To determine posteroanterior cephalometric norms for North Bangalore adults

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Abstract

Aims and Objectives: (1) To establish the cephalometric norms from PA cephalograms for north Bangalore adults, (2) To identify the sex difference between north Bangalore men and women, (3) Compare the norms with norms of different population adults and identify correlation between transverse linear measurements.

Materials and Methods: PA cephalograms of 150 patients (75 men and 75 women) were taken with the distance between x- ray tube and ear post axis fixed at 5 feet (1.524m), with the film near the nose using Sirona Dental System ORTHOPHOS XG 5DS cephalometric unit with exposure time of 9.1 seconds, 80 kvp voltage, current of 14 mA and 127.4 mAs. Ear rods were inserted into external auditory canals and Frankfort plane was parallel to the floor. Cephalometric radiographs were traced manually on 0.003 inches matte acetate sheets. Nineteen transverse linear measurements, twenty- one landmarks and five reference planes were used on each radiograph. Statistical analyses (independent samples *t*- tests and Pearson product-moment correlation coefficient) were performed with software (IBM SPSS version 21.0).

Result: Of the 19 craniofacial transverse measurements, 15 showed significant sexual dimorphism. No statistically significant sex differences were found in the NC-CN (nasal width), B6-6B (mandibular intermolar width), B3-3B (mandibular intercanine width), and the upper midline deviation. Comparison between the north Bangalore men and women indicated larger measurements for men in all investigated linear transverse measurements except JL-FFP distance, A6-B6 difference, 6A-6B difference.

Conclusion: (1) Comparisons between north Bangalore men and women indicated higher measurements for men in all linear transverse measurements except the JL-FFP distance, A6-B6 difference, 6A-6B difference. (2) All transverse linear variables were shorter in north Bangalore adults as compared to other population adults.

Keywords: Posteroanterior, Cephalograms, Norms

Introduction

In orthodontics most of the facial and radiographic records are based on profile. There are different cephalometric norms for different ethnic and racial groups that have been established in many studies, as a result many cephalometric standards have been developed lately.[1]

The use of PA cephalometry is not standardized like any other lateral cephalometry.[2] Researchers have been very reluctant to use PA cephalometry For many reasons such as:

1. Problem in reproducing head posture and landmark identification Due to superimposition.
2. Poor radiographic technique. [3,4]

These difficulties could be overcome by careful attention to radiographic technique and selection of skeletal and dental landmarks that are acceptable and reliable.[3] Transverse measurements or widths from PA cephalograms are least affected by positional errors.[3]

Cephalometric analysis errors are classified in:

1. Radiographic projection,
2. Landmark identification,
3. Tracing and measurement errors.[4]

Cephalometric points that are located on a sharp curve or at the intersection of two curves are, easier to identify than those located on a flat or broad curve.[4] Cephalometric points located in high contrast areas are easier to identify than the low contrast ones.[4]

PA cephalogram is easily available and reliable film to identify and evaluate transverse skeletal dysplasia. Ricketts developed the Rocky Mountain analysis and suggested norms that will allow to determine the discrepancy from the ideal and also estimate the degree of treatment difficulty for a patient's problem.[5]

Several PA cephalometric analysis systems have been proposed such as (Sassouni, 1958; Letzer and Kronman, 1967; Ricketts *et al.*, 1972; Hewitt, 1975; Svanholt and Solow, 1977; Grayson *et al.*, 1983; Grummons and Kappeyne Van De Coppello, 1987). Among them, the two that are commercially available through the Dolphin® software (Ricketts *et al.*, 1972; Grummons and Kappeyne Van De Coppello, 1987), of the two only Ricketts' analysis (Ricketts *et al.*, 1972) is accompanied by a comprehensive set of norms, proposing age specific adjustments from adolescence to adulthood (Ricketts, 1981, Ricketts *et al.*, 1982).[7]

Cephalometric norms should represent the means and ranges or clinically useful parameters from large samples of subjects of a similar age and ethnicity with untreated almost ideal occlusions to be valid as standards for comparison. According to these criteria, few of the existing data allow valid interpretations of skeletal versus dental components of malocclusions in the frontal plane, particularly for adolescent subjects.[7]

Fig: 1 Sirona dental system orthophos XG 5DS cephalometric unit.

