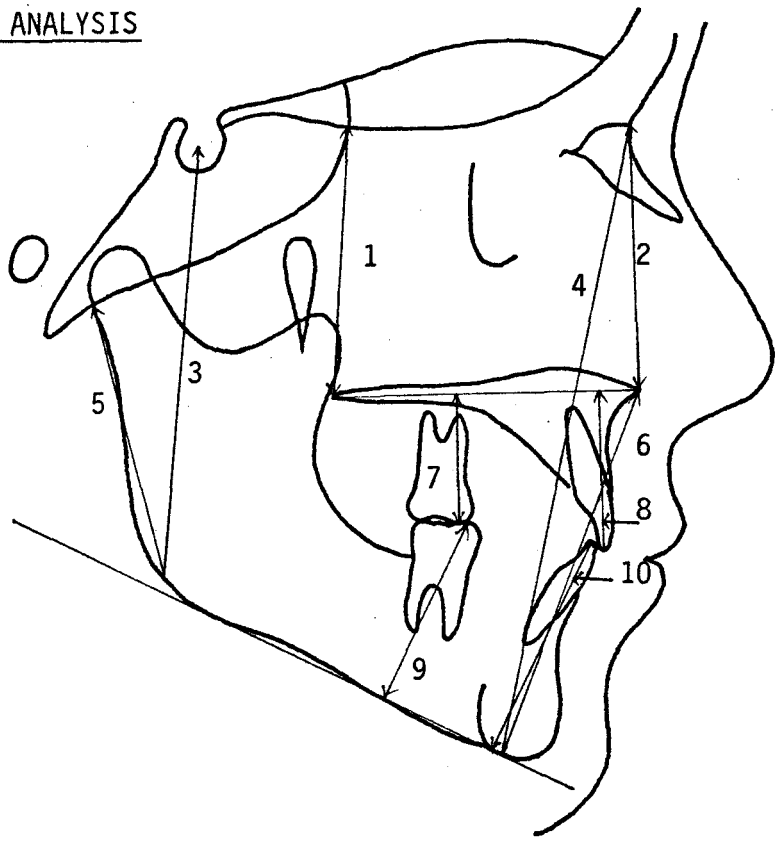
3) Posterior Facial Height - Sella to Gonion

4) Anterior Facial Height - Nasion to Menton

5) Lower Posterior Facial Height - Articulare to Gonion

FIGURE 8

VERTICAL ANALYSIS



1. Upper Posterior Facial Height
2. Upper Anterior Facial Height
3. Posterior Facial Height
4. Anterior Facial Height
5. Lower Posterior Facial Height
6. Lower Anterior Facial Height
7. Upper Molar Height
8. Upper Incisor Height
9. Lower Molar Height
10. Lower Incisor Height

6) Lower Anterior Facial Height - ANS to Menton

7) Upper Molar Height - The distance between the UMT to the palatal plane.

8) Upper Incisor Height - The distance between the UIE to the palatal plane.

9) Lower Molar Height - The distance between the LMT to the mandibular plane.

10) Lower Incisor Height - The distance between the LIE to the mandibular plane.

11) SE - PNS / N-ANS

12) S - Go / N - Me

13) Ar - Go / ANS - Ne

14) UMH / UIH

15) LMH / LIH

1) - 10) : Linear measurements

11) - 15) : Proportional measurements

CHAPTER IV

RESULTS

A. KOREAN MALE VS. KOREAN FEMALE

The comparison was made between Korean males and Korean females by means of the student "t" test. The results are shown in Table 1, 2, 3, and 4.

(1) DOWNS ANALYSIS

There is no significant difference between Korean males and Korean females in the Downs analysis.

(2) STEINER ANALYSIS

There is no significant difference between Korean males and Korean females in the linear measurements. The following angular measurements are significantly different between the two groups:

1) SNA ($P<.02$): larger in male
2) SND ($P<.05$): larger in male
3) Occlusal plane to S-N ($P<.05$): larger in female
4) Go-Gn to S-N ($P<.05$): larger in female
5) Upper Lip Protrusion ($P<.01$): larger in female

(3) RICKETTS ANALYSIS

There is no significant difference between Korean males and Korean females in the angular measurements except:

1 Lower Face Height (P<.05): larger in female

2) Maxillary Height (P<.01): larger in female

In the linear measurements, the following significant differences are observed:

1) Canine Relation (P<.02): larger in female

2) Upper Molar Position (P<.01): larger in male

3) Upper Lip Length (P<.05): larger in male

4) Cranial Length (P<.01): larger in male

5) Posterior Facial Height (P<.01): larger in male

6) Porion Location (P<.01): larger in male

7) Corpus Length (P<.01): larger in male

(4) VERTICAL ANALYSIS

Nine out of fifteen measurements are significantly different between Korean males and Korean females in the vertical analysis as follows:

1) Upper Posterior Facial Height (P<.01)

2) Upper Anterior Facial Height (P<.02)

3) Posterior Facial Height (P<.01)

4) Anterior Facial Height (P<.01)

5) Lower Anterior Facial Height (P<.01)

6) Lower Molar Height (P<.01)

7) Lower Incisor Height (P<.01)

8) Posterior Facial Height/Anterior Facial Height (P<.05)

9) Upper Molar Height/Upper Incisor Height (P<.02)

All the above measurements are larger in males than in females.

