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SKULL MORPHOMETRIA OF ANCIENT AND MODERN NOBA SUDANESE POPULATION IN COMPARISON WITH MODERN AND ANCIENT AUSTRIAN POPULATION

Using a new method of anthropometric Scale.

A Comparative anthropometric

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ملخص

هذه دراسة مقارنة للقياسات المورفولوجية، مبنية على مقارنة بين القياسات الرأسية للنوبيين القدماء السودانيين مع أحفادهم الذين يعيشون اليوم من جهة، والسكان القدماء والحديثين النمساويين من جهة أخرى. يتراوح الفارق الزمني بين السكان القدماء والحديثين في كلا البلدين بين 4500-5000 سنة.
تعتمد الطريقة المستخدمة في هذه الدراسة على تطبيق إحدى الطرق المستخدمة على نطاق واسع وهي التحليل الرأسي الذي يستخدم في جراحة تقويم الأسنان والفكين لأغراض التشخيص وتخطيط العلاج والتقييم بعد العلاج. كما أنها تستخدم لأغراض مختلفة من المقارنات وتقييم التطور.
تم تطوير طريقة مصممة خصيصًا للقياس الرأسي من قبل البروفيسور هولمان وتلميذه الدكتور عماد الدين الحاكم كتعديل لطريقة تحليل هولمان الشهيرة لخدمة غرض هذه الدراسة.
تُعد هذه الدراسة الخطوة الأولى في تحديد معيار القياس الرأسي للسكان الأفارقة وهو هدفنا النهائي. هذه المعايير غائبة عن وسائل الإعلام العلمية الدولية، ومعظم المعاهد الطبية في مختلف أنحاء العالم تقوم بتشخيص وعلاج المرضى من أصل أفريقي، بالرجوع إلى المعايير الأوروبية المتاحة.
كلمات مفتاحية: المورفولوجية، القياسات الرأسية، النوبيين القدماء، السودانيين ،النمساويين

Abstract

This is a comparative morph metric Study, built on establishing comparison between the Cephalometrics of Sudanese Ancient Nubian with their descendant living today from one side, and Austrian Ancient and modern population on the other side.Time difference between the ancient and modern population in both countries is between 4500-5000 years.

The method utilized in this study, is based on the application of one of the widely used method The Cephalometric Analysis which is used in Orthodontic and Orthognathic Surgery for purposes of diagnosis, treatment planning, and evaluation after treatment. It is also used for different purposes of comparisons and assessment of development.

Specially designed method of cephalomentrics was developed by Prof Holman and his student Dr Imadeldin AlHakim as modification from his famous Method Holman Analyze to serve the purpose of this study.

This study is the first step in establishing Cephalometrics norm of African population which is our ultimate Goal. These norms are lacking in the International Scientific Media,and most of medical institutes in different parts of the world are diagnosing and treating African origin patients, referring to the available European Norms.

Keywords: Morphology, Cephalometric Measurements, Ancient Nubians, Sudanese, Austrians

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Purpose

1: To standardize a method of Anthropometria for the widely diverse human population groups in the different continents,with scale sensitive measurement based on external genetic manifestation of the human head and face.

2: To improve art of comparison among different human ethnic groups .

3: To establish Norms of Sudanese Noba population living today, as first step towards establishing African populations cephalometric norms.In the same time establishment of cephalometric norms of ancient Noba population (5000 years ago)

4:establishment of cephalometric norms Ancient Austrian population.

5: To undergo comparative study among the four above mentioned groups.

6: To asses effect of time factor in human development.

Materials:

Martials collected for the purpose of this study consist of four groups of population of African and European origins.2 of these groups represent population living today,while the other 2 groups represent ancient population lived round 5000 year ago in Africa and Europe.

The first group consist of 74 lateral cephalographs views taken from Sudanese male and female Noba population living today in Sudan. For the purpose of this study will be referred to this group as Noba group.

The second group consist of 37 Lateral Skull Views of Ancient Sudanese male and female population (Circa: 5000 years old) Originally excavated in Karma town north Sudan. These ancient skull are stored in the museum of institute of anthology of university of Geneva Switzerland. This group will be referred to as Karma group

The third group consist of 40 lateral skull views of Ancient Austrian population (Circa: 5000 years old).

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The fourth group: Austrian population belong to the Caucasian group of population living in Europe and North America. Cephalometric norms introduced by Bolton were utilized to obtain standard Austrian man referred to as Bolton.

All groups are class 1 skeletal and dental relation. From each subject a standard lateral Cephlaographic X-ray was taken from 6 feet distance from object at MA.

Dry skull of the Hianburg Austerian ancient groups male or female as classified by the anthropologist in their institutes in Vienna national historic museum. While Karma Sudanese group Institute of anthropology University of Geneva Switzerland ,were taken with aid of craniostat in institute of anthropology clinic Geneva.the second group in Vienna old general hospital clinic.

The living group Noba standard lateral cephalometric x-ray were taken from each subject male or female at National Rebat Hospital Burri Khartoum.

Exclusion: Only pure races of Noba populations living in kourdofan Regions of Noba mountain were included in this study.Mixed Noba population are excluded.

Ethical issues:

Regulation of Helsinki announcement is followed at the time of data. collection..living subject participating in the research were consented and informed of the x-ray hazards and kept be within the medically accepted doze.

Method

Modified Holman- Hakim method of cephalometric anthropometric analysis.

Result:Both Sudanese group show bimaxillary protrusion profile, they have the same shape and size in all dimension and angles there fore they are genetically related to each other, and belong to the same group.

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The European groups showed straight profile have the same shape, but the modern group showed more than 10 % increase in size than the ancient European group.there fore they are genetically related to each other.

The ancient European group showed same dimension as both Sudanese group but differ in shape, while the modern European group is larger by dimension than the other three groups.This give clear evidence to the effect of environmental changes in human development

Conclusion:This study prove that, Both Sudanese groups are genetically related to each other.In addition that it also prove that, both European groups are genetically related to each other.

Time factor (5000) has showed no effect on the African group.

Increase dimensions of the modern European group by more than 10 % of all dimension show significant effect of time factor effect on human development.possibly explained by the industrialization of the European life.

The method is scale sensitive, and is suitable to group Human population in different continent, according to their genetic manifestation on the external features.

Standard Norms of Cephlometrics of an African population are now available for scientific and medical applications at list for one group namely Sudanese Noba, which will not be much different from the other African groups.

INTRODUCTION

Literature Review

Physical Anthropology began in the dissecting room mainly as a descriptive discipline. Human bodies were at first regarded as what they were:primarily anatomical specimens. But then speculation centered upon differences, rather than resemblances. Were there sex differences? National or ethnic differences? Racial or sub-specific differences. All these inquiries were largely studied with reference to their genetic descriptive features.Aged bones from previous

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centuries, how were they looking like? How do they differ here?or there? From the bones of peoples living today? These questions stirred man to seek new ways to answer,new technique to employ.

How to compare skulls?.Why, do we describe them as we describe the soft parts!. We describe skull types, study supraorbital tori,parietal bones,and so on. But that is not enough for the skull, the pelvis,the femur.What is the answer to objectivity, rather than subjectivity?.How do we do direct,standard communication rather than vague description?.

The answer is: Measurement !.Therefore Osteometry was introduced, of which craniometry is a subdivision,and which is a prelude to somatometry,of which cephalometry is a subdivision.(W. Kruegman 1957).

Cephalometric analysis is a method by which linear and angular relation-ships between the different parts of the face can be obtained, utilizing standard anatomical and created land marks on standard lateral skull radiograph.