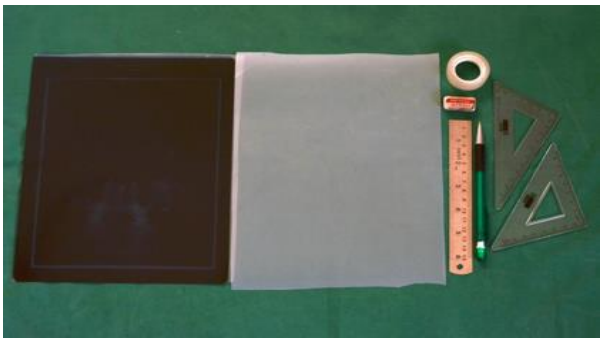

Fig: 2 Tracing materials used for the study.

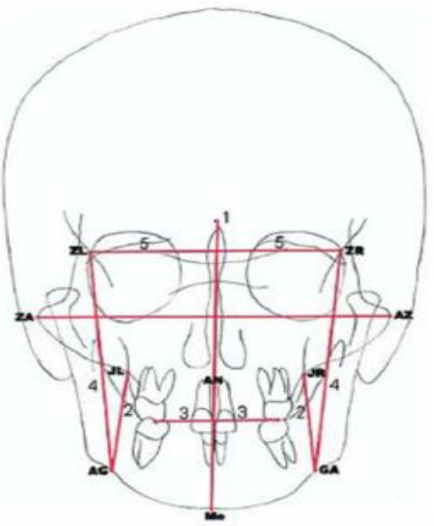

Fig: 3 Five reference planes used in the study.

Fig: 4 Posteroanterior cephalometric landmarks used in the study.

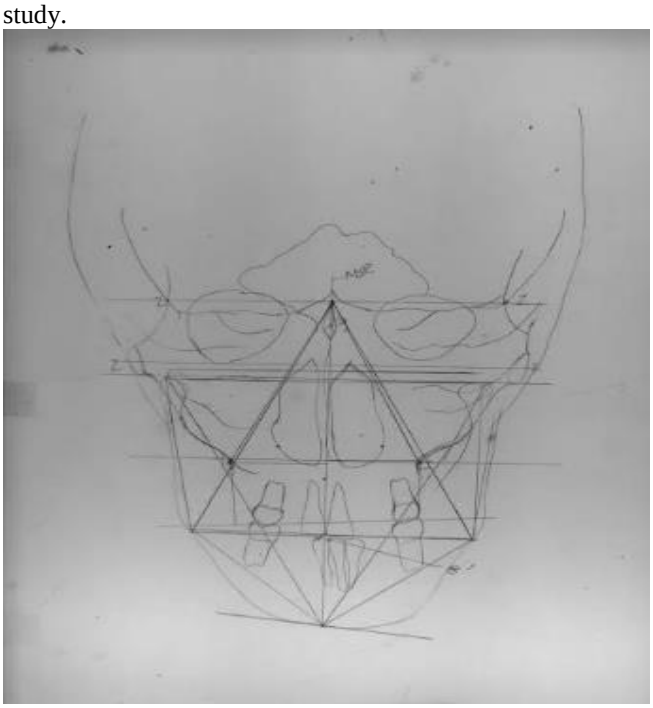

Fig: 5 Manually traced posteroanterior cephalogram.

Materials and Methods

This study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, and the Department of Oral Medicine and Radiology, Krishnadevaraya College of Dental Sciences.

Inclusion criteria

1. North Bangalore local population living since two Age group of 20 to 30 years that include both men and women (Mean generation's age 25 years).
2. Class 1 occlusion with minor or no crowding.
3. Normal growth and development.
4. All teeth present with or without third molars.
5. Patients with no gross facial asymmetry determined clinically and radiographically.

Exclusion criteria

1. Medically compromised patients with systemic disorders.
2. Patients with history of trauma related to TMJ and craniofacial skeleton in general.
3. Patients who underwent extensive dental procedures related to any previous orthodontic, prosthodontic treatment, soft tissue surgery, extraction, missing teeth, maxillofacial or plastic surgery cases.
4. Patients with class II and class III malocclusion.

