Comparison of gonial angle determination from cephalograms and orthopantomogram

Mandeep Kaur Bhullar, Amandeep Singh Uppal[1], Gulsheen Kaur Kochhar[2], Sanjay Chachra[2], Anuraj Singh Kochhar[3]

Department of Orthodontics and Dentofacial Orthopedics, Luxmi Bai Institute of Dental Sciences and Hospital, Patiala, Punjab, [1]Department of Conservative Dentistry and Endodontics, HSJ Institute of Dental Sciences and Hospital, Panjab University, Chandigarh, [2]Department of Pedodontics and Preventive Dentistry, Swami Devi Dayal Hospital and Dental College, Barwala, Panchkula, Haryana, [3]Private Practice, New Delhi, India

Abstract

Introduction: Gonial angle is an important parameter of the craniofacial complex giving an indication about the vertical parameters and symmetry of the facial skeleton. Both orthopantomogram (OPG) and lateral cephalograms can be used for the measurement of gonial angle. Because of the superimpositions seen on lateral cephalograms, reliable measurement of the gonial angle becomes difficult. The aim of the present study is to check the possible application and reliability of OPG for gonial angle determination by clarifying whether there is any significant difference between the determination of gonial angle from OPG and cephalogram. **Materials and Methods:** Gonial angle measurements were made on lateral cephalograms and orthopantomograms of 98 patients - 44 males (mean age 25.9 years) and 54 females (mean age 21.3 years), and compared using Statistical Package for Social Sciences. **Results:** One-way analysis of variance demonstrated no significant differences between the values of gonial angles determined by lateral cephalogram and panoramic radiography. Pearson correlation showed a high correlation between cephalometric and OPG gonial angle value. **Conclusion:** Panoramic radiography can be used to determine the gonial angle as accurately as a lateral cephalogram. For determination of the gonial angle, an OPG may be a better choice than a lateral cephalogram as there are no interferences due to superimposed images of anatomical structures as in a lateral cephalogram. Thus, the present study substantiates the possibility of enhancing the clinical versatility of the panoramic radiograph, which is an indispensable tool for dental diagnosis.

Key words: Cephalogram, gonial angle, orthopantomogram

INTRODUCTION

Orthodontic diagnosis and treatment planning involves detailed study of dental occlusion, hard tissue relationships and soft tissue proportions.[1] The orthodontic diagnosis database is derived from three major sources: History, clinical examination and evaluation of diagnostic records including dental casts, radiographs and photographs. Cephalograms and orthopantomogram (OPG) are routinely taken for every orthodontic patient. The goal of cephalometric analysis is to evaluate the horizontal and vertical relationship of five major functional components of the face: The cranium and cranial base, skeletal maxilla, skeletal mandible, the maxillary dentition and alveolar process and the mandibular dentition and alveolar process.[2] The vertical relationship of these structures is as important as the horizontal relations, as the treatment plan as well as the outcome is affected by the vertical relationships and the growth pattern of the patient. The external gonial angle is an important angle of the craniofacial complex. It is significant for the diagnosis of craniofacial disorders. Gonial angle is one of the important parameters giving an indication about the vertical parameters and symmetry of the facial skeleton. The gonial angle is measured by taking the tangent to the posterior border of the ramus and tangent to the lower border of the mandible on lateral cephalogram. Because of the superimpositions seen on lateral cephalograms, reliable measurement of the

Address for correspondence:
Dr. Mandeep Kaur Bhullar,
H. No. 3275, Sargodha Housing Society, Sector 50 D,
Chandigarh, India.
E-mail: mkbhullar@yahoo.co.in

gonial angle becomes difficult. Panoramic radiography first introduced by Professor Yrjö Paatero of the University of Helsinki (1961) is frequently used in orthodontic practice to provide important information about the teeth, their axial inclinations, maturation periods and surrounding tissues. By virtue of its ability to take a single picture of the entire stomatognathic system-teeth, jaws, temporomandibular joints, sinuses-panoramic radiography forms an indispensable orthodontic screening tool. Studies examining panoramic radiographs as a means of investigating skeletal patterns are lacking in the orthodontic literature. OPG, which is also used as an essential diagnostic aid, can be used for reliable measurement of the gonial angle as there is no complication of superimposed images appearing as in cephalograms.

Aims and objectives

The aim of the present study is to check the possible application (reliability) of OPG for gonial angle determination by clarifying whether there is any significant difference between the determination of gonial angle from OPG and cephalogram.

MATERIALS AND METHODS

Lateral cephalograms and orthopentomograms of 98 patients - 44 males (mean age 25.9 years) and 54 females (mean age 21.3 years) - were obtained from the patient records of the Department of Orthodontics and Dentofacial Orthopedics. Gonial angle was measured by drawing a tangent to the lower border of the mandible and a tangent to the distal border of the ramus and condyle. In lateral cephalograms, the mean of gonial angles in the superimposed projections was calculated.