TABLE 1

DOWNS ANALYSIS (Comparison between Korean Males and Korean Females)

	Male Mean	S.D.	Female Mean	S.D.	t value
Facial Angle	89.1	2.4	89.3	3.0	0.340
Convexity	3.7	4.4	3.6	4.4	0.152
A-B Plane	-4.9	2.6	-4.5	2.7	0.601
Mandibular Plane	23.0	4.6	23.4	3.9	0.413
Y-axis	60.6	2.2	60.8	2.9	0.363
Occlusal Plane	7.1	3.0	7.7	3.3	0.778
Interincisal Angle	124.9	7.8	128.2	7.3	1.970
$\overline{1}$ to Occlusal Plane	22.9	4.9	20.8	5.4	1.852
$\overline{1}$ to Mandibular Plane	6.8	6.2	4.3	5.7	1.832
$\overline{1}$ to APo	7.6	2.2	7.0	1.7	1.354

* Significant at the 5% probability level
** Significant at the 2% probability level
*** Significant at the 1% probability level

TABLE 2

STEINER ANALYSIS (Comparison between Korean Males and Korean Females)

	Male Mean	S.D.	Female Mean	S.D.	t value
SNA	82.1	3.4	80.2	3.4	2.507 **
SNB	79.5	3.6	77.9	3.5	0.203
ANB	2.6	1.7	2.4	1.9	0.556
SND	76.6	3.5	75.0	3.3	2.169 *
$\underline{1}$ to NA (mm)	7.2	2.4	6.8	2.0	0.913
$\underline{1}$ to NA (degree)	24.2	5.6	22.6	5.1	1.359
$\overline{1}$ to NB (mm)	7.5	1.6	6.9	1.8	1.454
$\overline{1}$ to NB (degree)	28.1	4.9	26.7	4.9	1.220
Po to NB	1.9	1.5	1.7	1.0	0.681
Interincisal Angle	124.9	7.8	128.2	7.3	1.970
Occlusal Plane to SN	15.9	4.3	17.9	3.9	2.233 *
GoGn to SN	32.3	5.7	34.5	4.4	2.004 *
Upper Lip Protrusion	0.4	2.1	1.6	1.7	2.864 ***
Lower Lip Protrusion	-0.7	2.7	-0.2	1.7	0.788

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

TABLE 3

RICKETTS ANALYSIS (Comparison between Korean Males and Korean Females)

	Male Mean	S.D.	Female Mean	S.D.	t value
Molar Relation	-1.5	0.6	-1.6	1.0	0.275
Canine Relation	-0.6	0.6	-1.0	0.8	2.407 **
Incisor Overjet	3.6	0.9	3.5	0.9	0.394
Incisor Overbite	2.8	1.3	2.9	1.2	0.352
Lower Incisor Extrusion	2.0	1.2	1.6	1.3	1.243
Interincisal Angle	124.9	7.8	128.2	7.3	1.970
Convexity	2.1	2.3	1.7	2.2	0.747
Lower Face Height	46.1	3.3	47.6	2.8	2.206 *
Upper Molar Position	19.2	3.8	16.9	3.3	2.925 ***
Mandibular Incisor Protrusion	4.3	2.1	3.7	1.7	1.365
Maxillary Incisor Protrusion	7.6	2.2	7.0	1.7	1.354
Mandibular Incisor Inclination	27.0	4.2	25.7	3.9	1.459
Maxillary Incisor Inclination	28.0	4.9	26.2	4.3	1.793
Occlusal Plane to Ramus	0.6	3.0	-0.3	3.0	1.263
Occlusal Plane Inclination	22.5	3.1	23.7	3.2	1.655
Lip Protrusion	0.7	2.7	0.2	1.7	0.788
Upper Lip Length	29.2	2.1	28.3	1.9	2.058 *

TABLE 3 (cont'd)

RICKETTS ANALYSIS (Comparison between Korean Males and Korean Females)

	Male Mean	S.D.	Female Mean	S.D.	t value
Lip Embrasure to Occlusal Plane	-2.5	2.4	-2.5	2.1	0.081
Facial Depth	89.1	2.4	89.3	3.0	0.340
Facial Axis	88.0	3.8	86.6	3.3	1.832
Facial Taper	67.5	3.6	66.5	2.8	1.448
Mandibular Plane Angle	23.0	4.6	23.4	3.9	0.413
Maxillary Depth	90.9	2.3	90.8	2.8	0.119
Maxillary Height	60.8	3.7	63.3	3.0	3.253 ***
Palatal Plane	-0.5	2.9	0.2	3.1	1.034
Cranial Deflection	28.4	2.5	29.4	2.6	1.760
Cranial Length	61.5	2.7	58.4	2.9	5.000 ***
Posterior Facial Height	73.6	6.2	69.8	4.4	3.234 ***
Ramus Position	76.2	2.5	76.4	3.7	0.303
Porion Location	-41.2	2.1	-39.6	2.5	2.994 ***
Mandibular Arc	32.0	5.0	31.8	3.8	0.215
Corpus Length	75.0	4.0	71.3	3.7	4.230 ***

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

TABLE 4

VERTICAL ANALYSIS (Comparison between Korean Males and Korean Females)

	Male Mean	S.D.	Female Mean	S.D.	t value
SE-PNS	53.4	3.5	50.9	3.0	3.570 ***
N-ANS	59.1	4.2	57.2	2.9	2.431 **
S-Go	85.4	6.2	80.0	4.6	4.493 ***
N-Me	130.4	6.6	126.1	4.4	3.479 ***
Ar-Go	49.4	5.6	47.8	4.0	1.537
ANS-Me	73.0	4.1	70.4	3.0	3.291 ***
UMT ⊥ ANS-PNS	25.2	2.2	24.3	1.7	1.968
UIE ⊥ ANS-PNS	30.1	2.4	30.3	2.0	0.432
LMT ⊥ GoI-Me	37.3	2.5	35.5	2.0	3.540 ***
LIE ⊥ GoI-Me	46.3	2.5	43.7	2.0	5.128 ***
$\frac{\text{SE-PNS}}{\text{N-ANS}}$	0.91	0.07	0.89	0.05	1.311
$\frac{\text{S-Go}}{\text{N-Me}}$	0.66	0.04	0.64	0.03	2.326 *
$\frac{\text{Ar-Go}}{\text{ANS-Me}}$	0.68	0.08	0.68	0.06	0
$\frac{\text{UMT} \perp \text{ANS-PNS}}{\text{UIE} \perp \text{ANS-PNS}}$	0.84	0.07	0.80	0.06	2.536 **
$\frac{\text{LMT} \perp \text{GoI-Me}}{\text{LIE} \perp \text{GoI-Me}}$	0.81	0.04	0.81	0.04	1.047

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

B. KOREAN VS. CAUCASIAN

The comparison was made between the results of this study and previous studies of Caucasians. The results are shown in Table 5, 6, 7, and 8.