Materials and Methods

1. Sirona Dental System ORTHOPHOS XG 5DS / cephalometric unit (Fig.1).
2. 150 Posteroanterior cephalograms of non- growing north Bangalore adults.(75 men, 75 women), (20-30 years of age).
3. 0.003inches matte acetate sheets, pencil, ruler, set square, eraser, cello tape, and scissors (Fig 2).

Method of data collection

PA cephalograms of 150 patients (75 men and 75 women) were taken with the distance between x- ray tube and ear post axis fixed at 5 feet (1.524m), with the film near the nose using Sirona Dental System ORTHOPHOS XG 5DS cephalometric unit with exposure time of 9.1 seconds, 80 kvp voltage, current of 14 mA and 127.4 mAs.

Ear rods were inserted into external auditory canals and Frankfort plane was parallel to the floor. The central beam penetrated patient's skull in a PA direction and bisected the transmeatal axis perpendicularly.[1]

Cephalometric radiographs were traced by hand on 0.003 inches matte acetate sheets and whole investigation made by one investigator. Nineteen transverse linear measurements were measured on each radiograph. Twenty-one landmarks were identified and five reference planes were used.

Five reference planes namely (Fig 3);

1. Midsagittal plane (AN-Me)
2. Frontal tooth plane (FTP) (JL-AG and JR-GA).
3. Occlusal plane
4. Frontal face plane (FFP) (ZL-AG and ZR-GA)
5. Z plane (ZL-ZR)

Linear transverse measurements used in the study are as follows (Fig 4):

1. **Cranial width (Eur – Eur)**: width of the cranium from most lateral points on the cranium parallel to the superior aspect of the orbits.
2. **ZL** (intersection between left zygomatico-frontal suture and orbit) - ZR (intersection between right zygomatico-frontal suture and orbit) **width.**
3. **Facial width (ZA-AZ)**: width of zygomatic arch at its most lateral aspect. ZA (intersection of lateral borders of left zygomatic arch) AZ- (intersection of lateral borders of right zygomatic arch.)
4. **Nasal width**: between NC (widest part of left nasal cavity) and CN (widest part of right nasal cavity) points.
5. **Maxillary width**: width between JL (intersection between processus zygomaticus and processus alveolaris maxillae on left side) and **JR** (intersection between processus zygomaticus and processus alveolaris maxillae on right side) points.
6. **Mandibular width (bigonial width):** width between AG (lateral and inferior border of left antegonial notch) GA (lateral and inferior border of right antegonial notch) points.
7. **Intermolar width of maxillary first molar (A6- 6A)**: distance between left and right points A6 (outermost point of maxillary left first permanent molar, determined perpendicularly to occlusal plane) and 6A (outermost point of maxillary right first permanent molar, determined perpendicularly to occlusal plane), which are perpendicular projections of buccal surfaces of the maxillary first permanent molars to the frontal occlusal plane.
8. **Intercanine width of maxillary canines A3 (**cusp tip of maxillary left permanent canine**)-**3A (cusp tip of maxillary right permanent canine) : distance between the incisal tips of the maxillary canines.
9. **Intermolar width of mandibular first molars (B6-6B)**: distance between the left and right points B6 (outermost points of Mandibular left first permanent molar, determined perpendicularly to occlusal plane) and 6B (outermost point of Mandibular right first permanent molar, determined perpendicularly to occlusal plane), which are perpendicular projections of the buccal surfaces of the mandibular first permanent molars to the frontal occlusal plane.
10. **Intercanine width of mandibular canines (B3-3B)**: distance between the incisal tips of mandibular canines. B3 (cusp tip of mandibular left permanent canine), 3B (cusp tip of mandibular right permanent canine).
11. **A6-B6 difference**: difference between the outermost points of maxillary and mandibular left permanent molars, determined perpendicularly to the occlusal plane.
12. **6A-6B difference**: difference between the outermost points of the maxillary and mandibular right permanent molars, determined perpendicularly to the occlusal plane.
13. **JL-FFP distance**: distance between JL point and FFP (frontal face plane), determined perpendicularly to occlusal plane.