Statistical analysis

The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA; version 15.0 for Windows). As our data for angles were quantitative data, these were estimated using mean and standard deviation. Normality of data was checked by measures of Kolmogorov Smirnov tests of normality. These data were normally distributed and means were compared using Student's *t*-test for male versus female. For malocclusion classes, means were compared using one-way analysis of variance (ANOVA). The Tukey HSD (*post hoc* test of multiple comparisons) test was not applied as there was no statistically significant difference observed by ANOVA. Pearson correlation was applied for comparing the correlation of different variables. All statistical tests were two-sided and performed at a significance level of $\alpha = 0.05$.

RESULTS

The mean value of the gonial angle in lateral cephalogram was 123.62° with a standard deviation of 6.80°. The mean value of the gonial angle in OPG was 122.82° with a standard deviation of 7.54°. In OPG, the mean value of the right gonial angle was 123.12° with a standard deviation of 6.7° and the mean value of the left gonial angle was 122.53° with a standard deviation of 11.0° [Table 1]. One-way ANOVA demonstrated no significant differences between the values of gonial angles determined by lateral cephalogram and OPG. Also, in OPG, there was no significant difference between the right and left gonial angles [Table 2]. As no statistically significant difference was seen by ANOVA, the *post hoc* test for multiple comparisons was not applied.

The subjects were then divided based on gender into males and females and compared using the T-test to check any overall gender difference for the value of gonial angle on OPG or cephalogram. In lateral cephalograms, the gonial angle in females was 123.94° and that in males was 123.23°. In panoramic radiography, the gonial angle in females was 122.69° and that in males was 122.98°. Table 3 shows that there was no statistically significant difference between the gonial angle values taken on lateral cephalograms and OPG.

Pearson correlation was applied to check for correlation between cephalometric and OPG gonial angle value. Table 4 shows a high correlation between the values taken on both the radiographs.

DISCUSSION

The goal of this study was to enhance the panoramic radiograph's clinical use by determining its potential for evaluating craniofacial specifications. Even though there are a number of published articles on magnification and image distortion in panoramic radiographs, there are only a few studies involving the use of panoramic radiographs in evaluating dentoskeletal specifications and gonial angle measurements.

The results of the study demonstrate that there are no statistically significant differences in the values of gonial angle measured on cephalogram and OPG. Therefore, it is possible to use OPG for measuring the gonial angle with equal accuracy as cephalogram. Rather, it may be desirable to make the gonial angle measurements on the OPG as both right and left gonial angles can be viewed separately and clearly on the OPG. This fact was established in the study

Table 1: Mean, standard deviation and standard error of OPG and cephalometric gonial angle values in subjects distributed on the basis of malocclusion

	N	Mean	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
Cephalometric gonial angle								
Cl I	42	123.12	6.714	1.036	121.03	125.21	105	132
Cl II	49	123.92	7.317	1.045	121.82	126.02	98	139
Cl III	7	124.57	2.992	1.131	121.80	127.34	120	130
Total	98	123.62	6.806	0.687	122.26	124.99	98	139
Gonial angle OPG right								
Cl I	42	122.60	6.808	1.050	120.47	124.72	104	132
Cl II	49	123.33	7.131	1.019	121.28	125.37	99	138
Cl III	7	124.86	2.968	1.122	122.11	127.60	120	130
Total	98	123.12	6.757	0.683	121.77	124.48	99	138
Gonial angle OPG left								
Cl I	42	122.90	6.778	1.046	120.79	125.02	103	132
Cl II	49	122.08	14.339	2.048	117.96	126.20	35	139
Cl III	7	123.43	2.637	0.997	120.99	125.87	121	129
Total	98	122.53	11.037	1.115	120.32	124.74	35	139
Gonial angle OPG total								
Cl I	42	122.7500	6.75373	1.04212	120.6454	124.8546	103.50	132.00
Cl II	49	122.7041	8.66261	1.23752	120.2159	125.1923	85.50	138.50
Cl III	7	124.1429	2.68816	1.01603	121.6567	126.6290	120.50	129.50
Total	98	122.8265	7.54953	0.76262	121.3129	124.3401	85.50	138.50

OPG: Orthopantomogram

Table 2: ANOVA comparing cephalometric gonial angle, OPG gonial angle right, OPG gonial angle left and OPG gonial angle total

	F	Sig.
Cephalometric gonial angle	0.226	0.798
Gonial angle OPG right	0.376	0.688
Gonial angle OPG left	0.086	0.917
Gonial angle OPG total	0.113	0.893

OPG: Orthopantomogram, ANOVA: Analysis of variance

Table 3: Means, standard deviation and standard error of gonial angle based on gender

