

# Cephalometric Analysis for Diagnosis and Treatment of Orthodontic Patients

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## ABSTRACT

Cephalometric analysis for diagnosis and treatment planning of orthodontic patients is essentially a measurement system designed to describe relationships between various parts of the skeletal, dental and soft tissue elements of craniofacial complex. As the linear and angular measurements vary between males and females and with the age, one of our objectives was to compare the statistical difference between males and females. The study was performed using sample size of 60 cephalometric radiographs of 30 males and 30 females. The samples were selected on the basis of class I dental relationship with clinically acceptable profile, no history of orthodontic treatment and of Jaipur (Rajasthan) population.

**Keywords:** Cephalometric analysis, orthodontic patient, cephalometric radiographs, orthodontic treatment, craniofacial complex, dental

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## INTRODUCTION

The introduction of the cephalometer to orthodontics by Broadbent in 1931 provided the avenue for the creation of series of cephalometric analysis (1;2). Roentgenographic cephalometry was first developed as a tool to study craniofacial growth and development (3;4). Later the uses were expanded to include the growth prediction of individual patients, diagnosis and treatment planning and assessment of treatment progress (3;4;1).

One of the most valuable adjuncts to diagnosis and treatment planning available to orthodontists is lateral cephalogram. A well planned cephalometric analysis is invaluable, as it offers a gradually consistent and dependable guide to diagnosis and treatment planning (5). However no two faces are alike, with the exception of monozygotic twins and even right and left halves of face do not match perfectly, but show subtle differences (6). The use of any analysis as a definitive formula, without proper consideration for age, sex, type, anatomic limitations and ethnic differences, will invariably result in frustration and failure (5). According to Steiner "These esti-

mates are useful as guides but must be modified for the individuals" (7).

A number of investigators noticed the variation of craniofacial morphology in different ethnic groups (4). Richardson defined ethnic group as a "nation or population with a common bond such as geographical boundary, a culture or language or being radically or historically related (4)." The standards of beauty vary from race to race, place to place and from time to time. Similarly the morphologic feature varies from one ethnic group to another. Therefore, it is important to know the normal Dentofacial pattern of each group for better clinical evaluation (8). Cephalometric norms can be invaluable aids to the practitioner in determining the location as well as severity of existing abnormalities (8).

The present study was designed to establish the skeletal cephalometric norms of Jaipur (Rajasthan) population. We had selected the male and female subjects of clinically acceptable class I occlusion and balanced profile, to set up norms for the population, to investigate the significant difference between them, so that the data obtained can be an aid in the cephalometric

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treatment planning for local population and to compare the data obtained with that of norms of Caucasians.

## MATERIALS AND METHODS

### Materials

In the present study lateral cephalograms of 60 adult subjects, 30 females and 30 males were included. All the cephalograms were obtained from the records of the department of Orthodontics and Dentofacial Orthopedics, Jaipur Dental College and Hospital, Jaipur. Age group of selected subjects was in the range of 18 – 25 years. The total numbers of subjects were determined based on discussion held with biostatistician. The study was reviewed by board of ethical committee of dental college and was envisaged.

### Criteria for selection of the sample

- Class I molar and canine relationship.
- Overjet and overbite not exceeding more than 2- 4mm, with little or no

incisor crowding or rotations.

- Full compliments of permanent teeth in proper intercuspation, except third molars.
- No apparent skeletal or dental deformity.
- Acceptable facial profile
- No previous history of orthodontic, orthognathic or plastic surgery.

All the radiographs were obtained in natural head position with centric occlusion and lips relaxed. Cephalometric radiographs, Plaster models and extra oral and intraoral photographs of each subject were obtained with their consent.

All the cephalograms used in the study were obtained by single operator and in a single machine. The cephalograms were taken with standard "ROTOGRAPH 230 EUR" cephalostat, manufactured by VILLA MEDICAL SYSTEM in 1995 made in Milano, Italy. Standardized 8"x10" Kodak green sensitive lateral radiographic head

films with intensifying screen were used for each subject.