14. **JR-FFP distance**: distance between JR point and FFP, determined perpendicularly to occlusal plane.
15. **B6-FTP distance**: distance between B6 point and FTP (frontal tooth plane) determined perpendicularly to the occlusal plane.
16. **6B- FTP distance**: distance between 6B point and FTP, determined perpendicularly to the occlusal plane.
17. **Occlusal plane inclination**: difference between right and left occlusal plane distances to the Z plane (ZL-ZR).
18. **Upper midline deviation**: distance between the contact point of maxillary central incisors and the midsagittal plane.
19. **Lower midline deviation**: distance between the contact point of mandibular central incisors and the midsagittal plane.

All the above mentioned procedures were performed at the Department of Orthodontics and Dentofacial Orthopaedics, and Department of Oral Medicine and Radiology, Krishnadevaraya College of Dental Sciences.

All statistical analyses were performed with a commercial software package (IBM SPSS version 21.0). For each variable, mean, standard deviation, minimum and maximum values were calculated. To compare the changes observed in men and women, appropriate statistical analysis independent samples *t*- tests was performed. The Pearson product-moment correlation coefficient was calculated to indicate the relationship between all investigated linear dimensions.

Table 1 Posteroanterior cephalometric norms of north bangalore adults- linear transverse measurements

	Mean	**SD**	**Min**	**Max**	**Percentiles**		
					Q1	Median	Q3
Cranial width (Eur-Eur)	145.21	5.32	134	157	142	145	149
ZL-ZR width	90.25	3.29	80	99	88	90	92.25
Facial width (ZA-AZ)	127.41	6.23	110	144	123	127.5	132
Nasal width (NC-CN)	30.57	3.07	20	38	29	31	32
Maxillary width (JL-JR)	64.18	3.38	55	72	62	65	67
Mandibular width (AG-GA)	83.09	7.78	7	95	80	84	87
Maxillary intermolar width (A6-6A)	62.25	3.77	54	72	60	62	65
Maxillary intercanine width (A3-3A)	34.42	2.70	29	42	33	34	36
Mandibular intermolar width (B6-6B)	64.52	4.34	53	77	61.75	64	67
Mandibular intercanine width (B3-3B)	34.33	3.35	26	44	32	34	36
A6-B6 difference	1.73	1.59	0	10	1	1	2
6A-6B difference	1.07	1.10	0	5	0	1	2
JL-FFP distance	10.97	1.88	6	16	10	11	12
JR-FFP distance	10.89	2.00	4	15	10	11	12
B6-FTP distance	4.49	2.47	0	11	3	4	6
6B-FTP distance	5.55	2.61	0	12	4	6	7
Occlusal plane inclination	1.93	1.50	0	6	1	2	3
Upper midline deviation	0.50	0.93	0	4	0	0	1
Lower midline deviation	0.54	0.91	0	4	0	0	1

Table 2a: Descriptive statistic results of the measurements for the samples of adult north bangalore men

Gender - Male	**Mean**	**SD**	**Minimum**	**Maximum**
Cranial width (Eur-Eur)	147.23	4.67	135	157
ZL-ZR width	91.29	2.70	85	98
Facial width (ZA-AZ)	130.97	4.56	117	144
Nasal width (NC-CN)	30.71	2.80	24	38
Maxillary width (JL-JR)	65.49	2.69	59	71
Mandibular width (AG-GA)	84.79	4.50	75	95
Maxillary intermolar width (A6-6A)	63.00	3.41	55	71
Maxillary intercanine width (A3-3A)	35.08	2.50	29	42

Mandibular intermolar width (B6-6B)	64.55	3.72	57	73
Mandibular intercanine width (B3-3B)	34.60	3.26	26	41
A6-B6 difference	1.44	1.58	0	10
6A-6B difference	0.84	0.89	0	3
JL-FFP distance	10.77	1.88	6	15
JR-FFP distance	11.08	2.24	4	15
B6-FTP distance	4.91	2.47	0	9
6B-FTP distance	6.21	2.36	0	12
Occlusal plane inclination	2.17	1.57	0	6
Upper midline deviation	0.51	0.94	0	3
Lower midline deviation	0.60	0.93	0	3

Table 2b: Descriptive statistic results of the measurements for the samples of adult north bangalore women.