Out line form and dimensions of human face has been a concern of man since his existence on earth.Anthropologist since early times of Aristotle's tried to group human population in the five continents into different ethnic categories. The scale for this categorization was mostly based on Geographical distribution, racial,color of the skin, the common language,the common culture, religions and shared traditions,such as ceremonies of marriage,funeral, the music, and way of dancing.

A search fore a more sensitive scale for outlining human face,and therefore amore scientific means of categorization for different ethnic groups has been a main concern of physical Anthropologist through out time. This need has become more louder after antiracist movements, has become of power and reject any classification of human races on the base of their color or race or religion. In addition now a days language and music, is no longer local properties as they are conveyed through the modern media through out the

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earth. Also wide immigration of the individuals and their families is now more easy and quick . This is more influenced by the inter- racial war,as well as the national,and the international geo- political and economical conflict here and there round the world .This has led to wide local in boarder exudation of large masses of population as well as, out border immigration as refugees or seeking for better living status from poor countries to more rich countries.

A lot of artistic carvings and paintings as attempts to simulate human face since old civilization and until to day are found in Museums and galleries every where in the world. Artist from ancient Nubian and ancient Egyptian practiced carving and painting of human face.Of course they follow certain principle for outlining human face.The old Indian shuia has their own criteria for drawing human face with vertical and horizontal lines.

By the sixteenth century the artists Durer and Da Vinci had sketched series of human faces with straight lines joining homologous anatomic structures. By simply modifying some coordinates, Durer had shown the contrast between a convex and a concave profile, or between a broad and narrow face. Santayana, writing on the sense of beauty made a game out of mismatching facial components of the same size and producing disproportionate profiles.

Much later anthropologist invented the craniostat for orienting the dry skull, which improved the art of comparison(Campe). The need for a method for studying serial changes of the successive forms of the living head,required a modification of the craniostat for use with the living individuals that is the standardized radiographic procedure. The first paper on cphalometrics was probably that by pacini in 1922. Credit for standardizing and popularizing the procedure goes to Broadbent whose classic paper of 1931 was received with great interest through orthodontists.Hofrath published in Germany during the same period. Also at the same time Simon system of gnathostomatics, a method for orienting orthodontic casts, was in use. These ideas from

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anthropometrics and gnathostatic naturally evolved and fuse in to a new technology: Radiographic cephalometry..Highly instrument one of the most modern cephalometers in used today. Numerous systems for evaluation of cephalometrics are now in use as well.

Our method of sketching out human face, is based on outlining the true external features of man face as it is manifested by the external representation of his genetic code inherited from his parents.This together with the different influential environmental factors that may come to play a role in molding and modifying his facial development from his birth till adulthood.

This study may be considered as a part of the international effort to study the human population through their true genetic background and the environmental factors influences. It can be considered as the external reflection of the genetic map of these populations ,studied in a simpler and less cost full method.

AIM OF THE STUDY

By using this method of anthropometric cephalometric analysis, it is possible to establish norms for male and female Nobian population. These standard values of the linear and angular relation-ships between the different standard anatomical land marks on the skull can be utilized for different purposes.

In this study our aim will be directed towards establishing "standard cephalometric norms" for Sudanese Nubian population living to day and also for the ancient Nubian (4000 -5000years ago). In the same time we will establish standard norms for ancient Austrian population living in the same period as the ancient Nubian during the Bronze Age (4500-5000 years).

Our aims will be listed as the following:

1. Establishing the standard cephlometric norms for the Sudanese Nubian population living today.
2. Establishing cephlometric norms for the ancient Sudanese Nubians (4000-5000 years).

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3. Establishing cephlometric norms for ancient Austrian (Hainburg) population from the same period as the ancient Sudanese Nubian (Bronze age 4500-5000 years ago)

4. Establishing Cephlometric norms for Sudanese Noba children (6-years age).

By utilizing these "NORMS" it is possible to attain the following objectives:

1: Outlining the features of the head and face of the average modern Nobian man and woman and 6-years age child male or female.

2. Outlining the features of the head and face of the average ancient Nubian man and woman

3. Outlining the features of the head and face of the average ancient Austrian man and woman

4: Anthropological comparisons:-

A: to compare between female and male of the ancient Nubian population and male and female of the same population living today.

B: Differentiation between male and female skulls, knowing the standard readings for each group it may possible to assert sex of an unknown skull of the same group.??!!!!!

C: Comparing the Norms of the ancient Nubian populations to that of the ancient Austrian (Hainburg man).

D: Comparing the Norms of the Sudanese modern Nubian to that of the modem Austrian

E: Comparing between the Norms of modem and ancient Sudanese population on one side, and modern and ancient Austrian population on the other side.

F: Comparing between Noba population of the ancient time and the neighboring population of the same time namely ancient Egyptian and Kenyan. (Nearest neighbor).

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5. Diagnosing abnormality or deformity of a single or group of skulls from the same group. This may give possibility of calculating incidence of or facial defects among this group.

6.For forensic medicine purpose,its help identification of criminally suspected killed bodies by analyzing their head or skull X-ray.In this way it is possible specify to which group of population he may belong.

7. As reference averages for diagnosis and treatment planning of dento-facial anomalies of these populations.

8. Assessment of the evolutional changes that may have taken place in the size and shape of the human skull through time factor.

9. Study and assessment of the Ancient fossils and skeletal remains and identifying their similarity or dissimilarity with homosapien modern man.

10. as academic and research reference.

MATERIALS

The materials used for our study comprise of four groups of two different populations, Namely Sudanese and Austrian. Two ancient groups and two modern groups with 4000-5000 years time distance between them. The first group is collections of ancient skulls from Kerma region located in the north of Sudan. We will refer to this group as KERMA in this study. They are collected in the last ten years and well preserved in the department of anthropology of the university of Geneva Switzerland. This group is composed of 37 skulls, of this 11 are males,7 are females the sex of the rest 21 is not specified, age range between 17 – 63,average 44.9, SD 16.96 .The second group is composed of 74 individuals of Noba tribe from Noba mountain origin (kurdufan west of Sudan),38 are males 36are females with age range between 18- 47, average 26 years old with SD 5.8. . This group will be referred to as NOBA.

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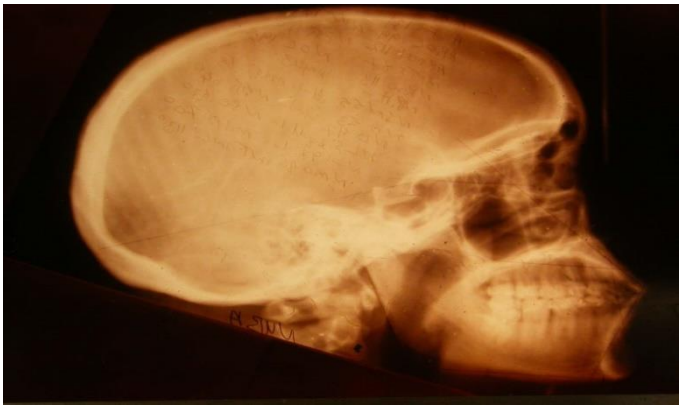

Fig: 1 Noba (Modern Sudanese)

The 3rd group is the ancient Austrian skulls from the Bronze Age (4500-5000 years ago).40 skulls was the total number, by age all skulls are adults above 18, sex is not specified. They were collected from Hainburg in Lower Austria, and well preserved in the Natural History Museum in Vienna, and this group will be referred to as HAINBURG.