(1) DOWNS ANALYSIS

The original Downs measurements were used for Caucasian standards. All the measurements showed significant differences with the exception of the Mandibular Plane Angle, the A-B plane Angle and the Y-axis Angle. The significantly different measurements are:

1) Facial Angle, female ($P<.05$)
2) Angle of Convexity, male ($P<.01$) and female (P .01)
3) Occlusal Plane Angle, male ($P<.05$)
4) Interincisal Angle, male ($P<.01$) and female ($P<.01$)
5) $\overline{1}$ to Occlusal Plane, male ($P<.01$) and female ($P<.01$)
6) $\overline{1}$ to Go-Me, male ($P<.01$) and female ($P<.05$)
7) $\underline{1}$ to A-Po, male ($P<.01$) and female ($P<.01$)

All the above measurements are larger in Koreans except the intercisal angle.

(2) STEINER ANALYSIS

The original Steiner measurements were used for Caucasian standards. All measurements showed significant differences either in males or in females. The results are:

1) SNA, female ($P<.01$): larger in Korean
2) SNB, female ($P<.01$): larger in Korean
3) ANB, male ($P<.05$): larger in Korean

4) SND, female ($P<.05$): smaller in Korean

5) $\underline{1}$ to N-A (linear), male ($P<.01$) and female ($P<.01$): larger in Korean

6) $\underline{1}$ to N-A (angular), male ($P<.05$): larger in Korean

7) $\overline{1}$ to N-B (linear), male ($P<.01$) and female ($P<.01$): larger in Korean

8) $\overline{1}$ to N-B (angular), male ($P<.01$) and females ($P<.05$): larger in Korean

9) Po to N-B, male ($P<.01$) and female ($P<.01$): smaller in Korean

10) Interincisal Angle, male ($P<.01$) and female ($P<.02$): smaller in Korean

11) Occlusal plane to S-N, male ($P<.02$) and female ($P<.01$): larger in Korean

12) Go-Gn to S-N, female ($P<.01$): larger in Korean

13) Upper lip protrusion, male ($P<.01$) and female ($P<.01$): smaller in Korean

14) Lower Lip Protrusion, male ($P<.01$) and female ($P<.01$): smaller in Korean

(3) RICKETTS ANALYSIS

It is not appropriate to perform a "t" test to make a comparison between the Korean norms of this study and the Ricketts norms, because the numbers of the Ricketts norms were based on 8.5 year olds and computed yearly changes. The differences between the Korean norms of this study and the Ricketts Caucasian norms were divided by the Ricketts clinical

deviations. The Korean norms of this study are more than 1 clinical deviation off the Ricketts norms in the following measurements:

Male

1) Mandibular Incisor Protrusion, + 1 C.D.
2) Maxillary Incisor Protrusion, + 1 C.D.
3) Mandibular Incisor Inclination, + 1 C.D.
4) Occlusal Plane to Ramus, + 1 C.D.
5) Occlusal Plane Inclination, - 1 C.D.
6) Lip Protrusion, + 2 C.D.
7) Upper Lip Length, + 2 C.D.
8) Maxillary Height, + 1 C.D.
9) Posterior Facial Height, + 3 C.D.
10) Porion Location, + 1 C.D.
11) Corpus Length, - 1 C.D.

Female

1) Mandibular Incisor Protrusion, + 1 C.D.
2) Maxillary Incisor Protrusion, + 1 C.D.
3) Lip Protrusion, + 1 C.D.
4) Upper Lip Length, + 2 C.D.
5) Maxillary Height, + 2 C.D.
6) Posterior Facial Height, + 3 C.D.
7) Corpus Length, - 1 C.D.

(4) VERTICAL ANALYSIS

The measurements of the Vertical analysis for Caucasians were from

TABLE 5

DOWNS ANALYSIS (Comparison between Koreans and Caucasians)

	CAUCASIANS (DOWNS)	KOREANS (PARK)	
		MALE	FEMALE
Facial Angle	87.8	89.1	89.3 *
	3.57	2.4	3.0
Convexity	0	3.7 ***	3.6 ***
	5.09	4.4	4.4
A-B Plane	-4.6	-4.9	-4.5
	3.67	2.6	2.7
Mandibular Plane	21.9	23.0	23.4
	3.24	4.6	3.9
Y-axis	59.4	60.6	60.8
	3.82	2.2	2.9
Occlusal Plane	9.3	7.1 *	7.7
	3.83	3.0	3.3
Interincisal Angle	135.4	124.9 ***	128.2 ***
	5.76	7.8	7.3
T to Occlusal Plane	14.5	22.9 ***	20.8 ***
	3.42	4.9	5.4
T to Mandibular Plane	1.4	6.8 ***	4.3 *
	3.78	6.2	5.7
$\underline{1}$ to APo	1.7	7.6 ***	7.0 ***
	3.05	2.2	1.7

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

TABLE 6

STEINER ANALYSIS (Comparison between Koreans and Caucasians)

