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Can OPG serve as a substitute for Lateral Cephalogram to determine the Jarabak's Gonial Angle and to evaluate any Gender difference in this Angle in different Skeletal groups

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Abstract: Introduction: *The external gonial angle is an important angle of the craniofacial complex. It is significant for the diagnosis of craniofacial disorders. Lateral and anteroposterior projections are mostly used when cephalometric measurements are made from radiographs. However, because of the interference of superimposed images appearing on the lateral cephalograms, reliable measurements of the individual gonial angles become very difficult, particularly when planning any type of jaw surgery. This disadvantage is not encountered in orthopantomography which is being used increasingly for jaw examination.*
Aims and objectives: *The main purpose of this article is to assess and compare the quantification of gonial angle from panoramic radiographs and lateral cephalograms in adult patients with different malocclusion groups and also to determine any gender difference in gonial angle measurements.*
Materials and Methods: *The study was carried out by including a total sample of 60 subjects with 20 subjects in each Class I, Class II and Class III skeletal pattern. The level of significance was set at 0.05. A total of 60 subjects (aged 18–30 years) were included, with male and female subjects and external gonial angle in OPG and Lateral cephalogram was measured and comparison between the external gonial angle in lateral cephalogram was made with the right and left gonial angles in OPG and comparison was also made between males and females in different malocclusions groups to check any gender differences, and mean values, SDs, and P values were calculated with Statistical software SPSS (version 20.0) and Microsoft Excel.*
Results & observation: *Descriptive statistics was first done to find out the means of external gonial angle in OPG and lateral cephalograms and the standard deviation was calculated in each group (Table 1), then intergroup comparison was done between three groups for each group and between males and females by using the Analysis of variance (ANOVA) and Student's independent t test. On comparing the right and left gonial angles in OPG with each other and also with the external gonial angle in lateral cephalogram, the P value was statistically insignificant in class I, and III subjects. On comparing the right and left gonial angles in OPG in Class II subjects there was no statistically significant difference but on comparing the external gonial angle in lateral cephalogram with right and left gonial angles in OPG in Class II subjects, the P value was statistically significant and any gender difference was statistically insignificant in all the three groups.*
Conclusions: *The study demonstrates that the size of the gonial angle can be determined from the orthopantomogram with the same degree of accuracy as from the generally used lateral cephalogram in class I & III subjects. But in case of class II subjects it also shows that the right and left gonial angles can be more accurately determined from orthopantomograms, thus avoiding the disturbing influence of the superimposed images found in lateral cephalograms & comparison of gonial angle between males and females didn't show any significant difference in any malocclusion group.*
Key words: *Lateral cephalogram; OPG; Gonial angle.*

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I. Introduction

The external gonial angle is an important angle of the craniofacial complex. It is significant for the diagnosis of craniofacial disorders. It is an expression for the form of the mandible with reference to the relation between body and ramus. The gonial angle also plays a role in growth prognosis. A large gonial angle indicates more of a tendency to posterior rotation of the mandible, with condylar growth directed posteriorly. A small gonial angle on the other hand indicates vertical growth of condyles, giving a tendency to anterior rotation with growth of the mandible.[1]

Panoramic radiography was introduced for the first time by Professor Yrjo Paatero of the University of Helsinki in 1961.[2] It is frequently used in orthodontic practice to provide important information about the teeth, their axial inclinations, maturation periods, and surrounding tissues.[3,4,5] Lateral and anteroposterior projections are mostly used when cephalometric measurements are made from radiographs. However, because of the interference of superimposed images appearing on the lateral cephalograms, reliable measurements of the individual gonial angles become very difficult, particularly when planning any type of jaw surgery. This disadvantage is not encountered in orthopantomography which is being used increasingly for jaw examination.[6] However, Larheim and Syanaes indicated that lateral cephalograms did not permit reliable registration of the gonial angle, and the superimposed images created difficulties in recognition and measurement of the individual angles, whereas the gonial angle assessed from a panoramic film was almost identical to that measured on the dried mandible. Hence the gonial angle can be determined more easily in an orthopantomogram than in a lateral cepahlogram.[7,8]

II. Aims and objectives

The study was carried out with the following objectives:

- To scrutinize the reliability of gonial angle in orthopantomogram as compared to lateral cephalograms.
- To assess the gonial angle in different malocclusion groups and also to determine any gender difference in gonial angle measurement.

III. Materials and Methods

For the proposed study the probability of type 1 error (α) is fixed at 5% and probability of type 2 error (β) at 20%. Hence, the power of the study will be 80%.

The sample size for this study has been determined scientifically. Sample size determination was done using Cohen's d power table. The following formulae was used to calculate Cohen's d,

Cohen's d = $\frac{M1-M2}{SD}$ where, M_1 is mean 1 and M_2 is mean 2.

So, for the power of the study as 80% the sample size of minimum of 20 for each group had to be established.

