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Assessment of Cephalometric Norms Among Ethiopians Based on Steiner's Skeletal and Soft Tissue Analysis.

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ABSTRACT:
BACKGROUND: Cephalometry is one among the diagnostic aids that are important for treatment planning. It is a reliable and valid diagnostic modality by which the anatomical parameters of patients are compared with normal range of values and the target components are corrected based on cephalometric norms in order to reach a better facial balance and harmony. The standard cephalometric norms conducted on Caucasians are widely used throughout the world.
OBJECTIVE: To assess the cephalometric norms for orthodontic patients with class I malocclusion using Steiner's skeletal and soft tissue analysis from pre-treatment lateral cephalograms of patients visiting Orthodontic Department, ACSH, Mekelle, Ethiopia.
METHODS:A retrospective cross sectional study design was conducted on seventy nine patients using a simple random sampling technique. The data was collected from lateral cephalograms of class I malocclusion orthodontic patients. The data was analyzed by SPSS version 20. The results were expressed as mean ± standard deviation (SD) for continuous variables and frequency (%) for categorical variables. Shapiro Wilk test was used to test for distributions of data while homogeneity of equal variance was assessed using Levine's test. The categorical variables were analysed by using the chi-square test. Comparison of skeletal parameters of Steiner's analysis with gender was evaluated using independent t-test. A two-tailed p value less than 0.05 was considered statistically significant.
RESULT: From the sample of seventy nine patients the mean and SD of SNA,SNB,ANB,MPA were computed (83.11 ±3.5, 81.29 ±3.6 , 2.56 ±1.8, 32.95 ±6.3) respectively and with regard to soft tissue 89% of study population had protrusive lip while 7% had normal lip. There was no statistically significant gender dimorphism among study population and when the mean of the present study was compared with that of standard Caucasian mean there was statistically significant variation regarding SNA and SNB of study population.
CONCLUSION: The study population had a slightly prominent mandibular and maxillary base as compared to Caucasians but had a comparative maxillo-mandibular differential with slightly vertical growth pattern. There was no statistically significant gender dimorphism regarding skeletal parameters and majority of study populations had protrusive lip.
KEY WORDS: Cephalometry, Malocclusion, Steiner's Analysis, Caucasians, Ethiopian.

I. INTRODUCTION:

Orthodontic treatment is performed to provide stable occlusal relationships, optimal masticatory function and favourable aesthetics. This treatment often includes diagnosis, prevention and correction of dental and skeletal discrepancies[1, 2].

Diagnosis in orthodontics, requires collection of an adequate database of information about the patient's history, intraoral & extra oral examination, assessment of study models, photographs and intra oral &extra-oral radiographs, particularly from lateral cephalograms; which is a reliable and valid diagnostic modality by which the anatomical parameters of patients are compared with normal range of values and the target components are corrected based on cephalometric norms in order to reach a better facial balance and harmony[2, 3].

Radiographic cephalometry was

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introduced and popularized in 1934 by Hofrath in Germany and Broadbent in US, is a radiographic technique of measuring the human skull into a geometric scheme and has become an important part of morphological diagnostic procedures to assess craniofacial growth and development. It also allows changes associated with growth to be observed as well to diagnose and classify malocclusion[4].

Since the development of cephalometric radiography, diverse methods of analysis developed by Downs, Steiner, Hasund, McNamara and many others have been used to identify the dental and facial structures of different ethnic groups[5].

In 1950 Steiner used SN plane as a reference line to develop numerical analysis, containing measurements to diagnose the problem as well as provide guidance to form an accurate treatment plan by predicting the changes that result from growth or orthodontic therapy. Steiner's analysis based on the predetermination of the sagittal position of maxillary and mandibular teeth by estimating the changes in the SNA, SNB angles, ANB angle and the position of the bony chin (Pg) to the line NB[6]. Steiner's analysis has been used widely by orthodontists and maxillofacial surgeons; the measurements proposed for this analysis were collected from white Caucasians American sample or North Americans and Scandinavian populations[6].

If we view the face respectively there is a tremendous amount of facial variable, measurements, differences in facial profile and skeletal features between different racial group. Therefore, we can only use the established data for Caucasians as a reference and it is not applicable for all ethnic group[7].

II. NEED FOR THE STUDY:

Populations of the world differ in their character, size, growth, and shape. These differences are due to a complicated interaction of genetic and environmental factors. Distinctions between races by geographical location, historical origins, culture, and language were usually subsumed into three major racial groups: Mongoloid, Negroid and Caucasian[8, 9].