### Tracing technique

All the cephalograms were traced by a single operator on Garware matted acetate tracing paper of 0.003" thickness and with 3 H microlead pencil. Cephalometric landmarks were located, identified and marked. The parameters used in the study were taken from, Steiner (7), Downs (9), Tweed (10) and McNamara (11).

Reference points used for this study. (Figure I A)

Sella, Nasion, Orbitale, Point A, Point B, Pogonion, Gonion, Menton and Gnathion  
Various parameters used in the study (Figure I B, I C and I D)

### From Steiner analysis

- SNA -  $82^{\circ}$
- SNB -  $80^{\circ}$
- ANB -  $2^{\circ}$
- GoGn - SN -  $32^{\circ}$
- Upper incisor to NA (angle) -  $22^{\circ}$
- Upper incisor to NA (linear) - 4mm
- Lower incisor to NB (angle) -  $25^{\circ}$
- Linear incisor to NB (linear) - 5mm
- Interincisal angle -  $131^{\circ}$

### From McNamara analysis

- Nasolabial angle

### From Downs Analysis,

- Y - Axis -  $59.4^{\circ} \pm 3.82^{\circ}$

### From Tweed Analysis,

- IMPA -  $90^{\circ}$

### From Jaraback Analysis,

- Upper incisor to SN -  $102^{\circ} \pm 2^{\circ}$
- Anterior facial height
- Posterior facial height
- Jarabak's ratio

### From Ricketts Analysis

- E - line -  $\pm 2^{\circ}$

### STATISTICAL ANALYSIS USED

Mean, standard deviation was calculated. The "Z" test was used to determine whether there was a statistical difference between males and females. The p value,  $< 0.05$  was taken to be statistically significant. Whole data was analyzed using SPSS (Statistical Package for Social Science, V10.5) package.

