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Posteroanterior cephalometric norms in Pakistani adults

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Abstract

Introduction: Posteroanterior cephalometric (PAC) projections and relevant analyses constitute an important adjunct for qualitative and quantitative evaluation of the dentofacial region. PA cephalometric films can be used to evaluate vertical, transverse and sagittal dimensions. More over dentoalveolar/ facial asymmetries, dental / skeletal cross bites and functional mandibular displacement can also be assessed. PAC norms for different ethnic and racial groups have been established in many studies. The objective of present study was to determine the norms of postero-anterior cephalometric measurements in Pakistani adult population.

Material and Methods: 100 subjects including 47 males and 53 females (18-35 years) with skeletal class I were included in the study. PAC was taken in standardized conditions. 13 linear transverse skeletal and dental measurements were done for each radiograph.

Results: The data was processed using SPSS. For each variable mean and standard deviations were calculated by applying descriptive analysis.

Conclusions: PA cephalometric norms for Pakistani adults are close to Rickett's Posteroanterior cephalometric norms. Clinically this will help orthodontists and maxillofacial surgeons to get more definite and predicted results in their treatment domains.

Keywords: Class I occlusion; Pakistani population; Asymmetry

Introduction

The face is the most unique feature of a person and plays an inimitable role in all social interactions as well as in the formation of self image. The variability of face can be depicted by angles and planes but not its beauty.[1,2] Human face grows in all three plans of spaces. The transverse dimension of the face affects the overall determination of the dentofacial proportions as well its balance and harmony.[3-5] Detailed information in the transverse along with vertical plane is needed in many cases which can be provided by posteroanterior cephalogram (PAC).[1,2] Posteroanterior (PAC) projections and relevant analyses constitute an important adjunct for qualitative and quantitative evaluation of the dentofacial region. PAC are regular part of diagnostic records of every patient reporting for the treatment of their craniofacial anomalies; to evaluate dento-skeletal asymmetry of patients,[6,7] to evaluate changes in transverse dimensions after rapid palatal expansion,[8] early diagnosis of displacement of upper permanent canines, prognosis of canine impaction resolution[9] and to determine transverse growth of maxilla and mandible.[7,10] In cases where there is unilateral or bilateral cross bites, nasal obstruction with mouth breathing and tendency towards "long face syndrome",[11] estimation of differences during growth in millimeters and/or ratios.[12-15] Reproducing head posture, difficulty in identifying landmarks because of superimposed structures, poor radiographic technique and concerns about exposure to radiation are the major limitations of PAC.[12-15]

PA radiographs of the head are taken with the x-ray beam perpendicular to the patient's coronal plane with the x-ray source behind the head and the film cassette in front of the patient's face[16] maintaining a film- porionic plane distance of 13 cm as a standard.[11]

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Cephalometric norms for different ethnic and racial groups have been established in many studies. Most investigators have concluded that there are significant differences between various ethnic and racial groups and as a result, a number of cephalometric standards have been developed. All these studies indicate that measurements of a single group cannot be considered normal for every race or ethnic group. Different racial groups must be treated according to their own characteristics.[17-19] However, it is not the purpose of these normal data to be used as a template. Orthodontic and orthognathic treatments should always be planned according to each patient's needs and desires.[20]

Basyouni and Ahmad conducted a study in which they developed standard norms for the transverse dimensions of the face from childhood to adulthood. The sample consisted of PA cephalometric radiographs for 60 subjects including both gender at each age-level of 6, 12 and 18 years. All subjects belonged to Caucasian of northern European descent.[20] Uysal developed PA cephalometric norms for Turkish adults.[21] Taki in 2009 revealed norms for Palestinian adult population.[22] Ioi and Nakata conducted a study on Japanese population in the antero posterior dimension. The Japanese subjects had a significantly more retruded chin position, typically protruding mandibular incisors and protruded lip positions compared with the Caucasian norms. In the vertical dimensions, the Japanese had a significantly steeper mandibular plane angle. The results of this study suggest that these cephalometric measurements might be helpful to formulate treatment plans for Japanese patients.[23] Wei in 1970 conducted a study on craniofacial dimension of Chinese population and concluded that Chinese people's facial width is significantly higher than white population.[24] Allan conducted a retrospective study in 2003 in which he concluded that seven characteristics were significantly different between the cross-bite and non-cross bite groups namely; mandibular plane angle, lower face height, skeletal maxillary to mandibular width ratio, maxillary inter-molar width, mandibular inter-molar width, maxillary to mandibular inter-molar width ratio and mandibular unit length.[25]