The last group are the Austrian people living today. As this group is one of the European Caucasian population, the standard cephalometric Norms of Caucasian already established by Bolton-Broadbent work will be utilized.This group will be referred to as BOLTON.According to Angle classification, All of the cases of all of these groups are Angle class 1 skeletal and molar relation with mild degrees of malocclusion ranging between anterior teeth irregularity, open bite,deep bite and cross bite.

Kerma Group

History

For historical comment on this group we will borrow the abstract word of Dr. Christian Simon's article about the same group(Kerma) namely - Les Se'pultures De Kerma Sudan (3000-1550 B.C.): Apport De L'Anthropologie Published in ARCHE'O-NIL Bulletin of the society of the study of the culture of the prepharaonic of the Nile Valley. October. 1992.

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The sepulture of Kerma (SUDAN) (3000-1500 B.C.):

The contribution of the Anthropology:

About 200 graves have been excavated by the archeological mission of the University of Geneva at Kerma. The paleodemographic analysis shows a relatively high mortality characterized by a low surviving rate (eO022-23 years). The none adult skeleton represent 32% of the population. Mortality increase by the presence of human sacrifices, especially adolescents between 15 and 19. Morphologic analysis shows a heterogeneous population with some groupment of persons with identical characteristics. The human type of populations remains the same all over the period. The comparison of Kerma population with those of the Nile Valley (Egypt, Noba) and Africa demonstrates that it makes part of the NUBIAN population. There are affinities with the Egyptian population, but very few with the African ones (except the Ethiopian, which is quite similar to the Nubian). The mutilation of tooth -a well attested customs among Africans - exists in the Kerma culture. At Kerma 6-7 % of persons have an ablation of the upper and lower incisors. The practice itself shows the influence of the south on Kerma. The human sacrifice is an important ritual. First appear in the old Kerma period it becomes more important in the classical period. There are several persons in a sacrifice grave (men women, children). They represent the same population as other graves though there is no possibility, until now to discover a family relation-ship among them.

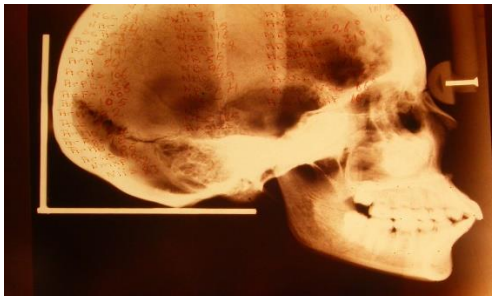

Fig: 2 Kerma man (Ancient Sudanese 5000 old)

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2- Noba Group

The second group represent Noba population which are Sudanese citizens usually live west kordofan estate.Most of them are concentrated in the Noba mountain in this estate.Their main town is Kadogli.These groups are called Noba mountain in the Sudanese culture and writings. Another group called Nilotic Noba are widely extended group of population from Wadi halfa far north of Sudan to Dongola town in the North.Physical Features of both group show some differences,but culturally in term of languages,tradition, religion and many social ceremonies they show great similarities. There fore hot debates and discussion were since long arising regarding origin and relationship between both groups.

Noba in this name were recognized in the historical texts since the third century A.C.They were mentioned as Noba tribes in the writings of Greek scholars several times (strabo).They were mentioned as a tribe living in scattered groups along the west bank of Nile river till Karima town in the north of Sudan .They were under ruling of the meroie Kingdom.Most of the historical writings agree that both groups Noba and Meroie populations are related to each other,but the question is:Noba are they originally existing in the Nile valley and for some reason following Axom (Ethiopian)invasion and destruction of Meroietic Kingdom(Arkel),

(Murdock), they have to migrate to Noba mountain.Or is it the other way round, vise versa?. I.e were they were originally inhabitants of Noba Mountain.They make their way gradually along the history to the Nile valley as a natural migration from Saha region to the source of water (Reisner and Helson). Or This population live in north and south west and east of Sudan as population of one ancient kingdom.The striking resemblance of cultures,languages, tradtions and music support this third theory (Prof Ahmed AlHakim,, Prof Ante Diob .

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Nilotic origin theory adopted by group of scientist among them was (Mcmillan 1923).They mention that Noba Kourdofan – Darfour are descending from the Nilotic Noba.Herzeug gave more details that they came to Kouordofan –Darfour from the Nile Valley round 320 A C (Trigor 1966).
These theories are still subject of debate among anthropologists.

3- Hainburg group

History of Hainburg group

The story of discovering this historical group will be reported with reference to the study done under the title:

The Skulls of the Bronze Age Cemetery of Hainburg, Lower Austria
By: WILHELM EGARTER

The 253 skeleton were dug up in 12 years time (1927-1939) in three periods. The first period were carried out under the effort of Obstl. F.Muhlhofer with the contract and support of the Austrian Natural History Museum, started 1n 1927 till summer of 1928 1-16 skeletons. This grave was there after historical studied by E.Beninger and anthropologically interpreted by E.Geyer and published in 1930. The second excavation were done in the time from 1930-1933 by a number of workers and also under the support of the Natural historic Museum of Austria in Vienna 17-146 skeletons. The last excavations were done by the personal efforts of E Beninger and the cooperation of Ä.Kloiber 147-253 skeletons.

The Anthropologic analysis revealed that all the grave are related together and belong to the same culture, the Hainburg bronze age. The Anthropologic analysis of Geyer 1930 showed that beside the Langschmalköpfigen,and may be autochthehonen population still two other racial elements lived in Hainburg. They are brachykran-planoccipital short head, can be seminaries with the types of the western tribes of the Neolithischen Glockenbech people. They can ready be identified as types of middle-Europe man of the Bronze Age.

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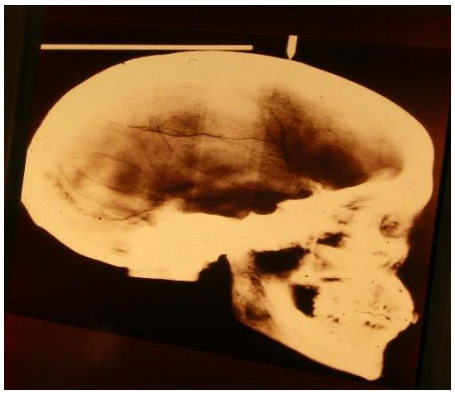

Fig: 3 Hainburg Man (Ancient Austrian 5000)

Bolton Group

This group represent modern European and American Caucasians.The cephalometric norms of this group were established by the work of Bolton Broadbent 1931).These norms were published and Popularized as Bolton Standards.they are used as references for diagnosis and treatment plan for denot-facial anomalies.

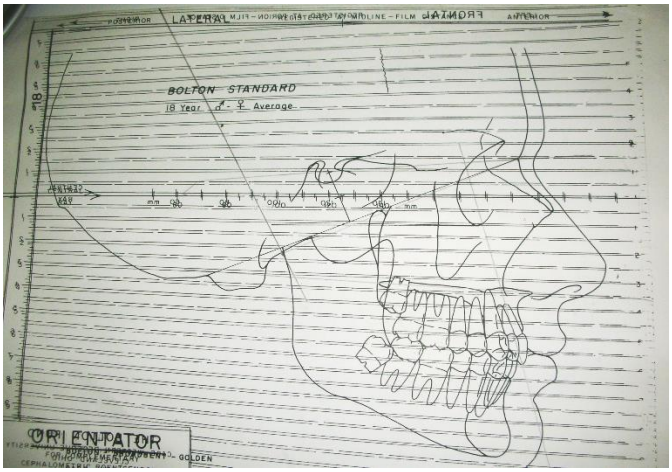

Fig.4: Bolton standard for average Caucasian man 18 years old.

From each of these groups a standard lateral cephalometric radiograph was taken.