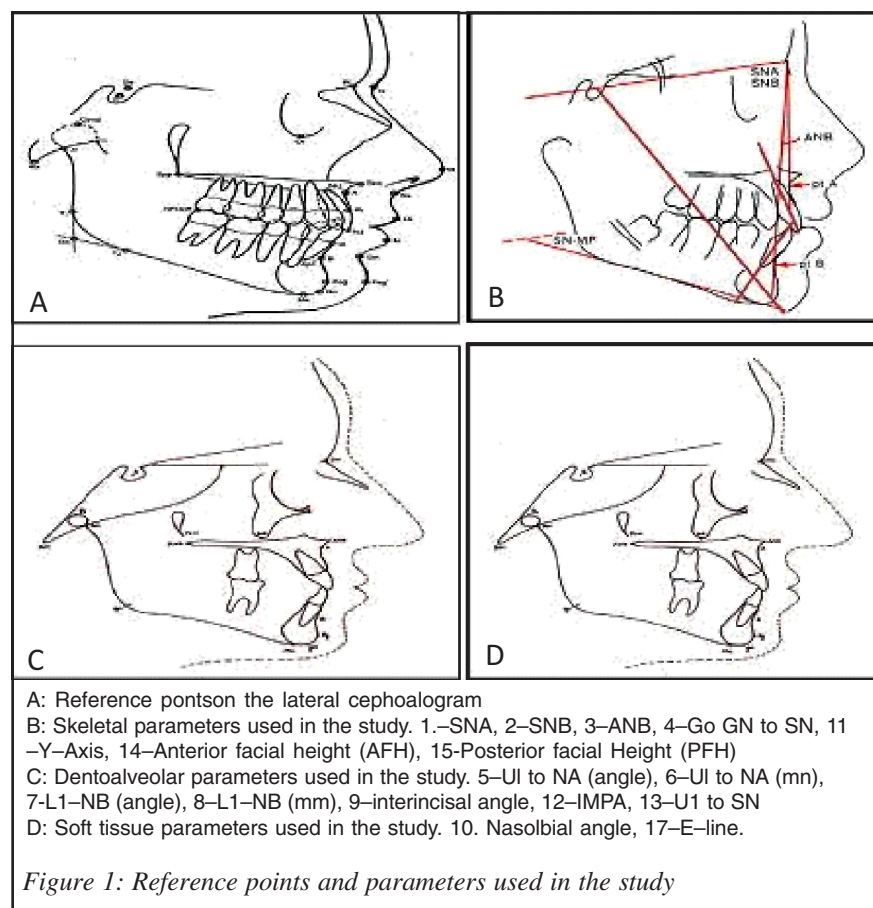


Figure 1: Reference points and parameters used in the study

# RESULTS AND OBSERVATIONS

Data obtained from 60 cephalometric radiographs taken from the Jaipur population were averaged. Mean, standard deviation values were calculated. The values obtained in males and females were compared statistically using 'Z' test. The p value <

0.05 was taken to be statistically significant.

Table 1 shows mean distribution of skeletal norms, dentoalveolar norms and soft tissue norms for males and females in the population respectively. In case of skeletal norms, mean values of males for SNA,

SNB, ANB, Y-axis, were 82.970, 81.500, 1.50 0, 63.230 respectively for males and 80.200, 79.100, 1.100, 65.230 respectively for females found to be near normal to that of Caucasian norms. But GoGnSN, Jarabak's ratio 24.600, 70.60% for males and 27.700, 66.90% respectively for females indicates mild tendency to horizontal growth pattern.

For mean distribution of dentoalveolar norms for males and females in the population, it was found that, U1- NA (angle), U1- NA(mm), L1-NB(angle),L1-NB(mm), U1 -SN, IMPA, interincisal angle with the values of 28.670, 7.77, 28.530, 6.10mm, 111.270, 102.200, 122.000 for males respectively and 290, 6.57mm, 27.770, 5.67mm, 108.870, 101.830, 122.030 for females respectively showed bimaxillary protrusion.

While in case of soft tissue norms, nasolabial angle and E - line with the values of 92.630 and 0.80mm for males and 95.070 and 2.78mm for females showed females have lower lips more protruded as compared to Caucasians.

Table 2, indicates the statistical difference between males and females in skeletal parameter, dentoalveolar parameter and soft tissue parameters. In case of skeletal parameter, insignificant difference was found between males and females for values of SNA, SNB, ANB, GoGn to SN, AFH, PFH, Jarabak's ratio. Statistical difference between males and females in dentoalveolar parameter showed insignificant difference between males and females for the value of U1- NA (angle),U1- NA(mm), L1-NB(angle),L1- NB(mm), U1 -SN, IMPA and interincisal angle.

While in case of statistical difference between males and females in soft tissue parameters, significant difference was found between males and females for the value of E - line, 0.080 for males and 2.78 for females showing female lower lip are more protruded than males.

Table 3 indicates intra examiner error (tracing I and tracing II) for skeletal parameter,