All these studies indicate that normal measurements for 1 group should not be considered normal for other races or ethnic groups. Different racial groups must be treated according to their own characteristics. The objective of this study was to determine norms in Pakistani population visiting Orthodontic department, de' Montmorency College of Dentistry, Lahore. The rationale for the present study was to determine mean PA cephalometric values for Pakistani adults to aid as a tool in diagnosis and the treatment planning of orthodontic and orthognathic surgery patients.

Material and Methods

A total of 100 subjects were included in this study (47 males and 53 females). All had class I dental and skeletal relationships. The mean age of the sample was 24.5 $\pm$ 4.3 years with a range of 18-35 years for both males and females. The inclusion criteria were Pakistani decent with Pakistani parents, age range between 18 to 35 years, class I occlusion with minor or no crowding on clinical assessment, normal growth and development, well-aligned maxillary and mandibular dental arches on clinical assessment, good facial symmetry determined clinically and radiographically. The exclusion criteria were; significant medical history which could affect growth e.g. growth hormone deficiency, history of trauma to maxillofacial region, history of previous orthodontic, prosthodontic treatment and maxillofacial or plastic surgery.

After taking informed consent, 100 adult patients of both genders of Pakistani decent were selected for the study from outdoor department of Orthodontics, de'

Montmorency College of Dentistry/Punjab Dental Hospital in accordance with the selection criteria. The demographic and other data were entered on proforma. PA cephalogram of all subjects were taken in the standard manner i.e. with the distance between the x-ray tube and the ear post axis fixed at 5 feet (1.524 m) and with the film near the nose. The ear rods were inserted into the external auditory canals while the Frankfort plane being parallel to the floor. The central x-ray beam was penetrating the patient's skull in a PA direction and bisected the trans-meatal axis perpendicularly.

The cephalometric radiographs were traced by hand on 0.003 matte acetate sheets by one Investigator and measured. Five individuals were dropped out at this stage as they were not skeletally class I and their soft tissue was masking the underlying skeletal discrepancy. Sixteen landmarks were identified (Fig 1) Thirteen transverse linear measurements were measured on each radiograph and five reference planes were used (Fig 2).

The confounding variables were controlled by strictly following selection criteria and biases addressed by using same radiographic technique and equipment. Statistical analysis was performed with a commercial software package (Statistical Package for Social Sciences, version 11.0. For each variable, mean, standard deviation and minimum and maximum values were calculated. The quantitative age and PA cephalometric measurements were presented by calculating mean and standard deviation.

Results

Table I presents the descriptive statistical results of the measurements for the samples of 100 adult Pakistani women and men. It shows the arithmetic mean, minimum value, maximum value and standard deviation for 13 skeletal and dental measurements. The standard deviations of most of the skeletal and dental measurements were relatively small when they were compared with their corresponding mean values.