	CAUCASIANS (STEINER)	KOREANS (PARK)	
		MALE	FEMALE
SNA	82	82.1 3.4	80.2*** 3.4
SNB	80	79.5 3.6	77.9 *** 3.5
ANB	2	2.6 * 1.7	2.4 1.9
SND	76	76.6 3.5	75.0 * 3.3
1 to NA (mm)	4	7.2 *** 2.4	6.8 *** 2.0
1 to NA (degree)	22	24.2 * 5.6	22.6 5.1
$\bar{1}$ to NB (mm)	4	7.5 *** 1.6	6.9 *** 1.8
$\bar{1}$ to NB (degree)	25	28.1 *** 4.9	26.7 * 4.9
Po to NB	4	1.9 *** 1.5	1.7 *** 1.0
Interincisal Angle	131	124.9 *** 7.8	128.2 ** 7.3
Occlusal Plane to SN	14	15.9 ** 4.3	17.9 *** 3.9
GoGn to SN	32	32.3 5.7	34.5 *** 4.4
Upper Lip Protrusion	4	0.4 *** 2.1	1.6 *** 1.7
Lower Lip Protrusion	4	-0.7 *** 2.7	-0.2 *** 1.7

TABLE 7

RICKETTS ANALYSIS (Comparison between Koreans and Caucasians)

	CAUCASIANS (RICKETTS)		KOREANS (PARK)	
	MALE	FEMALE	MALE	FEMALE
Molar Relation	-3.0	-3.0	-1.5	-1.6
	3.0	3.0	0.6	1.0
Canine Relation	-2.0	-2.0	-0.6	-1.0
	3.0	3.0	0.6	0.8
Incisor Overjet	2.5	2.5	3.6	3.5
	2.5	2.5	0.9	0.9
Incisor Overbite	2.5	2.5	2.8	2.9
	2.0	2.0	1.3	1.2
Lower Incisor Extrusion	1.25	1.25	2.0	1.6
	2.0	2.0	1.2	1.3
Interincisal Angle	130	130	124.9	128.2
	6.0	6.0	7.8	7.3
Convexity	0.1	0.8	2.1	1.7
	2.0	2.0	2.3	2.2
Lower Face Height	47.0	47.0	46.1	47.6
	4.0	4.0	3.3	2.8
Upper Molar Position	21.0	17.5	19.2	16.9
	3.0	3.0	3.8	3.3
Mandibular Incisor Protrusion	1.0	1.0	4.3 x	3.7 x
	2.3	2.3	2.1	1.7
Maxillary Incisor Protrusion	3.5	3.5	7.6 x	7.0 x
	2.3	2.3	2.2	1.7
Mandibular Incisor Inclination	22.0	22.0	27.0 x	25.7
	4.0	4.0	4.2	3.9
Maxillary Incisor Inclination	28.0	28.0	28.0	26.2
	4.0	4.0	4.9	4.3
Occlusal Plane to Ramus	-4.25	-2.5	0.6 x	-0.3
	3.0	3.0	3.0	3.0

x - One clinical deviation out of the Caucasian norm.
xx - Two clinical deviations out of the Caucasian norm.
xxx - Three clinical deviations out of the Caucasian norm.

TABLE 7 (cont'd)

RICKETTS ANALYSIS	CAUCASIANS (RICKETTS) MALE	FEMALE	KOREANS (PARK) MALE	FEMALE
Occlusal Plane Inclination	27.0 4.0	25.25 4.0	22.5 x 3.1	23.7 3.2
Lip Protrusion	-3.9 2.0	-3.2 2.0	0.7 xx 2.7	0.2 x 1.7
Upper Lip Length	24.0 2.0	24.0 2.0	29.2 xx 2.1	28.3 xx 1.9
Lip Embrasure to Occlusal Plane	-2.56	-3.0	-2.5 2.4	-2.5 2.1
Facial Depth	89.7 3.0	88.15 3.0	89.1 2.4	89.3 3.0
Facial Axis	90 3.5	90 3.5	88.0 3.8	86.6 3.3
Facial Taper	68 3.5	68 3.5	67.5 3.6	66.5 2.8
Mandibular Plane Angle	23.3 4.5	24.35 4.5	23.0 4.6	23.4 3.9
Maxillary Depth	90.0 3.0	90.0 3.0	90.9 2.3	90.8 2.8
Maxillary Height	56.8 3.0	55.4 3.0	60.8 x 3.7	63.3 xx 3.0
Palatal Plane	1.0 3.5	1.0 3.5	-0.5 2.9	0.2 3.1
Cranial Deflection	27.0 3.0	27.0 3.0	28.4 2.5	29.4 2.6
Cranial Length	62.6 2.5	59.8 2.5	61.5 2.7	58.4 2.9
Posterior Facial Height	61.65 3.3	59.2 3.3	73.6 xxx 6.2	69.8 xxx 4.4
Ramus Position	76.0 3.0	76.0 3.0	76.2 2.5	76.4 3.7
Porion Location	-43.5 2.2	-41.75 2.2	-41.2 x 2.1	-39.6 2.5
Mandibular Arc	30.75 4.0	29.0 4.0	32.0 5.0	31.8 3.8
Corpus Length	80.2 2.7	74.6 2.7	75.0 x 4.0	71.3 x 3.7

TABLE 8

VERTICAL ANALYSIS (Comparison between Koreans and Caucasians)