The cephalometric norms for the Caucasians, for many decades, were being applied on the population groups worldwide. However, with time many investigators concluded that there were variation of the craniofacial morphology between different ethnic groups, age, gender and race[10,11].The morphological and anthropological findings indicate not only did each racial group have its own standards but within the same race, each subgroup had its own standards so it is illogical to apply the standards of one racial group to another, or within the same race, or to apply the standards of one subgroup to another[8,10].

Cephalometric studies on different ethnic groups including those of Garcia's on Mexican Americans, Drummonds on Negros, Park's on Korean adults, Gleis on Israelis, Miura on Japanese have indicated that Caucasian normal measurements cannot be considered normal for other racial groups[10,12].

The variations support the idea that a single standard in facial aesthetics should not be applied and used to all racial and ethnic groups. The cephalometric norms for each ethnic group obtained in the study should be used as a reference point during treatment of any kind of dental or skeletal malocclusion specially orthognathic patient to achieve ideal esthetic profile[13].

So the establishment of cephalometric norms for local population and their consequent departmental application contributes to a more satisfactory diagnosis and treatment planning for patients hailing from a particular ethnic background.

Caucasian cephalometric values are still used for treating Ethiopian patients despite the differences between Ethiopian and Caucasian features. The aim of the study was to assess skeletal and soft tissue cephalometric values for an adult Ethiopian population, based on Steiner's analysis and to identify any differences between Ethiopian males and females and to evaluate differences between Ethiopian and Caucasian values.

III. METHODOLOGY:

The study was carried out on cephalograms obtained from orthodontic patients with class I malocclusion at the Orthodontic Department with the following criteria.

INCLUSION CRITERIA:

- Ethiopians
- Patients between 20 -35 years of age.
- Orthodontic patients with class I malocclusion with full permanent dentition.
- Normal growth with balanced facial symmetry and facial profile.
- No previous history of orthodontic treatment.

EXCLUSION CRITERIA:

- ✓ Non- Ethiopians.
- ✓ Individuals undergone / undergoing orthodontic treatment.
- ✓ Individual having moderate to severe Class II, III malocclusion.

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- ✓ Individual having moderate to severe convex or concave profile.
- ✓ Individuals having previous history of Prosthetic, major surgical/conservative treatment.

THE SAMPLE SIZE AND SAMPLING TECHNIQUE THE SAMPLE SIZE:

The sample size was calculated using the single population proportion formula assuming p = q = 0.

$n= (Z /2)^2 \times p \times q / d^2$

Where n= sample size. Z= desired 95% confidence, Z=1.96, p = proportion (0.5), q= l-p which is 0.5 , d = the margin of sampling error tolerated (5%)

THEREFORE: $n= (1.96)^2 (0.5) (0.5) / (0.05)^2 =384$

But the result of this formula is only for population size greater than 10,000. Since the study population size is less than this, the sample size is calculated using a correction formula of:

$Ni = n/ (1+ (n/N))$

Where, Ni = the desired sample size (When population is less than 10,000), n= the desired sample size (when the population is more than 10, 000, N= the study population size (which is 90 in this case)

Therefore: Ni = 384/ (1+ (384/90)) = 72, By adding 10% of contingence, total sample size is = 79

THE SAMPLING TECHNIQUES:

Samples were taken by using simple random probability, in which each population element had a known (non-zero) chance of being chosen for the sample after evaluation of eligibility had been fulfilled.

STUDY VARIABLES

INDEPENDENT VARIABLES:

- ➢ Age
- ➢ Gender
- ➢ Race
- ➢ Tracing paper

DEPENDENT VARIABLES:

Position of skeletal parameter of Steiner's analysis are:

- ✓ SNA
- ✓ SNB
- ✓ ANB
- ✓ Mandibular plane angle
- ✓ Position of soft tissue parameter (Steiner's S line)

DATA COLLECTION TECHNIQUES AND DATA COLLECTORS

Ethical clearance was obtained from an Ethics committee in the ACHS and then informed consent was obtained from the patients. The data was collected by self-designed questionnaires from lateral cephalograms of sample of class I malocclusion by orthodontic R3 residents after brief training on collection and tracing by principal investigator. The data was analysed after tracing had been done from the radiograph.

DATA QUALITY CONTROL:

5% of the sample size Cephalometric tracing and analysis of radiograph was done by the investigator and two data collectors, and the 5% tracings and analysis results were compared for any difference and shown to the advisor for confirmation. Training and orientation about the objectives and relevance of the study, components included in the study tools and the whole process of data collection was provided to the data collectors and supervisors. During data collection, regular supervision and follow up was undertaken. The supervisor checked each questionnaire daily which was further cross checked by the principal investigator for completeness and consistency of data. Once the data was collected and checked for completeness, consistency and accuracy; it was sorted, categorized and summarized.