Based on the above calculations the study included a total sample of 60 subjects with 20 subjects in each Class I skeletal pattern, Class II skeletal pattern and Class III skeletal pattern who had to undergo orthodontic treatment at the Department of Orthodontics Government Dental College and Hospital Srinagar, Kashmir. The level of significance was set at 0.05. Total of 60 subjects (aged 18–30 years) were included, with male and female subjects.

All the selected subjects should meet the following criteria:

Inclusion criteria:

1. Patients with different types of skeletal malocclusions.
2. Patients within the selected age group.
3. Complete eruption of all the permanent teeth.
4. Patients who will undergo orthodontic treatment.
5. The radiographs had to be of high quality and sharpness.
6. All the radiographs to be taken by the same operator and in the natural head position.

Exclusion criteria:

1. Patients with craniofacial anomalies and syndromes.
2. Cleft lip and cleft palate patients.
3. Cases with congenitally missing teeth.
4. X -Ray scans showing supernumerary teeth, enlarged/cystic follicle, or any other pathology.
5. History of facial trauma.

To have standardized cephalometric radiographs it became important that all the radiographs were taken from the same X-ray machine with the subjects in the natural head position, with teeth in maximum intercuspation and lips at repose. All the lateral cephalometric radiographs were taken by the same operator from the standardized Orthophos XG5 DS CEPH (SIRONA) on a standard Konica Minolta 8 × 10 inch size film with an anode to midsubject distance of 5 feet by the same operator. Natural head position was obtained by asking the subject to look straight ahead such that the visual axis was parallel to the floor.

All the orthopantomograms (OPG) were taken by the same operator from the standardized Orthophos XG-PLUS panoramic machine on a standard Konica Minolta 6×12 inch size film with an anode to midsubject distance of 5 feet by the same operator. Natural head position was obtained by asking the subject to look straight ahead such that the visual axis was parallel to the floor.

A sample of 60 lateral cephalograms and orthopantomograms (OPG) were taken. All the lateral cephalograms and orthopantomograms were traced upon an A4 size acetate paper with a 2B or 3HB hard lead pencil over well-illuminated viewing screen. The linear measurements were recorded with a measuring scale up to a precision of 0.5 mm. It was decided to segregate the radiographs into different anteroposterior skeletal patterns on the basis of parameters like ANB angle,[9] Beta angle,[10] Witt's Appraisal.[11]

Planes and Parameters used in methodology

1. External gonial angle in OPG by drawing a tangent to the posterior border of the mandibular ramus and the inferior border of the mandible.[1,7]
2. External gonial angle in Lateral cephalogram by drawing a tangent to the posterior border of the mandibular ramus and tangent to the lower border of the mandible by connecting two points i.e; Gonion and Menton.[9]
3. External gonial angle in male and female patients.

(Fig a) **(Fig b)**

External gonial angle in lateral cephalograms (Fig a) and OPG (Fig b)

Statistical methods

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Data were expressed as Mean±SD. Analysis of variance (ANOVA) and Student's independent t-test were employed for inter group analysis of data. Graphically the data was presented by bar diagrams. A P-value of less than 0.05 was considered statistically significant. All P-values were two tailed.

IV. Results

Descriptive statistics was first done to find out the means of external gonial angle in OPG and lateral cephalograms and the standard deviation was calculated in each group (table 1), then intergroup comparison was done between three groups for each group and between males and females by using the Analysis of variance(ANOVA) and Student's independent t-test. The standard deviation of right gonial angle in OPG was 5.99, 7.37, 8.82 in class I, class II, class III subjects respectively and SD of left gonial angle in I class I, class II, class III subjects in OPG was 6.26, 6.34, 9.20 respectively and the SD of external gonial angle in lateral cephalograms was 7.37, 7.68, 8.28 in class I, Class II, Class III groups respectively (table 1). On comparing the right and left gonial angle in OPG with each other and also with the external gonial angle in lateral cephalogram, the P value was statistically insignificant in class I, and III subjects (table 2 & 4). On comparing the right and left gonial angles in OPG in Class II subjects there was no statistically significant difference but on comparing the external gonial angle in lateral cephalogram with right and left gonial angles in OPG, the P value was statistically significant (table 3) and any gender difference was statistically insignificant in all the three groups (Tables 2, 3 and 4).