Landmark	Definition
ZL	Intersection between left zygomatico-frontal suture and orbit
ZR	Intersection between right zygomatico-frontal suture and orbit
ZA	Intersection of lateral borders of left zygomatic arch
AZ	Intersection of lateral borders of right zygomatic arch
NC	Widest part of left nasal cavity
CN	Widest part of right nasal cavity
Me	Most inferior point of mandibular symphisis, in midsagittal plane
AN	Anterior nasal spine
A6	Outermost point of maxillary left first permanent molar, determined perpendicularly to occlusal plane
6A	Outermost point of maxillary right first permanent molar, determined perpendicularly to occlusal plane
JL	Intersection between processus zygomaticus and processus alveolaris maxillae on left side
JR	Intersection between processus zygomaticus and processus alveolaris maxillae on right side.
B6	Outermost points of mandibular left first permanent molar, determined perpendicularly to occlusal plane
6B	Outermost points of mandibular right first permanent molar, determined perpendicularly to occlusal plane
AG	Lateral and inferior border of left antegonial notch
GA	Lateral and inferior border of right antegonial notch

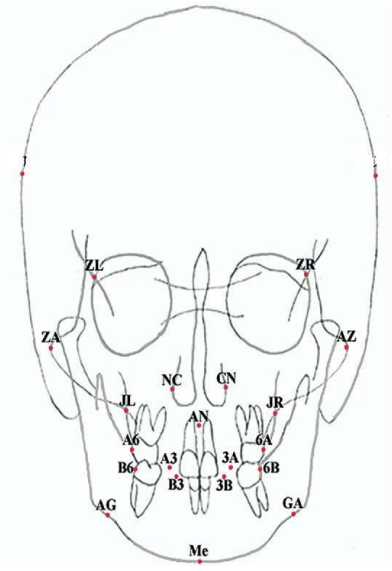

Figure 1: PA cephalometric landmarks

Serial #	Plane
1	Mid-sagittal plane (AN-Me)
2	Frontal tooth planes (FTP) (JL-AG and JR-GA)
3	Occlusal plane
4	Frontal face planes (FFP) (ZL-AG and ZR-GA
5	Z plane(ZL-ZR)

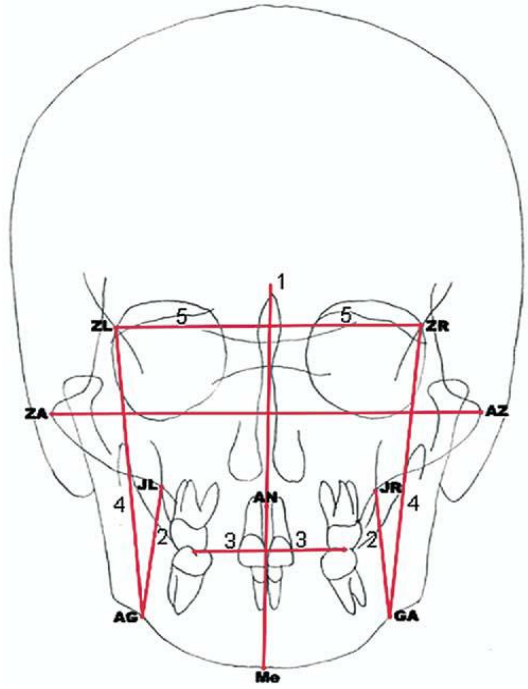

Figure 2: Reference planes used in PA cephalometric analysis

Linear Transverse Measurement

1	Facial width (ZA-AZ): width of the zygomatic arch at its most lateral aspect
2	Nasal width: width between the NC and CN points.
3	Maxillary width: width between the JL and JR points.
4	Mandibular width (bigonial width): width between the AG and GA points.
5	A6-B6 difference: difference between the outermost points of the maxillary and mandibular left permanent molars, determined perpendicularly to the occlusal plane
6	6A-6B difference: difference between the outermost points of the maxillary and mandibular right permanent molars, determined perpendicularly to the occlusal plane
7	JL-FFP distance: distance between JL point and FFP, determined perpendicularly to the occlusal plane.
8	JR-FFP distance: distance between JR point and FFP, determined perpendicularly to the occlusal plane.
9	B6-FTP distance: distance between B6 point and FTP, determined perpendicularly to the occlusal plane
10	6B-FTP distance: distance between 6B point and FTP, determined perpendicularly to the occlusal plane.
11	Occlusal plane inclination: difference between the right and left occlusal plane distances to the Z plane.
12	Upper midline deviation: distance between the contact point of the maxillary central incisors and the midsagittal plane.
13	Lower midline deviation: distance between the contact point of the mandibular central incisors and the midsagittal plane.