Gender - Female	**Mean**	**SD**	**Minimum**	**Maximum**
Cranial width (Eur-Eur)	143.20	5.20	134	155
ZL-ZR width	89.21	3.52	80	99
Facial width (ZA-AZ)	123.81	5.65	110	135
Nasal width (NC-CN)	30.44	3.33	20	38
Maxillary width (JL-JR)	62.87	3.50	55	72
Mandibular width (AG-GA)	81.40	9.78	7	95
Maxillary intermolar width (A6-6A)	61.51	4.00	54	72
Maxillary intercanine width (A3-3A)	33.76	2.75	29	42
Mandibular intermolar width (B6-6B)	64.49	4.91	53	77
Mandibular intercanine width (B3-3B)	34.05	3.44	26	44
A6-B6 difference	2.03	1.55	0	7
6A-6B difference	1.31	1.24	0	5
JL-FFP distance	11.17	1.88	7	16
JR-FFP distance	10.71	1.72	6	15
B6-FTP distance	4.08	2.42	0	11
6B-FTP distance	4.88	2.70	0	11
Occlusal plane inclination	1.69	1.40	0	6
Upper midline deviation	0.49	0.94	0	4
Lower midline deviation	0.48	0.89	0	4

Table 3:a Correlation coefficients of all parameters

		ZL-ZR width	**ZA-AZ**	**NC-CN**	**JL-JR**	**AG-GA**	**A6-6A**	**A3-3A**	**B6-6B**	**B3-3B**	**A6-B6 difference**
Eur-Eur	**r**	0.47	0.55	0.17	0.42	0.31	0.38	0.24	0.27	0.11	-0.03
	p-value	<0.001*	<0.001*	0.04*	<0.001*	<0.001*	<0.001*	0.004*	0.001*	0.2 (NS)	0.69 (NS)
ZL-ZR width	**r**	1	0.56	0.12	0.57	0.21	0.41	0.28	0.35	0.14	-0.01
	p-value		<0.001*	0.14 (NS)	<0.001*	0.009*	<0.001*	0.001*	<0.001*	0.09 (NS)	0.88 (NS)
ZA-AZ	**r**	0.56	1	0.21	0.65	0.35	0.51	0.34	0.31	0.13	-0.14
	p-value	<0.001*		0.009*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.1(NS)	0.09(NS)

NC-CN	**r**	0.12	0.21	1	0.25	0.16	0.34	0.27	0.25	0.23	-0.19
	p-value	0.14 (NS)	0.009*		0.002*	0.04*	<0.001*	0.001*	0.002*	0.005*	0.02*
JL-JR	**r**	0.57	0.65	0.25	1	0.33	0.72	0.4	0.53	0.24	-0.18
	p-value	<0.001*	<0.001*	0.002*		<0.001*	<0.001*	<0.001*	<0.001*	0.003*	0.03*
AG-GA	**r**	0.21	0.35	0.16	0.33	1	0.28	0.04	0.15	-0.03	-0.12
	p-value	0.009*	<0.001*	0.04*	<0.001*		0.001*	0.62 (NS)	0.08 (NS)	0.73 (NS)	0.16 (NS)
A6-6A	**r**	0.41	0.51	0.34	0.72	0.28	1	0.57	0.82	0.44	-0.14
	p-value	<0.001*	<0.001*	<0.001*	<0.001*	0.001*		<0.001*	<0.001*	<0.001*	0.09 (NS)
A3-3A	**r**	0.28	0.34	0.27	0.4	0.04	0.57	1	0.46	0.66	0.01
	p-value	0.001*	<0.001*	0.001*	<0.001*	0.62 (NS)	<0.001*		<0.001*	<0.001*	0.90 (NS)
B6-6B	**r**	0.35	0.31	0.25	0.53	0.15	0.82	0.46	1	0.44	0.24
	p-value	<0.001*	<0.001*	0.002*	<0.001*	0.08 (NS)	<0.001*	<0.001*		<0.001*	0.003*
B3-3B	**r**	0.14	0.13	0.23	0.24	-0.03	0.44	0.66	0.44	1	0.04
	p-value	0.09 (NS)	0.1 (NS)	0.005*	0.003*	0.73 (NS)	<0.001*	<0.001*	<0.001*		0.65 (NS)