DATA ANALYSIS:

Data was checked manually for completeness, coded and entered into Epi-info 7 and exported SPS version 20 for analysis. Descriptive statistics was presented as mean± Standard deviation for normal distributed data. The results were expressed as mean ± standard deviation (SD) for continuous variables and frequency (%) for categorical variables. Shapiro Wilk test was used to test for distributions of data while homogeneity of equal variance was assessed using Levine's test. The categorical variables were analyzed by using the Pearson chi-square test. Comparison of skeletal parameters of Steiner's analysis with gender was evaluated using independent t-test. A two-tailed p value less than 0.05 was considered statistically significant.

ARMAMENTARIUM USED:

- ✓ Lateral cephalograms, Lead acetate sheet, 3HB Pencil, Eraser, Sharpener
- ✓ Scale, Protractor, Clips, X-ray view box.

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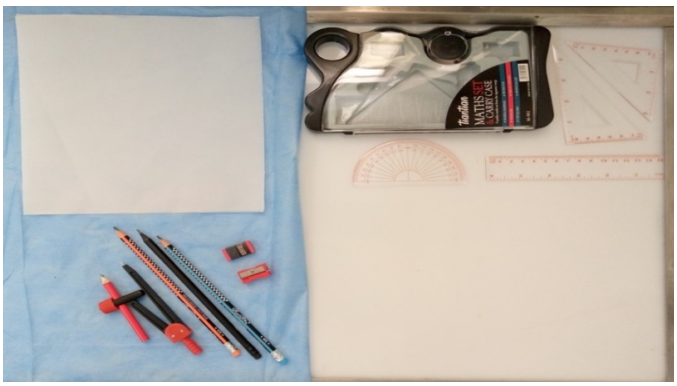
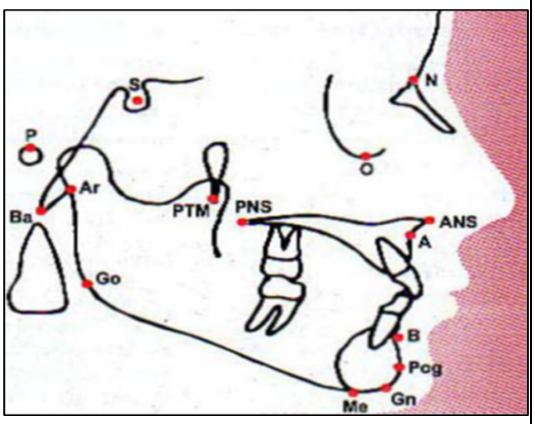


Figure 1: Armamentarium for tracing

Figure 2: Patient align for cephalograms

Figure 3: Lateral cephalogram

OPERATIONAL DEFINITION:
CEPHALOMETRIC LANDMARKS:



Sella (Point S): Midpoint of the pituitary fossa (sellaturcica)
Nasion (N): Defined as a point located on the most anterior point at the frontonasal suture.
Subspinale (Point A): Craniometric point that is deepest and the most posterior point in the midline on the alveolar process of the maxilla.
Supramentale (Point B): Defined as the deepest point on the profile curvature from pogonion to infradentale.
Gnathion (Gn): Defined as the most antero-inferior point on mandibular symphysis.
Gonion (Go): Gonion is a constructed point at the junction of ramal plane and the mandibular plane.
Pogonion (Pg): Defined as the most anterior point on mandibular syphilis.

LANDMARKS USED IN THE STUDY:
Angular Measurements:
SNA: Angle b/w Sella - Nasion plane and Nasion - point A line.
SNB: Angle b/w Sella - Nasion plane and Nasion - point B line.
ANB : Angle b/w Point A- Nasion line and Nasion-Point B line.
Mandibular plane: Angle b/w Gnathion - Gonion to Sella-Nasion plane.

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Occlusal plane :Angle b/w Sella - Nasion plane and line overlapping cusp of first premolar and molar.

Linear Measurements:

Steiner's S-line : Line tangent to Pogonion - S curvature of nose.

IV. RESULTS:

SOCIO-DEMOGRAPHIC CHARACTERISTICS OF STUDY POPULATION:

This study was conducted on 79 secondary data from pre-treatment lateral cephalometric radiograph with mean age of 24 ± 3.5 . Of the total study population females were dominant(65.8%).