The modern Sudanese group was radiogrphged in the department of radiology in the police central hospital in Khartoum Sudan. The skulls of first group, the ancient skulls from kerma region were radiographed in the department of dental radiology ; Medizine Dentaire University of Geneva.The ancient

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Austrian skull was radiographed in the Institute of Anthropology of the Natural History Museum in Vienna.

METHOD

Since the introduction of cephalometrics by Broadbent in 1931, a number of different cephalometric analyses have been devised. of the many analyses proposed are those of Downs (48, 52, 56) Steiner (53, 59, 60) Tweeds,53 54) and Ricketts, (60, Ricketts et al, 72) Ricketts ,81) have probably gained the widest acceptance. Jacobson (75, 76) and analysis of Jarabak (72). Sassouni 8 69, 70) and Enlow et al, 69.

Modified Holman-Hakim Analysis is the method which we used in our present study.It is a modification from the well known **Holman analyze** method of cephalometric analysis. The method was modified to face the need for this In this method linear measurement rather than angular are used in this method. In the same time this method do not depend on planes as prof Holman believed that planes are subjected to developmental changes and are not constantly stable and subjected to variability. Instead the method is based on tow points point Ar (Articulare of Bjork) as the main point, and point N (Nasion) as a helping point. The method if formulated on the geometrical fact which is: It is possible to locate the position of a certain point, if we have the linear distances between this point and two other defined points. A caliber is to be used fore this purpose to carryout the geometrical drawing.

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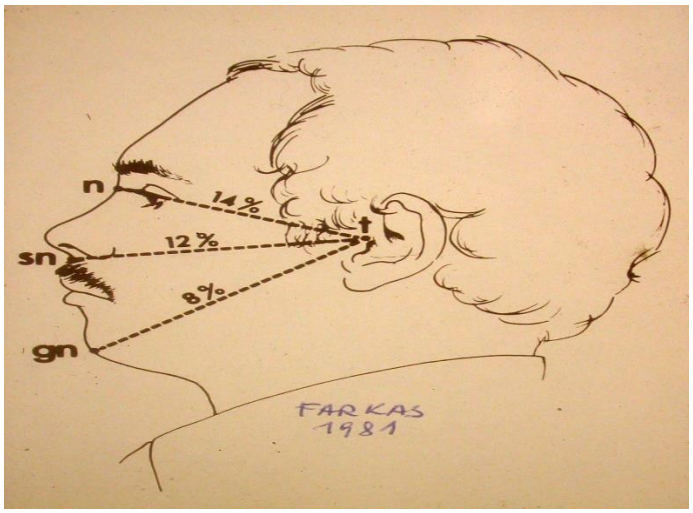

Fig 5:Direct measurement from Point Ar (Turuk)

Bolton - Broadbent standards for Caucasians, are the best standards available, Moyer has put Orthognathic surgery standards called Masochist standards. It is difficult to decide what to do with standard distances and angles. Distances are can be variable but angle are always the same i.e. if the line is increased or decreased the angle remains the same. The best angles are those of Downs SNA, SNB, and ANB. ANB is 4° for Caucasian adults. Maxillary plane is delineated by the two points anterior nasal spine (ANS) and the posterior nasal spine (PNS), Madibular plane is delineated by the tangential line from point menton to point inssusura premasseterica, the angle between mandibular and maxillary plane equal 20 °. The occlusal plane if drawn between them makes 8° with the maxillary plane. Frankfurt horizontal plane between Lower orbitale and porion (most superior point in external acoustic meatus makes 6° with the plane line between NA-Se (nearly parallel). 2-3 degrees exist if the line from N pass through Sella centre Sc instead of sella entrance Se. If a vertical line from the line Se-N is drawn in front of the face to cut all these levels it will make with the maxillary plane 58°, with the occlusal plane 75°, with the mandibular plane 65°. Bjork mentioned that, the external acoustic meatus is not always easily detected in the x-ray, so he suggested usage of Articulare at the meeting of the two shadows of the skull base with that of the mandibular neck. This

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creates the angles N Se Ar, Se Ar Go, and Ar Go Me with the sum of 396 °. Gonial angle =117 °, it is not constant it become smaller as the child grow up to be constant at adult-hood, cranial base angle (Se angle) equal to 127. Basion the most anterior point at the end of clivus bone, in x-ray is 21 mm above the dense of first cervical vertebra can be viewed in good x-rays.

Broadbent used a notch behind the mastoid process and draw a line between it and the Nasion, then he draw a perpendicular line from point Sella down up to this line (N-Mastoid notch line), and called it centre of the face. He uses this centre in his study. He studied changes during development in children to ass's aberration at different ages. Rickette said that the centre of facial growth exist at the foramen rotandum. After all growth centres is independent of point, one should know what is happening rather than points (K.Hollmann).

Occlusal plane make 75° with vertical plane and 35° and 35° with N-Ar plane (Pirker analysis). The facial plane (N-Pogonion) makes 92° angle with the occlusal plane (from Rickettes). Occlusal plane pass through Ar and teeth contact.

Teeth can be oriented to Skull, Maxilla or, Mandible. Upper teeth create angle equal to 105° with the Maxillary plane (ANS-PNS), against anterior skull base 104- 107°. The inferior incisor stands 90° to mandibular plane.

The tangential line between pogonion (Pg) and Gonion equal to 7cm, to upper most point of condyle = 5 cm. The distance from Na to Se + 3 = The distance from Gonion to Pogonion = 7 cm. Distance from point A to posterior point of Maxilla (Ptx - Mtx) = 2/3 rds of the mandibular plane length (Gnathion - Gonion). Ipsylon Axis passes from Se to Gnathion artificial (Gn).

Soft tissues

Vertically the distance between between Nasion cutaneuos (Ns) and Gnathion cutaneuos can be divided into three thirds. The first third start from hair meeting to Nc, the second from Nc to sub-nasal (Sn) the last one Sn to

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Gnathion cutaneuos, equal 1/3 rd + 10% I. e. 10 % more than any of the first two thirds. The last third is further divided into thirds. The first one from Sn to lip meeting point, the second to a point just inferior to the lower lip, the last to pogonion cutaneuos.

Merrifield line: This is the soft tissue line of Merrifield. It runs through the soft tissue points, Nc, Sn, Superior lip, Inferior lip, to pogonion cutaneuos. This line cross ANS - PNS line to make an angle of 80 °, and also angle of 80° with Se - N line.

Children differ from adults in two major things:

1. Gonion angle is more flat (obtuse) in children.
2. Relation -ship of lower jaw to upper jaw U / L is not 7 to 8 , but it is 10 -10.

Angle of Merrifield line is more acute in children (less than 80°).

To sort out Normal from abnormal face, we draw the normal face, and then lay the face to be assessed on it to see the differences generally speaking.

One of the primary procedures in analyzing dent facial relation-ship is the production of high-quality Cephalommetric radiographs. A cephalometer properly oriented to an x-ray source and a well trained cephalometrist is the requirement for such views. Since the introduction of cephalometrics by Broadbent in 1931 many types of Cephalometers are on the market and in use in the dental offices today.

The head, or skull is positioned on the instrument facing laterally in case of lateral view with the left side towards the x-ray; source eyes are looking straight forward towards a fixed point at a distance in front of the person. Frankfurt horizontal line (A line joining a point found at the middle of the inferior boarder of the eye (orbitale) to (barion) a point found at the upper boarder of the acoustic meatus); is positioned parallel to the floor. Ear rods are inserted in the external acoustic meatus; A rubber sleeves are fixed to the rod end for protection of the ear. Mid line rod is situated in the midline of the face

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with the plastic end situated on the upper root of the nose. This line is oriented to the midline of the instrument. Right angle metal rod 100 x 100 mm long is fixed to the head a long the mid sagital suture down to the nose in the living individuals ;and on the middle of the occipital bone down to the posterior boarder of the foramen magnum in case of the dry skulls. This rod is for purpose of calculating magnification which results usually after radiography and there after correct length is calculated out.