	CAUCASIANS (BIGGERSTAFF) MALE	FEMALE	KOREANS (PARK) MALE		FEMALE	
SE-PNS	54.7	49.6	53.4		50.9	
	4.4	3.3	3.5		3.0	
N-ANS	59.7	55.7	59.1		57.2	
	3.9	2.1	4.2		2.9	
S-Go	88.2	79.1	85.4		80.0	
	5.9	4.3	6.2		4.6	
N-Me	136.8	123.2	130.4	***	126.1	
	7.9	5.1	6.6		4.4	
Ar-Go	54.3	49.6	49.4	***	47.8	
	4.1	3.9	5.6		4.0	
ANS-Me	79.5	69.3	73.0	***	70.4	
	6.2	5.2	4.1		3.0	
UMT ⊥ ANS-PNS	27.9	24.8	25.2	***	24.3	
	3.1	2.2	2.2		1.7	
UIE ⊥ ANS-PNS	33	30.0	30.1	***	30.3	
	3.2	2.9	2.4		2.0	
LMT ⊥ GoI-Me	38	32.6	37.3		35.5	***
	2.8	2.9	2.5		2.0	
LIE ⊥ GoI-Me	48.9	41.5	46.3	***	43.7	***
	3.0	3.1	2.5		2.0	
SE-PNS / N-ANS	0.92	0.89	0.91		0.89	
	0.07	0.06	0.07		0.05	
S-Go / N-Me	0.65	0.64	0.66		0.64	
	0.04	0.02	0.04		0.03	
Ar-Go / ANS-Me	0.68	0.72	0.68		0.68	
	0.04	0.06	0.08		0.06	
UMT ⊥ ANS-PNS / UIE ⊥ ANS-PNS	0.84	0.83	0.84		0.80	
	0.05	0.05	0.07		0.06	
LMT ⊥ GoI-Me / LIE ⊥ GoI-Me	0.78	0.78	0.81	***	0.81	**
	0.03	0.03	0.04		0.04	

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

"AN ATLAS OF CRANIOFACIAL GROWTH"(Riolo and et al. 1979) and the proportional ratios were from Biggerstaff and et al. The student "t" test was used to make a comparison between Koreans and Caucasians. The results are:

Male

1) Anterior Facial Height (P<.01)
2) Lower Posterior Facial Height (P<.01)
3) Lower Anterior Facial Height (P<.01)
4) Upper Molar Height (P<.01)
5) Upper Incisor Height (P<.01)
6) Lower Incisor Height (P<.01)
7) Lower Molar Height/Lower Incisor Height (P<.01)

All the above measurements are smaller in Koreans except the measurement 7.

Female

1) Lower Molar Height (P<.01)
2) Lower Incisor Height (P<.01)
3) Lower Molar Height/Lower Incisor Height (P<.02)

All the above measurements are larger in Koreans

C. KOREAN (this study) VS. KOREAN (other studies)

The comparison was made between the results of this study and previous Korean studies of Ahn (1961), Suh (1967), and Joo (1970). The results of comparisons are seen in Table 9, 10, and 11.

(1) DOWNS ANALYSIS

Ahn's study was used for comparison. The following measurements are significantly different between the results of this study and Ahn's study:

1) Facial Angle, female ($P<.01$): larger in Park's
2) Mandibular Plane Angle, female ($P<.05$): smaller in Park's
3) Y-Axis, male (P .01) and female ($P<.01$): smaller in Park's
4) Occlusal Plane Angle, male ($P<.01$) and female ($P<.01$): smaller in Park's
5) Interincisal Angle, female ($P<.01$): larger in Park's
6) $\overline{1}$ to Occlusal Plane, male ($P<.01$): larger in Park's
7) $\overline{1}$ to GoMe, male ($P<.01$): larger in Park's
8) $\underline{1}$ to A-Po, female ($P<.02$): smaller in Park's

(2) STEINER ANALYSIS

Suh's and Joo's studies were used for comparison. Significant differences were found in the following measurements:

Comparison with Suh's study

1) $\underline{1}$ to NA (degree), female ($P<.01$): smaller in Park's
2) $\overline{1}$ to NB (mm), male ($P<.02$): larger in Park's
3) $\overline{1}$ to NB (degree), male ($P<.02$): larger in Park's
4) Po to NB, female ($P<.01$): smaller in Park's
5) Interincisal Angle, female ($P<.01$): larger in Parks

Comparison with Joo's study

1) SNA, female ($P<.01$): smaller in Park's

2) ANB, male ($P<.02$): smaller in Park's

3) $\overline{1}$ to NB (degree), female ($P<.01$): smaller in Park's

4) GoGn to SN, male ($P<.01$) and female ($P<.05$): smaller in Park's

* There was a consistent tendency to produce a significant difference between the first and second tracings in the following measurements: the mandibular incisor inclination and the palatal plane of the Ricketts analysis, $\overline{1}$ to NB of the Steiner analysis, and the upper posterior facial height and the upper molar height of the Vertical analysis. However, the average values of the differences between the first and second tracings were within 1 mm or degree.

TABLE 9

DOWNS ANALYSIS (Comparison between Park's and Ahn's studies)

	KOREANS (AHN)		KOREANS (PARK)	
	MALE	FEMALE	MALE	FEMALE
Facial Angle	88.68	87.04	89.1	89.3 ***
	4.41	2.54	2.4	3.0
Convexity	5.12	5.44	3.7	3.6
	5.27	5.04	4.4	4.4
A-B Plane	-5.96	-4.92	-4.9	-4.5
	3.04	3.15	2.6	2.7
Mandibular Plane	24.76	26.04	23.0	23.4 *
	9.01	4.14	4.6	3.9
Y-axis	64.40	63.68	60.6 ***	60.8 ***
	6.51	3.08	2.2	2.9
Occlusal Plane	10.84	11.00	7.1 ***	7.7 ***
	3.91	3.62	3.0	3.3
Interincisal Angle	128.88	122.52	124.9	128.2 ***
	12.20	7.39	7.8	7.3
$\overline{I}$ to Occlusal Plane	15.60	20.60	22.9 ***	20.8
	6.05	5.57	4.9	5.4
$\overline{I}$ to Mandibular Plane	2.36	5.20	6.8 ***	4.3
	5.16	5.24	6.2	5.7
$\underline{1}$ to APo	7.80	8.32	7.6	7.0 **
	3.93	2.15	2.2	1.7