Descriptive statistics of PA cephalometric measurements (mm) for 100 Pakistani adults

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Facial width (ZA-AZ)	100	128.0	156.0	141.149	6.8187
Nasal width (NC-CN)	100	24.0	43.5	34.112	5.0225
Maxillary width (JL-JR)	100	59.0	84.0	71.414	5.8047
Mandibular width (AG-GA)	100	9.0	123.0	103.194	13.5301
A6-B6 difference	100	0.0	4.8	2.026	1.3845
6A-6B difference	100	0.0	4.5	2.040	1.2396
JL-FFP difference	100	4.0	24.0	13.642	4.7252
JR-FFP difference	100	2.0	25.0	14.552	5.0688
B6-FTP difference	100	4.5	25.0	11.872	4.8900
6B-FTP difference	100	4.0	161.0	13.994	18.9823
Occlusal plane inclination	100	0.0	4.5	1.415	1.0808
Upper midline deviation	100	0.0	9.0	1.047	1.0186
Lower midline deviation	100	0.0	4.0	1.039	.7064

Facial width mean values were 141.1 ± 6.8. Nasal width estimated as 34.1 ± 5. Maxillary width (JL-JR) was 71.4 ± 5.8, bi-gonial width (AG-GA) was 103.1 ± 13.5. The mean of A6-6B difference was 2.02 ± 1.3 and 6A-6B difference was 2.04 ± 1.2 whereas JL-FFP and JR-FFP was 13.64 ± 4.7 and 14.5 ± 5.06 respectively. 11.8 ± 4 and 13.99 ± 18.9 were for B6-FTP and 6B-FTP. Occlusal plan inclination was 1.4 ± 1 and upper/lower midline deviation was 1.04 ± 1 and 1.03 ± 0.7 respectively.

Discussion

With paradigm shifted treatment planning, the need of frontal cephalometry has increased. PAC must be evaluated because growth in the transverse plane is completed earlier. This investigation is the first to study samples of untreated Pakistani adults with ideal occlusion and well balanced faces. The inclusion criteria and methodology were oriented to identify normative mean values that can assist in the diagnosis and treatment planning of Pakistani adults seeking orthodontic treatment or orthognathic surgery. Adults 18 to 35 years of age of both sexes were included in the sample.

Huertas[26] and Ghafari[27] found that the increase in mandibular width (Ag-Ag) was twice as much as that in maxillary width (J-J). Cortella[28] investigated a sample of 36 subjects (18 girls and 18 boys, Class I) from the Bolton-Brush growth center and reported greater growth observed in the mandibular width relative to the maxillary width in a normal group and as a consequence the ratio of J-J to Ag-Ag decreased from the age of 8 years till the age of 14 years. In the study conducted by Chan J-J/Ag-Ag in the two Class III groups were evaluated. The change of the J-J/Ag-Ag during this period was larger in the low-angle group than in the high-angle group. This is expected because of the Ag and Go point is closer to the ramus and the area of attachment of the masticatory muscles.

Among several analyses,[29-32] the method of Ricketts [29,30] seems to be the most widely used perhaps because it provides normative values for different ages. Broadbent[33] derived Bolton PA cephalometric film standards from patients with ideal occlusion and well-balanced faces. Athanasiou emphasized that the data obtained from PA cephalogram are of value for diagnosis of various types of craniofacial anomalies and for monitoring the growth of persons or groups of corresponding age and race and for specified treatment planning.[2]

According to Ricketts,[29] facial width (Za-Za) had a mean value of 115.7mm at age of 9 years with 2.4mm increases per year which predicts that adults at the age of 18 would have Za-Za distance of 137.3mm. While Uysal[21] found the mean value was 135.88mm for facial width, slightly less than the clinical norm of Ricketts. In Pakistani adults the facial width was 141.1 ± 6.1mm which was near to both Ricketts and Uysal norms.