The instrument and the x-ray source are positioned in a fixed relation to each other. The anode target of the x-ray source is placed at 1, 5 m from the cephalometer's centre. To Broadbent Distance is 5 feets (1.524m) in USA now are using 1.6 distance with less magnification, for our cephlomeric radiographs distance of 2.5m were used with very little magnification results. The cross line indicators of the x-ray source are positioned with the bisection point situated in the external acoustic meatus. Exposures with 84 kV, 46 mamp are used. Films were developed and labeled in names of individuals or Skull number.

Magnification is calculated from the following equation:

Correct length/Apparent length = 100 (correct length of the Rod)/ apparent length of the rod

Then: C (correct length) = (Apparent length x 100(correct length of the rod))/ Apparent length of the rod.

Equipments required for the analysis:

An illuminated board with either opal surface or with clear glass backed by milk white defusing plastic is required as tracing surface. A sharp pointed H or 2H drawing pencil is recommended. A triangle, ruler and a caliber is also needed. Computer with printer set is also of great benefit.

Drawing can be directly on the x-ray; this is even more accurate but may damage the radiograph or make it dirty or the x-rays may be indirectly traced on tracing papers. The results are then introduced into the computer for

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obtaining and analyzing the results. Pre-programmed Computer graphic with a programmed like Gamma Computer aided Diagnosis System (CADIAS) can also be used. This is more accurate and less time consuming.

We used two techniques in our work:

1.The manual technique

This is mainly handwork technique using the normal measurement-tools like the ruler, calipers, triangles and, pencils the results are later on introduced in the computer as input for statistical analysis.

With these methods Noba group and Kerma group are analyzed for the first time. Hakim2 is the name of the file in the dbase programmed of the computer for group Noba; Kerma is the file name for Kerma group.

2. The computer method using GAMMA Dental Software program, the computer aided diagnosis system CADIAS.

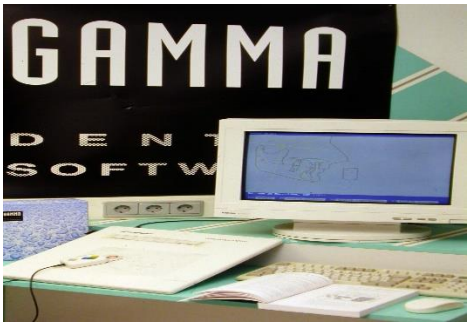

Fig: 6: Gamma Dental Software

Using these methods all groups are analyzed namely Noba and Kerma (For the second time), Hainburg, and Sudan children group (6 years age).

Manual Method

The face can be divided into a simplified group of fundamental units. Each of these areas is understood to be a combination of skeletal elements or anatomical parts.

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The division of the face depicted separates the cranial base (first part) from the midface (second part) or the maxilla. The third part is the mandible and the last part represents the soft tissue profile.

Linear and angular relation-ships between these four units are to be established to produce workable standards or yardsticks that could be widely applied for all ages for analysis of individual variations, variation in the same group of population, and for comparison between different groups of populations. Standard points marked on the cephalometric radiograph are defined using the illuminated board.

Utilizing these linear and angular measurements, the above mentioned four units can be related to each other. We can relate:

1. The maxilla to the skull base.
2. The mandible to the skull base.
3. Maxilla to the mandible.
4. Teeth to teeth, teeth to maxilla, teeth to mandible and teeth to the cranial base.

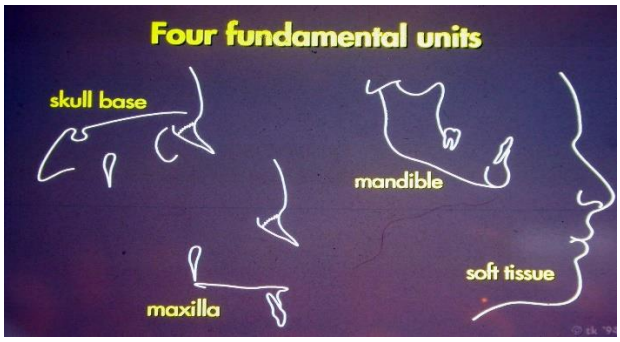

Fig 7:Anatomic structures to be traced:

1. The cranial base

1. Point "N"(Nasion), identified at the junction between nasal and frontal bone. It is an anatomical point.

2. Bo (Basion): The most anterior point of foramen magnum at the end of clevus bone.

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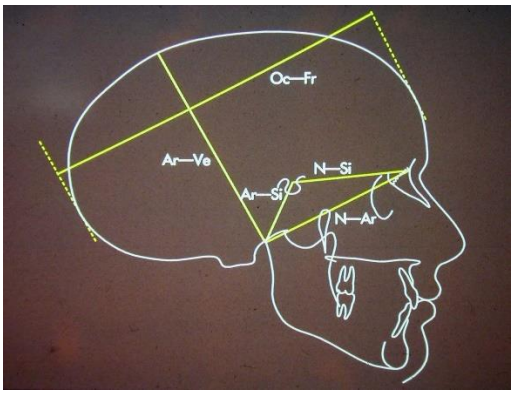

Fig 8: Neurocranium land marks Oc, Fr, Ve.

These two points (1&2) arbitrarily measure the cranial base.

3. Point "Bo" most upper point exists on the external acoustic meatus.

4. Fr (frontale) most anterior outline of the skull at a line tangential to the skull in the same at right angle to the line Ar-N.

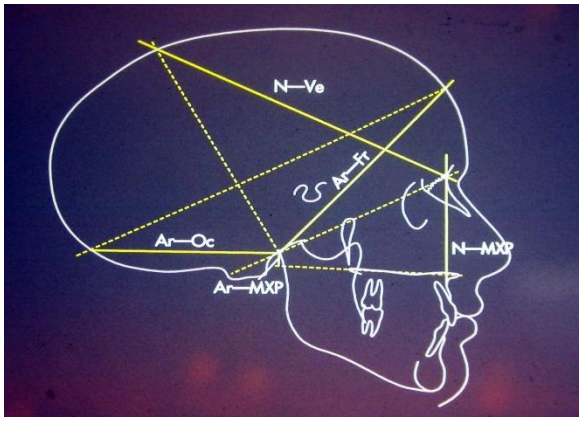

Fig 9: Skull base land marks Ve,Oc, and Fr in Relation to point Ar and point N.

5. Oc (ocipitale) most posterior point identified on the skull at a line tangential to the skull in the same time right angle to the line Ar.N

6. Ve (vertex) most upper point exists on the skull identified at a line right angle to the line Ar-N at point Ar.

Points Fr, oc, and ve are produced through line drawings

7. Se Sella Entrance. At the mid of the entrance to sella turcica determined by visual inspection.

11. Mid face (Maxilla).

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1. PNS (Posterior nasal spine).

2. ANS (Anterior nasal spine).

PNS &ANS are both anatomical points.