**Table 1: Mean  $\pm$  Sd of Different Parameters of male and female patients**

Skeletal Parameters		
Mean $\pm$ Sd		
Parameters	Male	Female
SNA degree	82.97 $\pm$ 3.28	80.20 $\pm$ 3.42
SNB degree	81.50 $\pm$ 3.24	79.10 $\pm$ 3.9
ANB degree	1.50 $\pm$ 1.48	1.10 $\pm$ 2.12
Go-GN to SN degree	24.60 $\pm$ 4.61	27.70 $\pm$ 4.56
Y- Axis	63.23 $\pm$ 2.72	65.23 $\pm$ 3.77
AFH (mm)	125.70 $\pm$ 6.15	154.30 $\pm$ 178.96
PFH (mm)	88.67 $\pm$ 7.03	80.77 $\pm$ 5.12
Jarabak's ratio (%)	70.60 $\pm$ 5.20	66.90 $\pm$ 4.03
Dentoalveolar Parameters		
Interincisal angle	122.00 $\pm$ 10.83	122.03 $\pm$ 8.58
U1 to SN(degree)	111.27 $\pm$ 7.21	108.87 $\pm$ 8.13
U1 to NA(degree)	28.67 $\pm$ 6.48	29.00 $\pm$ 7.77
U1 - NA(mm)	7.77 $\pm$ 3.49	6.57 $\pm$ 3.01
L1 - NB(degree)	28.53 $\pm$ 6.56	27.77 $\pm$ 5.63
L1 - NB (mm)	6.10 $\pm$ 2.74	5.67 $\pm$ 1.83
IMPA	102.20 $\pm$ 7.70	101.83 $\pm$ 5.93
Soft tissue Parameters		
Nasolabial Angle	92.63 $\pm$ 11.72	95.07 $\pm$ 9.28
E-line	0.80 $\pm$ 3.42	2.78 $\pm$ 2.73

**Table 2: Statistical difference between male and female Parameters**

Skeletal Parameters				
Parameters	Sex		P-value	Significance
	Male	Female		
SNA degree	82.97 $\pm$ 3.28	80.20 $\pm$ 3.42	> .05	NS
SNB degree	81.50 $\pm$ 3.24	79.10 $\pm$ 3.9	> .05	NS
ANB degree	1.50 $\pm$ 1.48	1.10 $\pm$ 2.12	> .05	NS
Go-GN to SN degree	24.60 $\pm$ 4.61	27.70 $\pm$ 4.56	> .05	NS
Y- Axis	63.23 $\pm$ 2.72	65.23 $\pm$ 3.77	> .05	NS
AFH (mm)	125.70 $\pm$ 6.15	154.30 $\pm$ 178.96	> .05	NS
PFH (mm)	88.67 $\pm$ 7.03	80.77 $\pm$ 5.12	> .05	NS
Jarabak's ratio (%)	70.60 $\pm$ 5.20	66.90 $\pm$ 4.03	> .05	NS
Dentoalveolar Parameter				
Interincisal angle	122.00 $\pm$ 10.83	122.03 $\pm$ 8.58	> .05	NS
U1 to SN(degree)	111.27 $\pm$ 7.21	108.87 $\pm$ 8.13	> .05	NS
U1 to NA(degree)	28.67 $\pm$ 6.48	29.00 $\pm$ 7.77	> .05	NS
U1 - NA(mm)	7.77 $\pm$ 3.49	6.57 $\pm$ 3.01	> .05	NS
L1 - NB(degree)	28.53 $\pm$ 6.56	27.77 $\pm$ 5.63	> .05	NS
L1 - NB (mm)	6.10 $\pm$ 2.74	5.67 $\pm$ 1.83	> .05	NS
IMPA	102.20 $\pm$ 7.70	101.83 $\pm$ 5.93	> .05	NS
Soft tissue Parameters				
Nasolabial Angle	92.63 $\pm$ 11.72	95.07 $\pm$ 9.28	> .05	NS
E-line	0.80 $\pm$ 3.42	2.78 $\pm$ 2.73	< .05	Sign