Variables		N(%)
Age (mean ± SD)		24±3.5
Gender	Female	52(65.8)
	Male	27(34.2)
Total		79(100)

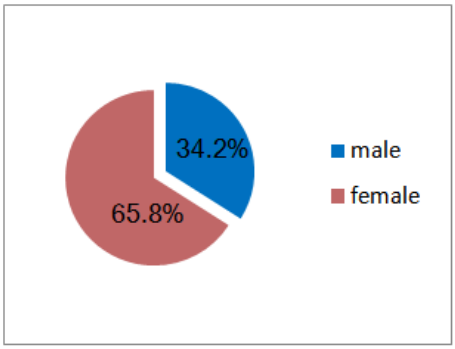

Table 1: Socio-demographic characteristic of orthodontic patients with Class I malocclusion.

SKELETAL PARAMETER USING STEINER'S ANALYSIS:

In this study both maxilla and mandible were slightly prognathic as SNA and SNB were both greater than the average Caucasian value while the study population had normal growth pattern as described by mandibular plane angle

Skeletal parameters	Mean ± SD (in degree)
SNA	83.11 ±3.5
SNB	81.29 ±3.6
ANB	2.56 ±1.8
Mandibular plane angle	32.95 ±6.3

Table 2: Distribution of skeletal parameters (Based on Steiner's analysis) among orthodontic patients with Class I malocclusion.

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SOFT TISSUE PARAMETER BY STEINER'S ANALYSIS:

Among the study population in Orthodontic department only 6.5 % had normal lip as determined by Steiner's S line while 88.6% of the patients with class I malocclusion had both upper and lower lip protrusion as measured by Steiner's S line and only 2.6% had both lip retrusion.

Soft tissue parameter	N (%)
Normal	5(6.5)
Both protrusive	70(88.6)
Both retrusive	2(2.6)
Only lower protrusive	2(2.3)

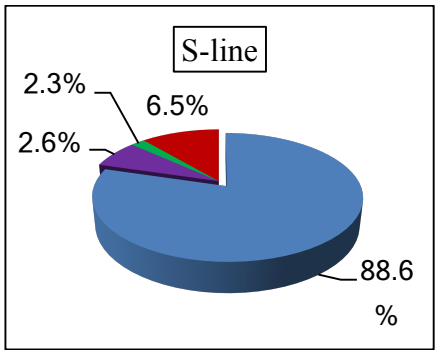

Table 3: Prevalence of soft tissue parameter by Steiner's analysis on orthodontic patients with Class I malocclusion

GENDER VARIABILITY OF STEINER'S SKELETAL PARAMETERS:

The study of Gender variability of skeletal parameters of orthodontic patients with class I malocclusion revealed that SNA and Mandibular plane angle was more in males than females while SNB and ANB were almost similar, but the difference is not statistically significant.

Skeletal parameters	Gender variability		95% CI	P value
	Male (Mean ± SD (in degree))	Female Mean ± SD (in degree)		
SNA	83.44± 3.65	82.92± 3.43	-1.16-2.16	0.87
SNB	81.15± 4.21	81.37± 3.26	-1.9-1.4	0.14
ANB	2.52± 1.71	2.58± 1.90	-0.9-0.8	0.57
Mandibular plane angle	33.07± 5.71	32.88± 6.60	-2.8-3.73	0.798

Table 4: Gender variability of Steiner's skeletal parameters among orthodontic patients with Class I malocclusion.

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COMPARISON OF MEAN OF PRESENT STUDY WITH CAUCASIAN STANDARD MEAN:

The study of mean comparison of skeletal parameters of orthodontic patient with class I malocclusion with standard Steiner's norm reveals difference between study population and standard norms; the difference being statistically significant in case of SNA and SNB with p-value of (0.042, 0.032) respectively while the study population had no significant difference statistically with regard to ANB and Mandibular plane angle since the p-value is greater than 0.05.

Measurement	Caucasian mean	Present study mean	Mean difference	P value
SNA	82±2	83±3.5	1.0	0.0421
SNB	80±2	81±3.6	1.0	0.0323
ANB	2˚± 2	2.56±1.8	0.56	0.1256
Mandibular plane angle	32˚± 4	32.95±6.3	0.95	0.3871

Table 5: Comparison of mean of present study with Caucasian standard mean by Steiner's analysis on orthodontic patients with Class I malocclusion.

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V. DISCUSSION:

Cephalometric radiography is essential for craniofacial morphology which aids in taxonomy, communication, analysis of dentofacial variation and treatment plan. Steiner's analysis was used in this study because its method of assessing skeletal and dental morphology are useful with the least number of measurements [5]. Cephalometric studies on non-Caucasian subjects indicate that there are measurable skeletal and dental differences when compared to Caucasians [3].