3. A the deepest midline point on the maxillary alveolus between the ANS and the maxillary alveolar crest.

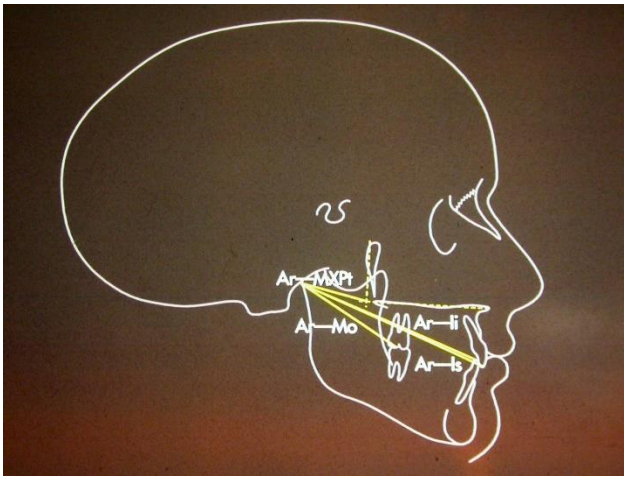

Fig 10: Ar in relation to Maxilla and teeth (Horizontal relation)

4 ptx, a point at the junction of a line passing through foramen rotendum with the maxillary plane at a right angle.

5 Mxp at the right angle of line passing through N at the maxillary plane.

Ptx and mxp are produced points.

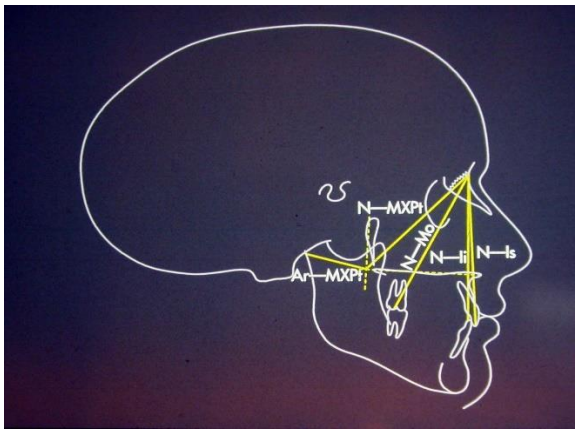

Fig 11: Point N relations to Maxilla and teeth.

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6. Or orbitale. The most inferior point on the orbital margin (Anatomic)

7. Is, Incisive superior. Mid point at edge of the upper anterior tooth.

8. Mo molar: Point where the mesio buccal cusp of upper first molar meets the lower molar.

111. Mandible

1. Ar, Articulare: The intersection of the posterior boarder of the ramus with the temporal bone.It is a. axial point in our method together with point N.

2. Go Gonion: Is determined by bisecting the angle formed tangent to the lower and posterior boarders of the mandible. It is the point where the bisector cuts the angle of the mandible.

3.Me Menton: The most inferior point on the lower boarder of the bony symphysis.

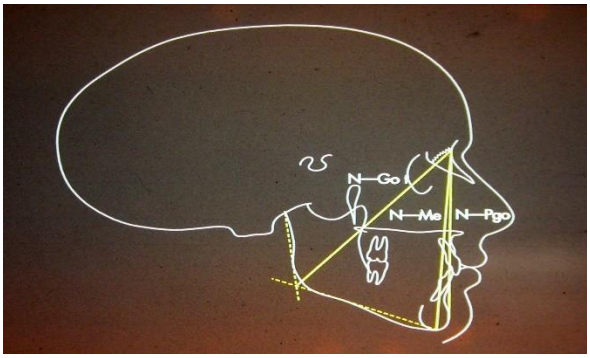

Fig 12:Point N relations to the mandible

4. Gn: Gnathion the most anterior inferior point on the contour of the bony chin symphysis located by the bisector of the N-Pg and mandibular planes.

5. Pg Pogonion: The most anterior point on the bony syphysis.

6. II Incisive inferior at the mid of the incisal edge of lower anterior central tooth.

7. Point B: The deepest midline point between the mandibular alveolar crest and pogonion.

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1V. Soft Tissue

1. Nc nasion cutaneous: On the skin at point N
2. Rh most anterior inferior point at the nasal tip.
3. Sn: Meeting point of philtrum and collumella of the nose.

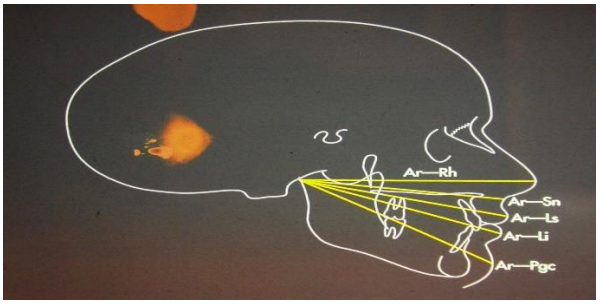

Fig 13: Soft tissue relation to point Ar

4. Ls Lip superior.
5. Li lip inferior.
6. Mc:Menton cutaneous.

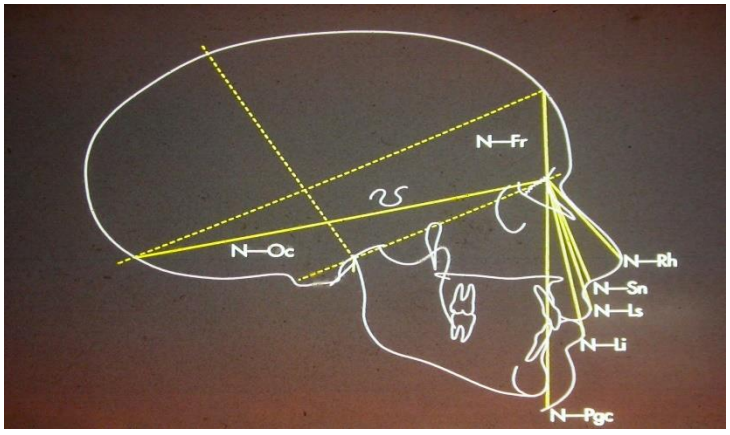

Fig 14:Soft tissue relation to point N

After marking these points on the cephalometric radiographs linear and angular relations can be obtained. Of course the soft tissue part is naturally missing in the dry skull. Utilizing points Ar and point N as axial points linear distance between each of these points and every one of the other point is determined using a calibrated ruler in terms of mm. Standard angles are also measured.

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1. Linear relation -ships.,,
2. Angular relation-ships.

X-ray Drawing

This method depends on two points "Ar" and "N" as axial points. There is linear relation between each of these two points and every one of remaining above mentioned points, i.e. every point is represented in two lines e.g. Me is represented in Ar-Me line and in N-Me line. To locate this point, using the results obtained from the radiograph a caliber is fixed on point Ar at a distance Ar-Me to draw an arch, and then fixed on N at the distance N-Me to draw another arch. Where the two arches intersect point Me is identified.