Table 3b: Correlation coefficients of all parameters continued

		6A-6B difference	**JL-FFP distance**	**JR-FFP distance**	**B6-FTP distance**	**6B-FTP distance**	**OPI**	**UMD**	**LMD**
Eur-Eur	**r**	-0.04	-0.005	0.02	-0.004	-0.04	0.14	0.15	0.14
	p-value	0.64 (NS)	0.95 (NS)	0.83 (NS)	0.96 (NS)	0.60 (NS)	0.09 (NS)	0.07 (NS)	0.08 (NS)
ZL-ZR width	**r**	-0.11	0.04	0.03	-0.06	-0.04	0.11	0.12	0.08
	p-value	0.18 (NS)	0.65 (NS)	0.76 (NS)	0.44(NS)	0.66 (NS)	0.17 (NS)	0.14 (NS)	0.33 (NS)
ZA-AZ	**r**	-0.21	-0.02	0.02	0.11	0.11	0.1	0.09	0.07
	p-value	0.009*	0.78 (NS)	0.77 (NS)	0.18(NS)	0.18 (NS)	0.22 (NS)	0.27 (NS)	0.39 (NS)
NC-CN	**r**	-0.02	0.04	-0.06	0.09	-0.03	0.02	0.2	0.20
	p-value	0.79 (NS)	0.61 (NS)	0.44 (NS)	0.28(NS)	0.71 (NS)	0.85 (NS)	0.01*	0.01*
JL-JR	**r**	-0.15	-0.32	-0.24	0.06	0.02	0.17	0.06	0.09
	p-value	0.06 (NS)	<0.001*	0.003*	0.47(NS)	0.81 (NS)	0.04*	0.46 (NS)	0.27 (NS)
AG-GA	**r**	-0.09	0.13	0.19	0.25	0.21	0.09	0.09	0.13
	p-value	0.25 (NS)	0.11 (NS)	0.02*	0.002*	0.01*	0.29 (NS)	0.25 (NS)	0.10 (NS)
A6-6A	**r**	-0.05	-0.19	-0.24	-0.25	-0.35	0.14	0.11	0.16
	p-value	0.57 (NS)	0.02*	0.003*	0.002*	<0.001*	0.10 (NS)	0.16 (NS)	0.04*
A3-3A	**r**	-0.10	-0.01	-0.04	-0.13	-0.22	0.03	0.19	0.21
	p-value	0.21(NS)	0.89 (NS)	0.59 (NS)	0.10(NS)	0.008*	0.71 (NS)	0.02*	0.009*
B6-6B	**r**	0.24	-0.14	-0.30	-0.47	-0.61	0.09	0.12	0.13
	p-value	0.004*	0.09 (NS)	<0.001*	<0.001*	<0.001*	0.29 (NS)	0.14 (NS)	0.10 (NS)
B3-3B	**r**	-0.05	-0.04	-0.04	-0.21	-0.27	0.03	0.17	0.15