Ricketts[29] found nasal width (NC-CN) to have a mean value of 25mm at age 9 years with 0.7mm increase per year. The estimated nasal width at the age of 18 is 31.3mm or 32.43 ± 3.85. Similar results were obtained by Uysal[21] who documented nasal width in Turkish adults. Taki showed that the mean value of nasal width in Palestinian adults was 32.19 ± 3.4 mm. While in Pakistani adults the nasal width is 34.1 ± 5.02 mm, all these results showed that nasal with is a parameter which is showing almost the same results in different ethnic groups.[22,29]

Ricketts[29] found that the width of the maxilla (JL-JR) was 61.9 mm for a 9 year old subject and increased at the rate of 0.6 mm / year. According to them at age 18, the JL-JR distance was approximately 67.3 mm. In the present study, the mean JL-JR distance was 71.4 mm. On the other hand, Uysal's mean values for maxillary width were 69.86 mm for males and 63.81 mm for females. In recent studies, Taki's[22] finding of JL-JR width for

Palestinian population are 68.18 to 68.58 mm. This showed that in present study the selected cases have slightly larger maxillary width.

Ricketts[30] found that, mandibular width as measured from the anti-gonial notch points (AG-GA) had a norm of 76.1 mm at age 9 years and increased at the rate of 1.4 mm / year. Moreover, the AG-GA distance was approximately 88.7 mm for a young adult. In present study that is 103.14 ± 13.5. Similarly Cortella[28] determined PA cephalometric norms from the Bolton Study Group for AG-GA and JL-JR distances for a young adult population. They reported an AG-GA distance of 86.4 ± 4.5 mm and a JL-JR distance 64.7 ± 2.7 mm. In this Turkish adult population, the AG-GA and JL-JR distances were 98.03 ± 7.36 mm and 66.59 ± 4.85 mm respectively. He used data from the Bolton-Brush growth study to generate new norms for the PA analysis. In their study it was found that maxillary width (J-J) had a mean value at age 18 of 64.7 ± 2.7 mm. Palestinian adults have mean values for J-J distance of 65.56 ± 5.25 mm being very close to Ricketts values. The Bolton maxillary and mandibular width norms by Ricketts are similar to the corresponding radiographic values for Pakistani adults.[20,22,29]

Uysal[21] measured the A6-B6 difference 1.38 ± 1.2 while 6A-6B was 1.67 ± 1.6. In present study the difference is 2.02 ± 1.3 and 2.04 ± 1.2 for A6-B6 and 6A-6B respectively. Occlusal plane inclination according to Ricketts varies from 0 to 5 in adults. The inclination was 1.4 ± 1.08 here, while in adults of Turkey the mean was 1.38 ± 1.2 showing that both the readings fall in the same criteria and are close to Ricketts' analysis.

Palestinians shows 0.95 ± 0.84 mm deviation of upper midline. Among the Turkish adults the measurement slightly varies being 0.38 ± 0.68 but in Pakistani adults, the mean value is 1.0 ± 1 mm. The reasons could be data collection methodology difference, early loss of deciduous teeth and crowding. Pakistani adults showed lower mid-line deviation as 1.03 ± 0.7mm while Uysal reported 0.3 ± 0.64 mm for Turkish adults. Palestinian population showed 0.97 ± 0.64 mm deviation. All these measurement showed great closeness.[21,22]

Conclusions

Following conclusions can be drawn from the posteroanterior cephalometric mean measurements in adult orthodontic Pakistani sample having class I occlusion:

- Means of PA transverse linear norms for local adults are close to Ricketts norms.
- The results of this study have clinical implications in the diagnosis and treatment planning of Pakistani patients.

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