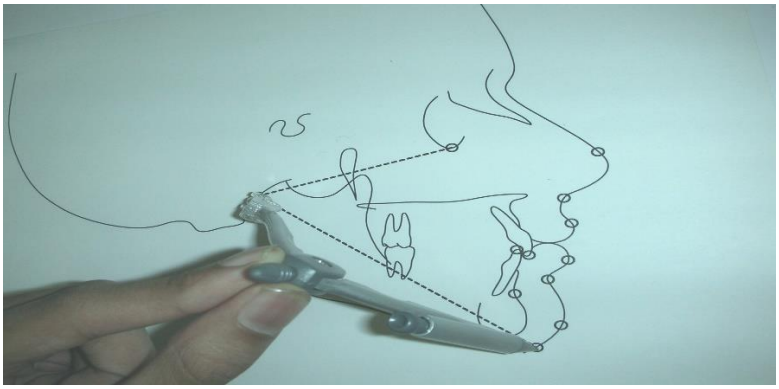

Fig 15 a: Technique of points locations (point Me Cutaneous) using the caliper:
Step 1: from point Ar

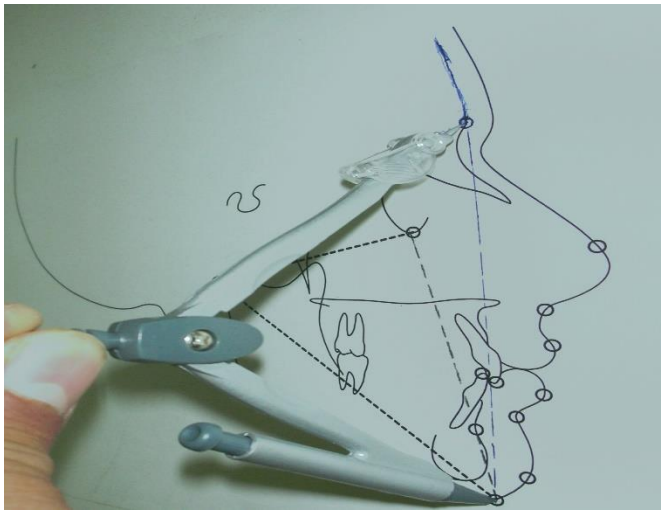

Fig 15 b: Step 2: from point N

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* The line N-Se is first drawn.

* Then the line N-Ar

* A line from N to piont A, and from N to B will create the angles SeNA, SeNB and ANB.

*Using a ruler fixed on the line N-Ar and a triangle moved in contact and at a right angle to the ruler to draw a tangential line touching the front of the skull. Where the line touched the skull at the most outer point, this is point Fr (Frontale). The same procedure on the posterior side will identify point Oc (Ocipitale).

* Fixing the triangle at point Ar right angle to the line N-Ar, if a line is extended from Ar vertically upward to cross the upper boarder of the skull point Ve (Vertex) is determined.

*A line extended downward from point Ar to touch the vertical ramus of the mandible at point pre gonial, will intersect with the line extended from point Me tangential to the lower boarder of the mandible, at the point "postgonial",that exist the depression created by the posterior boarder of Masseter muscle in the inferior boarder of the mandible. This meeting point is point Go (gonial).The angle Ar Go Me, or Gonial angle is now determined.

* A vertical line falling from the centre of foramen rotendum right angle to the maxillary plane identify point "ptx" at the meeting point between the two lines.

* Another perpendicular line from point "N" to maxillary plane, will identify point "mxp", where the to line cross each other.

* Extension of mandibular plane to intersect with maxillary plane, determines the angle between them,(mdp.mxp angle), and extension of the same plane to intersect with N-se line determine the angle between them (mdpNse).The two angles are nearly equal, i.e maxillary plane is nearly parallel to N-se line.

*A line through the axis of the upper central incisor (from point is), extended upward, will cross the maxillary plane at the angle upper inc. axis/mxp, and the

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line N-Ar at the angle upper Inc. A/N-Ar, and the line N-Se at the angle upper Inc. A /N-Se.

*A line through the axis of the lower incisor downward will cross the mandibular plane at the angle lower inc. A/Mdp.

The axis of both upper and lower teeth intersects at the angle incisal intersection angle.

2. Computer Techniques

Gamma Computer Aided Diagnosis System (CADIAS)

This program was developed by GAMMA medizinsiche wissenschaftliche Fortbildungs. m.b.H. under the direct supervision of Prof. Slavicek R. and direction of his Son Christian Slavicek the generous cooperation of whom enabled us to carry out this work and again to him we are very grateful.

For our analysis an I.P.M or I.P.M compatible computer system with a colored monitor, and a digitizer (a machine that registers the position of a pin or a loop on its surface and sends the coordinates to the computer, the digitizer can only transmit the position given by the user) the illuminated board were required. Illuminated digitizers make possible direct x-ray input digitization, while tracing the x-ray will be required In case of using digitizer without light. In this study we have to use direct tracing technique.to exclude error land marks and line identification were made first directly on the x-ray using a normal illuminated board later the land marks and lines were traced in the tracing paper, then input from the tracing paper to the computer were made using the digitizer. In this way measurements were made from the x-ray and not from the tracing to avoid errors usually encountered when making measurements from tracing.

In the computer programmed our standard model were programmed using the same individual point and landmarks and the same linear and angular relation-ships as in the manual method.

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Individualized points and landmarks of our study are added using cadias landmark and points editors. Using these points and landmarks, a standard tracing model was constructed.

Individualized values and norms were defined using cadias value editor. Here linear and angular relation-ships were defined and verbally described. The average reference with the standard deviation was also defined in our case Bolton standards were taken as reference.

The name Holman was given to our analysis, for numerical value analysis, and also for tracing form.

Data Input

After connecting the Digitizer to the computer and excess to the programmed were established for new data input. The option digitize were choice.

Lateral x-rays were digitized. First points and landmarks are digitized in the following sequence as is given by the computer on the standard model. Then anatomical contours of the mandible, maxilla and soft tissue profile are contoured in the flowing sequence as ordered by the computer. Then necessary adjustment and correction can be easily done. Then input data are stored with the necessary comments, the resulting magnification, and angle classification both left and right sides (which is class 1 for all of our cases).

After this the individual analysis of each x-ray can be checked analysis of restored data in the proper menu. Numerical analysis, as well as tracing form can be visualized to check the input, and continue to the next if it is perfect or repeat it again.

Using this scale and the obtained mean value for each group, it was possible to sketch out the standard man of each group of the studied populations

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Table: Same Above table repeated in table

The table below: Comparing the mean value of each group with the other three groups

Serial No.	Variable	Noba	Kerma	Hainburg	Bolton
1	N-SE	67	67	67	73
2	N-AR	90	90	92	98
3	Se-AR	36	36	37	40
4	AR-VE	133	127	131	140
5	Fr-OC	183	175	178	196
6	Ar-Rh	106.2	-	-	122
7	Ar-Sn	95.9	-	-	106
8	Ar-Ls	112.1	-	-	113
9	Ar-A	87.3	87	83.5	90
10	Ar-Is	100	97	92	100
11	Ar-Ptx	38.5	36	35	36
12	Ar-Li	107	-	-	112
13	Ar-B	98.9	93	92	102
14	Ar-Ii	97	93	88	96
15	Ar-Mo	76	65	61	68
16	Ar-Pgo	105.9	106	105	114
17	Ar-GO	45.94	45	47	50
18	N-Mxp	46.72	47	49	55
19	N-Is	78.94	78	77	84
20	N-Ii	76.4	78	77	82
21	N-Me	114.4	116	118	121
22	N-Go	114.3	114	114.5	122.5
23	ANSe angle	87.39	83	81	87
24	ANB angle	4.2	4.6	3.5	2.7
25	MDP/MXP angle	27.5	26	25	21
26	MDP/NSe angle	28.4	30.5	30	25
27	Me Go Ar angle	116.4	115	123	120
28	NA	57.1	54.3	53.2	60
29	NB	92	94.7	92.6	100
30	Ar-Me	102	105	107	112