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

TABLE 10

STEINER ANALYSIS (Comparison between Park's and Suh's studies)

	KOREANS (SUH)		KOREANS (PARK)	
	MALE	FEMALE	MALE	FEMALE
SNA	80.50 2.83	81.65 3.20	82.1 3.4	80.2 3.4
SNB	78.30 3.25	78.96 2.96	79.5 3.6	77.9 3.5
ANB	2.55 1.45	3.02 1.60	2.6 1.7	2.4 1.9
SND	75.94 3.49	76.23 2.94	76.6 3.5	75.0 3.3
$\underline{1}$ to NA (mm)	6.47 2.25	7.00 2.13	7.2 2.4	6.8 2.0
$\underline{1}$ to NA (degree)	24.96 6.74	27.73 6.12	24.2 5.6	22.6 *** 5.1
$\overline{1}$ to NB (mm)	6.17 2.28	7.19 1.92	7.5 ** 1.6	6.9 1.8
$\overline{1}$ to NB (degree)	24.72 5.48	28.27 3.82	28.1 ** 4.9	26.7 4.9
Po to NB	2.11 2.10	0.04 1.49	1.9 1.5	1.7 *** 1.0
Interincisal Angle	129.10 11.16	122.69 7.19	124.9 7.8	128.2 *** 7.3
Occlusal Plane to SN	17.50 4.53	17.73 3.41	15.9 4.3	17.9 3.9
GoGn to SN	34.40 6.01	34.65 3.42	32.3 5.7	34.5 4.4

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

TABLE 11

STEINER ANALYSIS (Comparison between Park's and Joo's studies)

	KOREANS (JOO)		KOREANS (PARK)	
	MALE	FEMALE	MALE	FEMALE
SNA	82.51	82.61	82.1	80.2 ***
	4.17	3.13	3.4	3.4
SNB	78.81	77.93	79.5	77.9
	4.02	2.01	3.6	3.5
ANB	3.51	1.62	2.6 **	2.4
	1.61	2.34	1.7	1.9
$\underline{1}$ to NA (mm)	7.20	7.19	7.2	6.8
	2.43	3.14	2.4	2.0
$\underline{1}$ to NA (degree)	24.56	24.49	24.2	22.6
	5.61	4.67	5.6	5.1
$\overline{1}$ to NB (mm)	6.65	7.58	7.5	6.9
	2.44	2.04	1.6	1.8
$\overline{1}$ to NB (degree)	27.97	31.59	28.1	26.7 ***
	2.55	4.26	4.9	4.9
Po to NB	2.31	1.84	1.9	1.7
	1.82	2.95	1.5	1.0
Interincisal Angle	126.70	126.73	124.9	128.2
	7.03	5.51	7.8	7.3
GoGn to SN	37.69	36.76	32.3 ***	34.5 *
	4.14	4.97	5.7	4.4

* - Significant at the 5% probability level
** - Significant at the 2% probability level
*** - Significant at the 1% probability level

CHAPTER V

DISCUSSION

A. KOREAN MALE VS. KOREAN FEMALE

Yang (1974), Son (1975), Lee (1979) and others (Ahn, 1961; Chang, 1976; Kang, 1976; Kim, 1970) reported the sexual dimorphism of Koreans using various analyses. Yang (1974) investigated the growth patterns of the skeletal structures of the Korean male and female using five sample groups of different ages (Hellman Dental age IIIA, IIIB, IIIC, IVA and IVC). He reported there was no significant difference between Korean males and Korean females until the Hellman Dental age IIIC, but the growth of the male exceeded that of the female after this stage. Similarly Ricketts showed the sexual dimorphism of Caucasians.

(1) DOWNS ANALYSIS

This study found no significant difference between Korean males and Korean females in all the skeletal and dental measurements of the Downs analysis.

(2) STEINER ANALYSIS

The SNA and SND angles are larger in males than in females. This indicates that the maxilla and mandible are positioned more forward in males than in females in relationship to the S-N plane. Contradictory to this, there are a few previous Korean studies (Chang, 1976; Lee, 1979; Suh, 1967) which showed the opposite findings in these angles. This will

be discussed later in this thesis.

In spite of the difference in these angles between the two groups, there is no significant difference in the ANB angle. This indicates that the relationship between the maxilla and mandible is the same in the two groups.

The occlusal plane to SN and GoGn to SN angles are larger in females than in males. This fact implies that the SN plane of the female is tipped up more than that of males because there is no significant difference in the occlusal plane angle and the mandibular plane angle of the Downs analysis between the two groups.

The measurement of the upper lip protrusion indicates that the upper lip is more protruded in males than in females. This coincides with Son (1975) and Lee (1979).

(3) RICKETTS ANALYSIS

The lower face height and maxillary height are larger in females than in males. This indicates that the proportional ratio of anterior facial height to posterior facial height is larger in females than in males. This corresponds with the finding in the Vertical analysis of this study which shows the proportional ratio S-Go/N-Me is smaller in females than in males. Lee (1978) reported the same finding in his longitudinal cephalometric study. Lee's study showed that the linear measurements of S-Go and S-Ar were larger in males than in females at the ages of seven and eleven.

The cranial length and corpus length are larger in males than in

females. The larger value of the upper molar position in males indicates the maxilla of the male is forward positioned. This enables the maxilla to be in good balance with the longer cranial base and the longer mandible of the male. There have been a number of Korean studies (Joo, 1970; Lee, 1979; Yang, 1974) which showed males exceeded females in most of the linear measurements.