Gender	N	Mean	Std. deviation	Std. error mean
Cephalometric gonial angle				
Male	44	123.23	6.153	0.928
Female	54	123.94	7.337	0.998
Gonial angle OPG right				
Male	44	122.66	6.232	0.939
Female	54	123.50	7.192	0.979
Gonial angle OPG left				
Male	44	123.32	6.003	0.905
Female	54	121.89	13.885	1.889
Gonial angle OPG total				
Male	44	122.9886	6.07079	0.91521
Female	54	122.6944	8.62391	1.17357

OPG: Orthopantomogram

conducted by Mattila *et al.*[3] They took measurements of gonial angle on cephalograms, OPG and dried skulls and concluded that the measurements on OPG for right and left gonial angles conform to the angles measured on dry skulls. They further concluded that means of the measurements made on cephalograms and OPG show that the measurements made on OPG are more accurate. The present study shows the same

results. But, still, the gonial angle measurements are routinely made on cephalogram rather than OPG. The results of the present study demonstrate that OPG can be used to make these measurements as often as lateral cephalograms, especially in cases where the outlines of two sides are not clearly visible and in asymmetry cases before PA cephalograms are taken. The present results are substantiated by Larheim and Svanaes (1986)[4] and Akcam *et al.*[5]

Alhaija[6] evaluated the potential of panoramic radiographs to measure mandibular inclination and steepness. A high correlation between the measurements taken from both radiographs was found. They concluded that panoramic radiographs are a useful tool for the measurement of gonial angle, which is an indicator of mandibular steepness and, subsequently, mandibular growth direction. The ability to determine growth direction from the OPG will be useful because majority of the dentists request an OPG for patients during routine dental examination. This will enable the dental professional to spot vertical growth problems using a readily available tool.

Fatahi and Babouei (2007)[7] evaluated the reliability of the cephalometric measurements when determined from an OPG. Comparison of actual measurements obtained from dry skulls and panoramic radiographic measurements revealed the highest correlation between panoramic and cephalometric radiographs in gonial angle, whereas the least correlation was seen in the length of the mandibular body. In different growth patterns, it was seen that gonial angle and ramus height showed the highest correlation between

Table 4: Correlations of cephalometric gonial angle, gonial angle OPG right, gonial angle OPG left, gonial angle OPG total

	Cephalometric gonial angle	Gonial angle OPG right	Gonial angle OPG left	Gonial angle OPG total
Cephalometric gonial angle				
Pearson correlation	1	0.988(**)	0.417(**)	0.747(**)
Sig. (2-tailed)		0.000	0.000	0.000
N	98	98	98	98
Gonial angle OPG right				
Pearson correlation	0.988(**)	1	0.406(**)	0.744(**)
Sig. (2-tailed)	0.000		0.000	0.000
N	98	98	98	98
Gonial angle OPG left				
Pearson correlation	0.417(**)	0.406(**)	1	0.913(**)
Sig. (2-tailed)	0.000	0.000		0.000
N	98	98	98	98
Gonial angle OPG total				
Pearson correlation	0.747(**)	0.744(**)	0.913(**)	1
Sig. (2-tailed)	0.000	0.000	0.000	
N	98	98	98	98

**Correlation is significant at the 0.01 level (2-tailed). OPG: Orthopantomogram

the two radiographs. They concluded that the ability to determine growth direction from the OPG should be useful because majority of the dentists request an OPG for patients during routine dental examination.

Kurt *et al.*[8] used OPGs to evaluate mandibular asymmetry in Class II subdivision malocclusion patients by measuring condylar, ramal, condylar-ramal asymmetry index values and gonial angle measurements. They concluded that acceptable results can be achieved with panoramic radiographs. The added advantages of panoramic radiographs is that they are non-invasive, have a favorable cost-benefit relationship and expose subjects to a relatively low dose of radiations.

Shahabi *et al.*[9] compared the external gonial angle determined from the lateral cephalograms and panoramic radiographs in Class I patients. Based on the obtained results, they concluded that panoramic radiography can be used to determine the gonial angle as accurately as a lateral cephalogram.

Jena *et al.*[10] concluded that OPGs can be used for vertical and angular measurements as well as evaluation of side to side mandibular asymmetry.

Ongkosuwito *et al.* (2009)[11] concluded that an OPG is as reliable as a lateral cephalogram for linear measurements of the mandible, i.e., condylion-gonion, gonion-menton and condylion-menton.

CONCLUSION

Panoramic radiography can be used to determine the gonial angle as accurately as a lateral cephalogram as there are no significant differences in the gonial angle values as measured on cephalogram and OPG. In addition, OPG forms an additional tool for easier and more accurate determination of both right and left gonial angles of a patient without interferences due to superimposed images of anatomical structures in a lateral cephalogram. For determination of the gonial angle, an OPG may be a better choice than a lateral cephalogram. Thus, the present study substantiates the possibility of enhancing the clinical versatility of the panoramic radiograph, which is an indispensable tool for dental diagnosis.

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