**Table 3: Mean  $\pm$  Sd of Different Parameters**

<b>Skeletal Parameters (Intra examiner error)</b>				
<b>Parameters</b>	<b>Tracing</b>		<b>P-value</b>	<b>Significance</b>
	<b>I</b>	<b>II</b>		
SNA degree	81.90 $\pm$ 3.30	81.80 $\pm$ 2.52	> .05	NS
SNB degree	80.65 $\pm$ 3.58	80.30 $\pm$ 3.10	> .05	NS
ANB degree	1.25 $\pm$ 1.81	1.60 $\pm$ 1.43	> .05	NS
Gong – SN degree	25.25 $\pm$ 4.71	27.20 $\pm$ 4.01	> .05	NS
Y- Axis	63.70 $\pm$ 3.29	65.20 $\pm$ 2.62	> .05	NS
AFH (mm)	122.55 $\pm$ 7.64	124.55 $\pm$ 7.16	> .05	NS
PFH (mm)	85.50 $\pm$ 6.09	85.85 $\pm$ 5.63	> .05	NS
Jarabak's ratio (%)	69.89 $\pm$ 4.49	69.03 $\pm$ 4.32	> .05	NS
<b>Dentoalveolar Parameters (Intraexaminer error)</b>				
Interincisal angle	121.6 $\pm$ 11.74	120.75 $\pm$ 11.79	> .05	NS
U1 to SN(degree)	111.65 $\pm$ 9.24	111.55 $\pm$ 9.15	> .05	NS
U1 to NA(degree)	30.15 $\pm$ 8.57	30.05 $\pm$ 8.02	> .05	NS
U1 - NA(mm)	7.1 $\pm$ 3.40	7.30 $\pm$ 3.48	> .05	NS
L1 - NB(degree)	27.75 $\pm$ 5.63	27.15 $\pm$ 5.55	> .05	NS
L1 – NB (mm)	5.45 $\pm$ 2.67	5.10 $\pm$ 2.53	> .05	NS
IMPA	101.80 $\pm$ 6.90	101.05 $\pm$ 7.00	> .05	NS
<b>Soft tissue Parameters (intra examiner error)</b>				
Nasolabial Angle	91.75 $\pm$ 11.61	91.85 $\pm$ 11.32	> .05	NS
E-line	2.20 $\pm$ 3.09	1.80 $\pm$ 2.84	> .05	NS

dentoalveolar parameters, soft tissue parameters respectively. The error was found to be statistically insignificant with p value >0.05.

## DISCUSSION

Cephalometric analysis for diagnosis and treatment planning of orthodontic patients is essentially a measurement system designed to describe relationships between various parts of the skeletal, dental and soft tissue elements of craniofacial complex.

The first attempt to apply cephalometric analysis to ethnic groups other than those of European ancestry was published in 1951 by Cotton, Takano and Wong (12) who applied the Downs analysis to African – Americans, Japanese – American and Chinese – Americans. Since that time, various investigators have analyzed Japanese (4;5; 8) Africans (13), Chinese (14) Indian (3, 15) and other ethnic groups shown that the normal measurements of skeletal and /or dental patterns of single group cannot be considered normal for other racial groups. Thus different racial groups will have to be treated according to their own individual characteristics.

Indian is a subcontinent with a large number of racial subgroups and several religious and interracial mixtures. Research work in this field has been carried out by Nanda and Nanda (3); Valiathan et al., (15) and many others.

The objectives of the study were to establish cephalometric norms for Jaipur population and to evaluate the difference between males and females. As the linear and angular measurements vary between males and females and with the age, one of our objectives was to compare the statistical difference between males and females.

The finding of the study was discussed under two headings, the skeletal pattern and dentoalveolar pattern. In each category the finding were discussed and males and females were compared.

## THE SKELETAL PATTERN

The mean values of SNA  $82.97^0 \pm 3.28^0$  and SNB –  $81.50^0 \pm 3.24^0$  for males and SNA  $80.20^0 \pm 3.42^0$  and SNB –  $79.10^0 \pm 3.9^0$  for females was found nearer to that of Caucasians, indicating normally related maxilla and mandible to the cranial base. The mean value of ANB  $1.50^0 \pm 1.48$  for males and ANB  $1.10^0 \pm 2.12$  for females

also matched to that of Caucasian norms indicating normally related maxilla and mandible.

Studies carried out by Valiathan (15) and Nanda and Nanda (3) on Indian population, showed normally related maxilla and mandible to cranial base and the jaws were normally related to each other. Our findings were well matching with these studies.