	p-value	0.53 (NS)	0.66 (NS)	0.61 (NS)	0.01*	0.001*	0.72 (NS)	0.03*	0.07 (NS)
A6-B6 difference	**r**	0.30	0.12	-0.06	-0.34	-0.19	-0.16	0.03	-0.03
	p-value	<0.001*	0.14 (NS)	0.48 (NS)	<0.001*	0.02*	0.05 (NS)	0.74 (NS)	0.76 (NS)
6A-6B difference	**r**	1	-0.15	-0.20	-0.24	-0.32	-0.05	0.12	0.03
	p-value		0.07 (NS)	0.01*	0.003*	<0.001*	0.54 (NS)	0.16 (NS)	0.68 (NS)
JL-FFP distance	**r**		1	0.38	0.32	0.15	-0.11	0.08	0.08
	p-value			<0.001*	<0.001*	0.06 (NS)	0.19 (NS)	0.31 (NS)	0.36 (NS)
JR-FFP distance	**r**	-0.20	0.38	1	0.25	0.40	0.07	-0.03	-0.009
	p-value	0.01*	<0.001*		0.002*	<0.001*	0.4 (NS)	0.76 (NS)	0.92 (NS)
B6-FTP distance	**r**	-0.24	0.32	0.25	1	0.61	0.08	-0.06	-0.04
	p-value	0.0038	<0.001*	0.002*		<0.001*	0.34 (NS)	0.46 (NS)	0.64 (NS)
6B-FTP distance	**r**	-0.32	0.15	0.40	0.61	1	-0.05	-0.03	-0.02
	p-value	<0.001*	0.06 (NS)	<0.001*	<0.001*		0.57 (NS)	0.71 (NS)	0.86 (NS)
OPI	**r**	-0.05	-0.11	0.08	0.08	-0.05	1	0	-0.08
	p-value	0.54 (NS)	0.19 (NS)	0.34 (NS)	0.34 (NS)	0.57 (NS)		1	0.35 (NS)
UMD	**r**	0.12	0.08	-0.06	-0.06	-0.03	0	1	0.84
	p-value	0.16 (NS)	0.31 (NS)	0.46 (NS)	0.46 (NS)	0.71 (NS)	1		<0.001 *

Result

In this study, 150 posteroanterior cephalometric radiographs of local population of north Bangalore adults with class I molar relationship were selected. The data obtained by linear measurements were subjected to statistical analysis.

Statistical methods

The results for each parameter were averaged (Mean ± Standard Deviation) for continuous data and are presented in Tables and Figures. To compare the changes observed in men and women, independent-samples *t* tests were performed. The Pearson product-moment correlation coefficient was calculated to indicate the relationship between all investigated linear dimensions.

Significant figures

Non -significant (p value: $p>0.05$)
Significant (p value: $p< 0.05$)

Statistical software

Data analysis was carried out using IBM SPSS version 21.0. Microsoft word and Excel have been used to generate graphs and tables.

The structures located in the PA cephalometric analysis were generally well visualized on the cephalograms. Table I shows the PA cephalometric combined norms, standard deviations, and minimum and maximum values of 19 linear transverse measurements for north Bangalore adults.

Results were obtained through the independent-samples *t* test applied to compare the measurement differences between men and women. The results were tabulated.

1. **Table** I depicts posteroanterior Cephalometric Norms Of north Bangalore Adults- Linear Transverse Measurements
2. **Table** IIa shows descriptive Statistic Results Of The Measurements For The Samples Of Adult north Bangalore Men
3. **Table** II b shows descriptive Statistic Results Of The Measurements For The Samples Of Adult north Bangalore Women.
4. **Table** III b: Correlates Coefficients Of All Parameters Continued.
5. **Table** III:a Correlates Coefficients Of All Parameters.

Discussion

This investigation was done to study samples of untreated north Bangalore adults with ideal occlusion and well balanced faces.

Facial features are variable and specific to populations and ethnic groupings; as a consequence, there are no universal radiograph norms as the basis for orthodontic treatment. For this reason and as a quest to provide culturally sensitive and appropriate orthodontic treatment,

norms ought to be developed for each population grouping as a basis for management. These norms include skeletal, dental, and soft tissues structures.[11]

The tracing of PA radiogram should be carried out by placing the cephalograph in front of the examiner as if he/she is looking at the skeletal structure of the patient.[13]

However, there are many differences between PA cephalographs of different nations, between Japanese and of European- American adults.[8] To establish a guide for facial balance, Arnett *et al* studied on STCA (soft tissue cephalometric analysis) for treatment planning for facial deformity cases.[14] They also scrutinized on the correlation between soft tissue and frontal aspect of skeletal structure.

Wei[9] produced PA cephalometric normative data for Chinese subjects after examining 84 boys and 22 girls.

Uysal [1] produced PA cephalometric normative data for Turkish adults after examining 46 men and 54 women.

With a similar aim, this study was carried out to establish cephalometric normative data from PA cephalograms for north Bangalore adults.

In our study, we used PA cephalometric analysis measurements of Ricketts *et al*[1] to determine the normative data for Indian adults. Method of Ricketts seems to be the most widely used, perhaps because it provides normative values for different ages.