In this study seventy-nine samples of pretreatment lateral cephalometric x-rays of orthodontic patients with class I malocclusion were traced, the mean and standard deviation for each skeletal parameter were computed by descriptive statistics. The gender variability of each skeletal parameter were computed to note the association by T test and P value. Regarding soft tissue, the prevalence of lip position as determined by S line was done.From the seventy nine samples assessed fifty two were females and twenty seven were maleswith mean value and standard deviation of SNA,SNB,ANB and Mandibular plane angle (83.11 ±3.5 , 81.29 ±3.6 , 2.56 ±1.8 , 32.95 ±6.3) respectively.

This study when compared with the cross sectional study done by Eman I Salama et al, with mean and SD values of SNA, SNB, ANB (84.54±2.07, 81.51±2.15 , 3.03±1.43)respectively; SNA is slightly lower while SD is slightly higher, indicating that the position of maxilla is less protruded as compared to that of Sudanese population. The mean value of SNB was almost similar with that of Sudanese. But SD was slightly higher as compared to Sudanese which reveals that the position of mandible in cranial base is almost similar, Regarding ANB angle the mean value is less indicating the relative position of maxilla and mandible is more of orthognathic as compared to its counter. In the present study there was no statically significant finding regarding gender dimorphism of Steiner's skeletal parameters while in Sudanese significant difference in SNA, SNB and MPA the position of maxilla and mandible was prognathic and their growth pattern is more of vertical when compared. Both study reveals that majority of study sample had protrusive lip[7].

Comparing present study with the cross sectional study done in Bangladesh population by Rizvi et al with result of SNA ,SNB ,ANB and MPA (83.8±4.02 , 81.5±3.52 , 2.3±2.70 , 25.8±6.33) respectively reveals comparable result both in mean value and SD except in case of mandibular plane angles where the mean value differ but SD remainscomparable which indicates the present study sample has average growth pattern than that of Bangladesh which is horizontal growth. With regard to gender variability in both studies there were no statistically significant variations between both gender[5].

Comparison of present study mean with standard Caucasian mean revealed that both mean and SD of present study varies from standard Caucasians , the sample of present study had SNA mean and SD of (83±3.5) with mean difference (1.0) which indicates maxillary apical base is slightly prognathic in the cranial base as compared to Caucasian standard. This difference in mean was computed for the position of maxilla and found statistically significant (p- value 0.042).

When the present mean and SD of SNB were compared with the mean and SD of Caucasians both revealed slight increase (81±3.6) with mean difference of (1.0) which indicates the apical position of the mandible in the cranial base of the study population which was slightly prognathic than Caucasian population , and this difference was found statistically significant (p-value 0.032). The study population has no gender variability regarding SNB angle.

Regarding maxillo-mandibular differentials (ANB), Angle which is the most common indicator to determine the relative positions of the upper and lower jaws to each other, showed comparable mean and SD (2.56±1.8) with Caucasians, with the mean difference of (0.56) which indicates that there is no statistically significant difference between study population and Caucasian standard (p value0.1256) there was no gender variability within study population regarding ANB angle.

The mean and SD of mandibular plane angle (32.95±6.3) is slightly greater than that of Caucasian population with mean difference of (0.95). It can be concluded that the study population had slightly increased vertical growth pattern as compared to Steiner's norm the p value was calculated and found that the difference is statistically not significant (p-value 0.387) and the study population has no difference between male and female regarding mandibular plane angle.

With regard to soft tissue only 7% of study population had normal lip as determined by S- line while 89% had protrusive lip and 2% had retrusive lip. It can be concluded that the study population varies significantly by lip position from standard Caucasian sample as determined by S- line.

VI. STRENGTH AND WEAKNESS OF THE STUDY:

STRENGTH OF THE STUDY

- The first study based on Steiner's norm in Tigray, Ethiopia

LIMITATION OF THE STUDY

- ✓ Restraint of patients, materials and software due to unavoidable situation of COVID wave and regional unrest due to War.
- ✓ Unable to generalize findings obtained from a sample to the population statistically as the sample size will not represent general population.

VII. CONCLUSION:

The results of the present study support the idea that a single standard of facial esthetics should not be applied to all racial and ethnic groups. These differences should be kept in mind to facilitate better diagnosis, and treatment of the Ethiopian orthodontic patients. Further studies with better diagnostic and clinical approach is needed to arrive at cephalometric norms for Ethiopian population for efficient diagnosis and treatment planning.

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