When considering the sexual dimorphism, all the male and female subjects showed statistically insignificant difference (p >0.05). The female subjects showed a relatively mild recessive mandible with the SNB angle ( $79.10^0 \pm 3.9^0$ ) when compared to males. Nanda has concluded that posterior positioning of mandible in relation to cranium in Lucknow population. However, the males in our study showed anterior position of mandible relative to cranial base than females. This was supported by mild increase in SNB value ( $81.50^0 \pm 3.24^0$ ).

GoGnSN ( $24.60^0 \pm 4.61^0$ ), Y-axis ( $63.23^0 \pm 2.72^0$ ), Jarabak's ratio ( $70.60 \pm 5.20$  %) for males and GoGnSN ( $27.70^0 \pm 4.56^0$ ), Y-axis ( $65.23^0 \pm 3.77^0$ ), Jarabak's ratio ( $66.90 \pm 4.03$  %) showed mild tendency to horizontal growth in Jaipur population. The values obtained from our study was matching with study conducted on other Indian population (3), Valiathan (15) and others, showed Jarabak's ratio established for south Indian males and females and north Indian males and females demonstrated a more horizontal growth pattern. In our study when males and females were compared all these values except Jarabak's ratio were almost similar with no statistically more in males than females.

Anterior facial height and posterior facial height showed insignificant (p value >0.05) difference between males and females, in which males showed AFH value of 125.70mm, females 154.30mm. PFH in males 88.67mm and in females 80.77mm. Our study values corresponds with Valiathan (15) and others, who established the AFH to be 124.74mm for males and 116.54mm for females while PFH for males



and females to be 88.60mm and 78.74mm respectively.

### THE DENTOALVEOLAR PATTERN

The dentoalveolar parameters showed an increase in the mean values. This increase in dental pattern was supported by both linear and angular measurements.

The inclination of upper anterior were relatively forward than the Caucasian norms which was indicated by U1 – NA 28.67° and 7.77 mm, U1 – SN 111.27° for males and U1 – NA 29.00° and 6.57 mm, U1 – SN 108.87° for females, indicates upper anterior protrusion. A distinct increase in L1 – NB 28.53° and 6.10 mm, IMPA 102.20° for males and L1 – NB 27.77° and 5.67 mm, IMPA 101.83° for females indicates proclination of lower anteriors when compared to Caucasians. The study results agree with Chopra et al. (16) study, where the IMPA values were higher in Indore cosmopolitan group. Our results were almost similar with that of the results obtained in other studies on Indian population (3;15) where the authors concluded bimaxillary protrusion in their samples.

However, surprisingly, with the high degree of protrusive mean value of dental pattern, all the subjects in the exhibited pleasing appearance and good facial harmony.

Statistically insignificant ( $p>0.05$ ) difference was seen in the males and female samples. Although both the groups showed proclination of upper anterior teeth, males showed slightly more values in U1 – NA and U1 – SN, L1 – NB and IMPA than females.

The interincisal angle was also smaller in our study group indicating labial positioning of both the upper and lower teeth. In males and females U1 – L1 showed statistically insignificant difference with the greater values in males.

### THE SOFT TISSUE PATTERN

The mean values of soft tissue pattern in the present study were found nearer to that of Caucasians. Considering the sexual dimorphism, all the male and female subjects showed statistically insignificant difference ( $p>0.05$ ) for Nasolabial angle ( $92.63\pm 11.72$  for males and  $95.07\pm 9.28$  for females). The E – line values for males ( $0.80\pm 3.42$ ) found statistically significant with values of females ( $2.78\pm 2.73$ ). It indicates that females have more protrusive lower lip than males.

According to Nanda and Nanda (3) north Indian population had significantly more protrusive teeth than Caucasians but lesser than Negros and Chinese who had more protrusive upper and lower teeth and Japanese group was nearly same as north Indians.

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