(4) VERTICAL ANALYSIS

The Vertical analysis used in this study consists of two parts, dimensional and proportional analyses. Biggerstaff and et al. (1977) introduced the Vertical analysis based on the data from "An Atlas of Craniofacial Growth" (Riolo and et al. 1979). They stated, "In applying this vertical dimensional analysis, one must be mindful of the limitations of any dimensional analyses. Linear analyses are of value only if factors related to magnification, ethnic groups, age, and sex are considered. Size, obviously, is a factor in the use of absolute direct measurements. The use of ratios is awkward because the necessary computations may be considered by some clinicians to be lengthy, complicated procedures. However, proportional linear analyses, in most instances, overcome the shortcomings of absolute dimensional analyses."

All the skeletal measurements of the dimensional part of the Vertical analysis show a significant difference between Korean males and Korean females except the lower posterior facial height. This suggests that the larger value of the posterior facial height of males is mainly due to the larger upper posterior facial height.

The proportional ratio of the posterior facial height to the anterior facial height is larger in Korean males than in Korean females. This suggests that the mandibular plane angle of females may be larger than that of males. Therefore, it can be speculated that the anterior part of the anterior cranial base of females is tipped up in relationship to the Frankfort horizontal plane because females have the same mandibular plane angle as males. This is seen most clearly from Steiner and Ricketts mandibular plane angle comparison. Yoo (1976) reported the same finding which demonstrated the larger value of the S-Go/N-Me ratio in males than in females.

The larger value of the upper molar height/upper incisor height ratio of males may, in part, contribute to the smaller occlusal plane to S-N angle in males than in females.

B. KOREAN VS. CAUCASIAN

(1) DOWNS ANALYSIS

The marked difference in skeletal patterns between Koreans and Caucasians according to the Downs analysis is the larger angle of convexity of Koreans in both sexes. However, the convexity measurements of Korean males and females are within 1 clinical deviation of the Caucasian norm of Ricketts.

There are differences shown even within the same race, mainly due to the differences resulting from sample selection. Taylor and Hitchcock (1966) introduced "The Alabama analysis" based on samples from

the southern part of the U.S.A. They showed significant differences between the result of their study and other studies of Higley, Bushra, Björk, Downs, Margolis and Riedel in six measurements. The Hypothesis of their investigation was that the ethnic background of Southern white children is different enough from that of children in other sections of the country to warrant a separate cephalometric standard. Similarly, the Downs norms present a more straight profile and a square mandible compared to other studies of Caucasians.

All the dental measurements show significant differences between Koreans and Caucasians. The smaller interincisal angle of Koreans indicates that Koreans have procumbent incisors compared to Caucasians. However, the interincisal angle of Koreans falls within 1 clinical deviation of the Ricketts norm. The lower incisors of Koreans are more labially inclined and the upper incisors of Koreans are more protruded in relationship to the A-Po line than Caucasians.

(2) STEINER ANALYSIS

It is interesting to note that the ANB angle of Korean males is significantly larger than that of Caucasians, while the SNA, SNB, and SND angles show no significant difference between the two groups. On the contrary, Korean females show the same ANB angle as Caucasians, while the SNA, SNB, and SND angles are significantly smaller. Korean females have a retrusive maxilla and mandible in relationship to the cranial base compared to Caucasians.

All the dental measurements clearly demonstrate that the upper and

lower incisors of Koreans are procumbent and protruded compared to Caucasians. The only exception is that the inclination of the upper incisors to the NA plane in Korean females is the same as Caucasians. The larger occlusal plane to S-N plane angle in both sexes of Koreans coincides with the finding of the Vertical analysis of this study which shows the lower molar height/lower incisor height is larger in Koreans than in Caucasians. The upper and lower lips of Koreans are shown to be more protruded in relationship to the esthetic plane than those of Caucasians. This corresponds to all previous Korean studies. This fact may be due to the combined effect of the small nose height and the lack of chin prominence of Koreans compared to Caucasians.

(3) RICKETTS ANALYSIS

Koreans have a similar skeletal pattern to Caucasians. Most of the skeletal measurements of Koreans are within 1 clinical deviation of Ricketts Caucasian norms. Among the skeletal measurements, the corpus length is of particular note. The corpus length of Koreans is smaller than of the Caucasians. In spite of a small value of the corpus length in Koreans, there is no significant difference in the convexity and facial depth between Koreans and Caucasians. One possible explanation for this is that the smaller value of the porion location, larger value of the posterior facial height, and a slightly larger value of the mandibular arc of Koreans counterbalances the smaller corpus length.

The maxillary height is another skeletal measurement which should be discussed. The maxillary height of Koreans is larger than that of

Caucasians in both sexes. Thus, Koreans have a longer anterior facial height than Caucasians because the lower face height is the same in Koreans and Caucasians. However, the Vertical analysis of this study doesn't support this finding, for the measurements of the upper anterior facial height and the ratio upper posterior facial height/upper anterior facial height were not found to be significantly different between the two groups. The significant difference in the cranial length between Koreans and Caucasians may partly contribute to these contradictory findings. Also, the difference in picking the A point can be another explanation.

Similar to previous Korean studies (Ahn, 1961; Chang, 1976; Joo, 1970; Kim, 1970; Lee, 1979; Suh, 1967), this study shows that Koreans have a different dental pattern from Caucasians. The upper and lower incisors are more labially positioned in Koreans than in Caucasians. However, it was found that the inclination of the upper and lower incisors to the A-Po plane is similar to that of Caucasians with the exception of the lower incisor inclination of males. This indicates that the upper and lower incisors of Koreans overall have the same angular relationship to the denture plane (Ricketts A-Po plane) as those of Caucasians.