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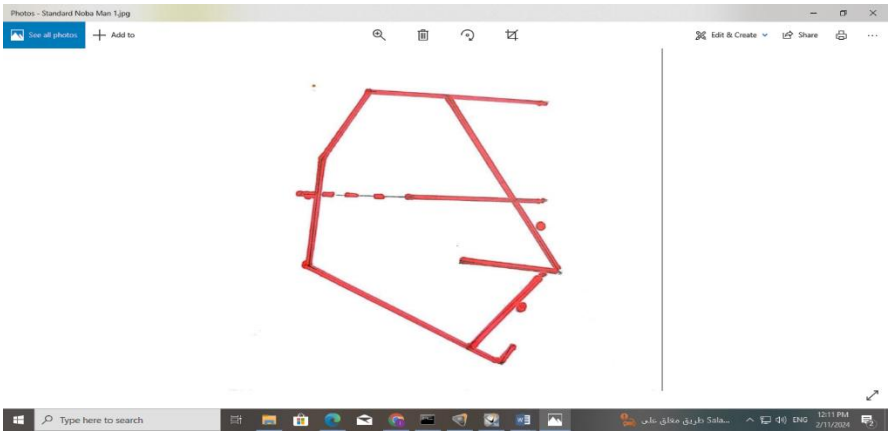
31	Ar-Mxp	14	12	9	10
32	Ar-Fr	113	112	125	119
33	Ar-Oc	100	95	88	98
34	N-Pg	107	103	113	116
35	N-Rh	53	-	-	55
36	Sn - N	52	-	-	62
37	N-Ls	77	-	-	75
38	N-Li	93	-	-	90
39	N-Oc	178	172	169	180
40	N- Fr	45	49	47	50
41	N- Ve	159	152	159	175
42	N-Mo	76	79	77	86
43	V-Ptx	68	68	70	75
44	Is axis/Mxp angle	117	116	107	108
45	Is axis/N-Ar	84	86	98	83
46	Is axis /N-Si	119	110	104	100
47	Li/MDP	78.5	67	95	97
48	Int.Incisal angle	117	110.8	131.4	137

Standard Noba Man



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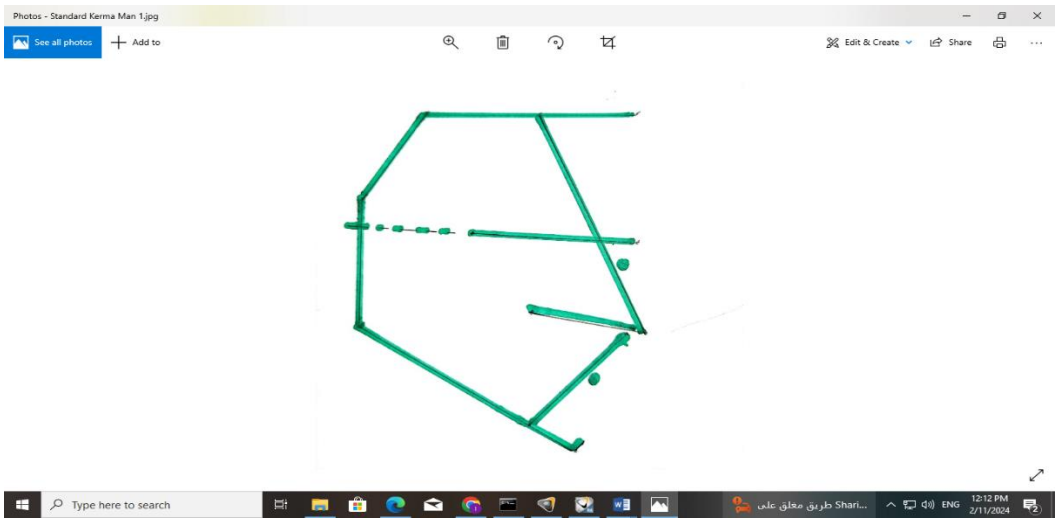
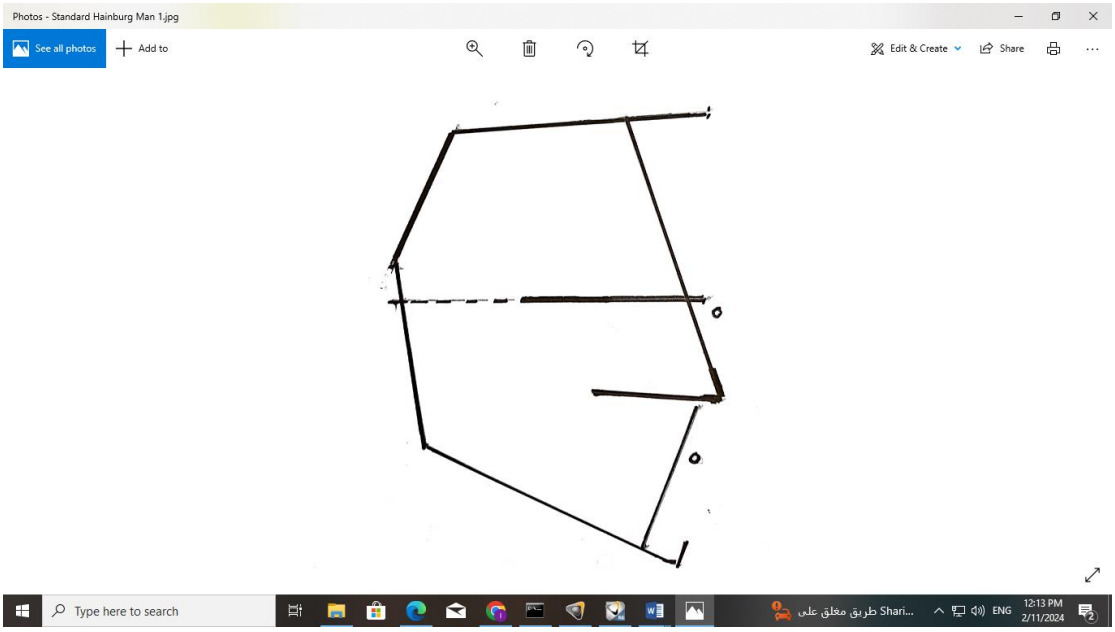
Standard Kerma Man



Standard Hianburg Man



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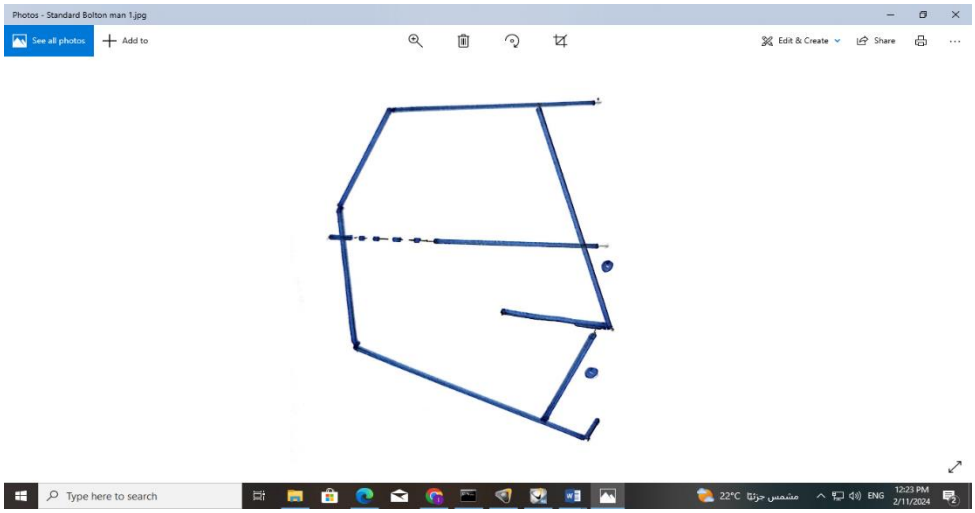
Standard Bolton Man.



Conclusion

Now it is possible to sketch out the exact facial outlines of human population bases on their external generic manifestations and made it available for various purposes of human studies, medical treatment and forensic medicine.

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