Comparing the skeletal features of different nations, this study showed that cranial width of north Bangalore adults is 145.2mm, whereas for Turkish adults this value measures 159.7mm[1], due to lesser overall skeletal measurements in north Bangalore adults as compared to other population adults.

Iranians cranial width (171.75 mm) is wider than of Palestinians (148.71 mm). This value was 150.31 mm for females and 177.09 mm for males, while this measurement for Palestinians was 147.46 mm for females and 150.31 mm for males.[16] However, no differences were found between Jordanian males and females.[15]

In the study done by Uysal[1] in Turkish adults ZA-AZ measurement was 139.6mm, similar to the clinical norms of Ricketts *et al.* In the present study ZA-AZ measurement was 127.4mm, for Iranian [11] population it was 146.5mm and for Pakistani [10] population facial width (ZA-AZ) measurement was 141.1mm. Wei[9] in Chinese subjects found this measurement 125.8mm for females and 132.8mm for males. The NC-CN measurement was approximately 31.3 mm for an adult (at age 18) according to Ricketts *et al.* [1] In our study, this measurement was 30.5mm similar-32.4mm in Turkish adults. Whereas for Iran[11] and Pakistan[10] population NC-CN measured 37.9mm and 43.5mm respectively.

Snodell *et al* [6] indicated that there is an average increase in maxillary intermolar width (A6-6A) of 1.4 mm from 16 to 18 years for boys. They stated that, after age 18, insignificant growth changes occur in A6-6A distances. In our study, the intermolar distance norm value was 62.2mm similar to Turkish adults being 61.1mm.

Meredith[1] found that male subjects had greater facial widths than female subjects for each age group studied. WC Ngeow *et al*[12] found that males in general have higher measurement than females for the Malaysian Indian population.

In the current study, the data were separated according to sex to obtain more specific and useful cephalometric normative values, the sexual dimorphism was found to be significant for 16 transverse linear measurements, not including the 6A-6B difference, the JL-FFP and A6-B6 difference. Additionally, comparison between Turkish men and women indicated larger measurements for men in all linear transverse measurements except for the JR-FFP distance.

Regarding the nasal width, Oladipo *et al* [17] in their study on Nigerian reported that the nasal width of males was 40.10 mm and of females was 39.30 mm. In comparison, this measurement for Palestinians was much less; 33.54 mm for male adults and for females was 31.14 mm [47]. However, nasal width of Iranian[11] adults averagely was 37.57 mm, and gender-based were 37.31 mm for males and a slightly wider 37.86 mm for females. Therefore, Iranian nasal width is shorter than of Nigerians but is wider than of Palestinian population.

In the present study NC-CN measurement was 30.5mm with slight variation between females (30.4mm) and males (30.7mm). Nasal width of north Bangalore adults were shorter than Nigerian[17], Iranian[11], Turkish [1] (32.4mm) and Pakistani adults (43.5mm).

In our study, the facial width was significantly correlated with the cranial width (r = 0.55), ZL-ZR (r = 0.56), nasal width (r = 0.21), maxillary width (r = 0.65), mandibular width (r = 0.35), maxillary intermolar (r = 0.51), mandibular intermolar width (r = 0.3). Maxillary intermolar width was significantly correlated with all the skeletal parameters and also mandibular intermolar width ($p < 0.05$).

Conclusion

Following conclusions are drawn

1. Posteroanterior cephalometric transverse linear norms for north Bangalore adults are determined.
2. The results of this study have clinical implications in the diagnosis and treatment planning of north Bangalore patients. In general, most measurements are similar to Ricketts' clinical norms.
3. Most of the north Bangalore PA cephalometric linear measurements showed statistically significant sex differences. Comparisons between north Bangalore men and women indicated higher measurements for men in all linear transverse measurements except the JL-FFP distance, A6-B6 difference, 6A-6B difference.
4. The PA radiograph norms for north Bangalore adults are comparable to other populations, all transverse linear variables are shorter in north Bangalore adults as compared to other population adults.

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How to cite: Garg P, Reddy V P, Ramesh P C, B Shetty, Chandrashekar B S, Arun AV To determine posteroanterior cephalometric norms for North Bangalore adults *J Contemp Orthod. 2021;5(4):6-14.*