The occlusal plane of Koreans has a tendency to tilt downward anteriorly especially in males. This may be explained by the finding of the Vertical analysis of this study which shows the proportional ratio of the lower molar height to the lower incisor height is larger in Koreans than in Caucasians. It also suggests that the alveolar bone in the posterior region of the mandible of Koreans is located upward in relationship to the internal structure of the ramus of the mandible (XI) compared to

Caucasians. This has been confirmed by the occlusal plane to ramus measurements which were significantly different between the two groups.

(4) VERTICAL ANALYSIS

There is no significant difference between Korean females and Caucasian females in the Vertical analysis except the lower molar height and lower incisor height, which have been discussed in the Ricketts analysis. Korean males have a shorter anterior facial height than Caucasian males mainly due to a shorter lower anterior facial height. The height of the alveolar bone in the maxilla is smaller in Korean males than in Caucasian males. However, there may not be a significant difference in the upper molar height measurement between the two groups in light of the fact that this is one of the five measurements which the author had a tendency to produce a significant difference between the first and second tracings.

All the measurements of the proportional part of the Vertical analysis show no significant difference except the lower molar height/lower incisor height. Consequently, the vertical relationships between the anterior and posterior skeletal structures of Koreans are similar to those of Caucasians in spite of the size differences.

Again, the higher ratio of the lower molar height to the lower incisor height in Koreans may contribute to a slight tilting of the occlusal plane.

C. KOREAN (This Study) VS. KOREAN (other Studies)

Mitani (Master's thesis, Loyola Univ., 1980) showed that there were

differences among cephalometric studies of the same ethnic group due to differences in sample selection and in methodology. In this study, Downs and Steiner analyses were utilized to compare this study and other Korean studies. Ricketts and Vertical analyses were not available previously with Korean norms.

(1) DOWNS ANALYSIS

Ahn's cephalometric study (1961) was used for comparison. Ahn's study contained five different age groups of 5, 10, 15, 20, and 23 year olds. Cephalometric standards of the twenty-year old group was used for comparison. The measurements of Y-axis and occlusal plane were shown to be significantly different between this study and Ahn's study in both sexes.

In males there are significant differences in $\overline{1}$ to occlusal plane and $\overline{1}$ to Go Me between two samples. This difference indicates that Ahn's sample has more upright lower incisors in the mandibular symphysis. In females significant differences are seen in the facial plane angle and mandibular plane angle. This fact suggests that the female sample of this study shows a square mandible compared to Ahn's study. This study also differs from Ahn's study in the interincisal angle and $\underline{1}$ to APo in females. The small interincisal angle of Ahn's female sample is due to the procumbent upper incisors, because the positions of lower incisors are almost identical in both samples. Interestingly, females have a smaller interincisal angle than males by 6° in Ahn's study, while females have a larger interincisal angle than males in this study. Many Korean studies show a large variation in the interincisal angle.

All these differences may be explained by differences of samples: for example, criteria of sample selection, number of sample etc.

(2) STEINER ANALYSIS

In males, this study differs from Suh's study (1967) in $\overline{1}$ to NB (both linear and angular); and from Joo's study (1970) in ANB and GoGn to SN. The lower incisors of Suh's male sample are shown to be less protruded and procumbent than those of this and Joo's studies. Joo's sample shows more convex profile and steeper mandibular plane than the sample of this study, while this study has the same findings as Suh's.

In females, this study differs statistically from Suh's study in $\underline{1}$ to NA (angular), Po to NB and interincisal angle; and from Joo's study in the SNA, 1 to NB (angular) and GoGn to SN. The interincisal angle of Suh's study is very close to that of Ahn's study. Joo's female sample also shows a steep mandibular plane compared to this and Suh's samples. It is interesting to note that there is no single measurement in which all these three studies differ from each other.

These three studies required normal occlusion for sample selection. The term "normal occlusion" has long been arbitrarily interpreted in cephalometric research. Wylie (Cotton and et al. 1951) discussed the concept of "normal occlusion" and showed different views of "normal occlusion" among investigators. He stated, "Cotton's view of 'normal' is apparently the opposite of that of Downs." Downs (1948) described his cases as having "clinically excellent" occlusion, in recognition of the fact that by some standards of judgment "normal" occlusion has perhaps never existed.

On the contrary, Cotton's (1951) view of "normal" was that "All individuals did not possess clinically excellent occlusions, but all possess more or less normal occlusion." Therefore, different views of "normal occlusions" may, in part, explain the differences between this study and other Korean studies.

CHAPTER VI

SUMMARY AND CONCLUSION

A cephalometric study of eighteen-year old Koreans with acceptable profile and occlusion was carried out by means of the Downs, Steiner, Ricketts, and Vertical analyses. The sample consisted of thirty-five males and forty-five females. Means and standard deviations of Koreans were established. Statistical analyses were performed to compare Korean males to Korean females, Koreans to Caucasians, and the results of this study to previous Korean studies. The following conclusions were drawn from this study:

1) The angulation of the S-N plane in relationship to the Frankfort plane, occlusal plane and mandibular plane is larger in Korean females than in Korean males.
2) The proportional ratio of the anterior facial height/posterior facial height is larger in Korean females than in Korean males.
3) The upper lip of Korean males is more protruded in relationship to the esthetic plane than that of Korean females.
4) The skeletal pattern of Koreans is, in general, similar to that of Caucasians.
5) The facial convexity of Koreans is slightly larger than that of Caucasians.

6) The maxillary and mandibular incisors of Koreans are more protrusive and labially inclined than those of Caucasians.

7) The ratio of the lower molar height/lower incisor height is larger in Koreans than in Caucasians.

8) The upper and lower lips of Koreans are more protruded than those of Caucasians.

9) The sample of this study exhibited a slight brachy-facial tendency in comparison with previous Korean studies.

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Am. J. An. : American Journal of Anatomy
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Angle Orthod.: Angle Orthodontist
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APPROVAL SHEET

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The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science in Oral Biology.

9/8/82
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