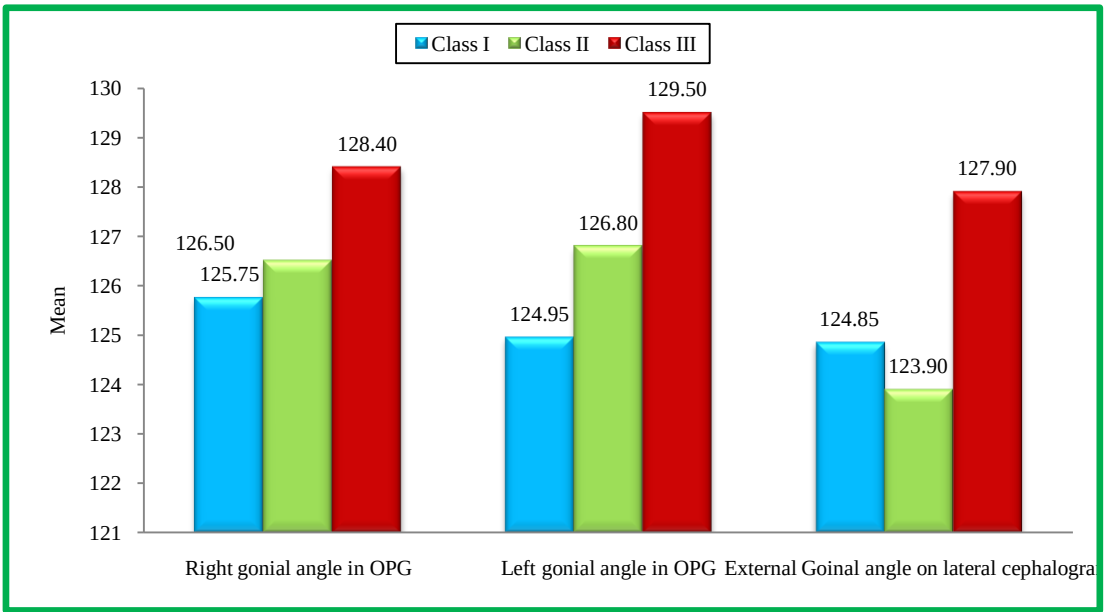
Table 1: Showing descriptive statistics of cephalometric variables according to malocclusion groups

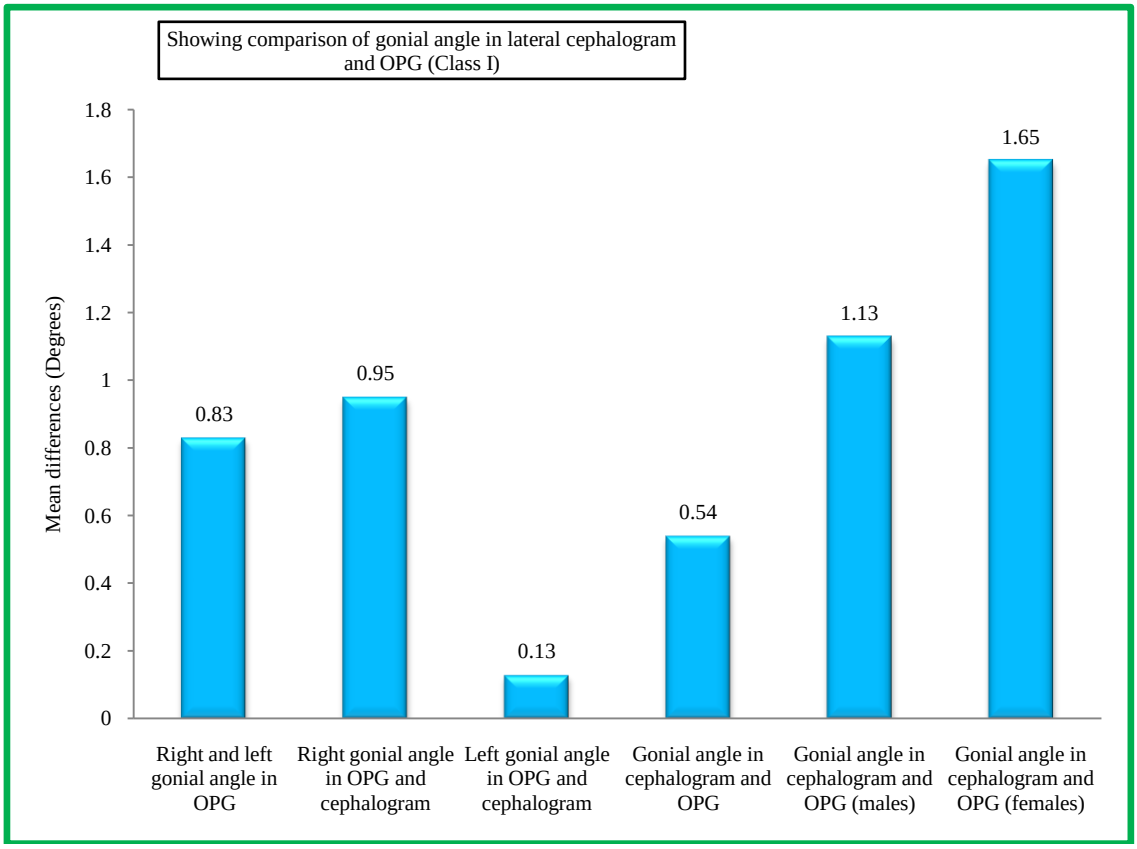
Cephalometric variable	Class I		Class II		Class III	
	Mean	SD	Mean	SD	Mean	SD
Right gonial angle in OPG	125.75	5.99	126.50	7.37	128.40	8.82
Left gonial angle in OPG	124.95	6.26	126.80	6.34	129.50	9.20
External Gonial angle in Lateral Cephalogram	124.85	7.37	123.90	7.68	127.90	8.28

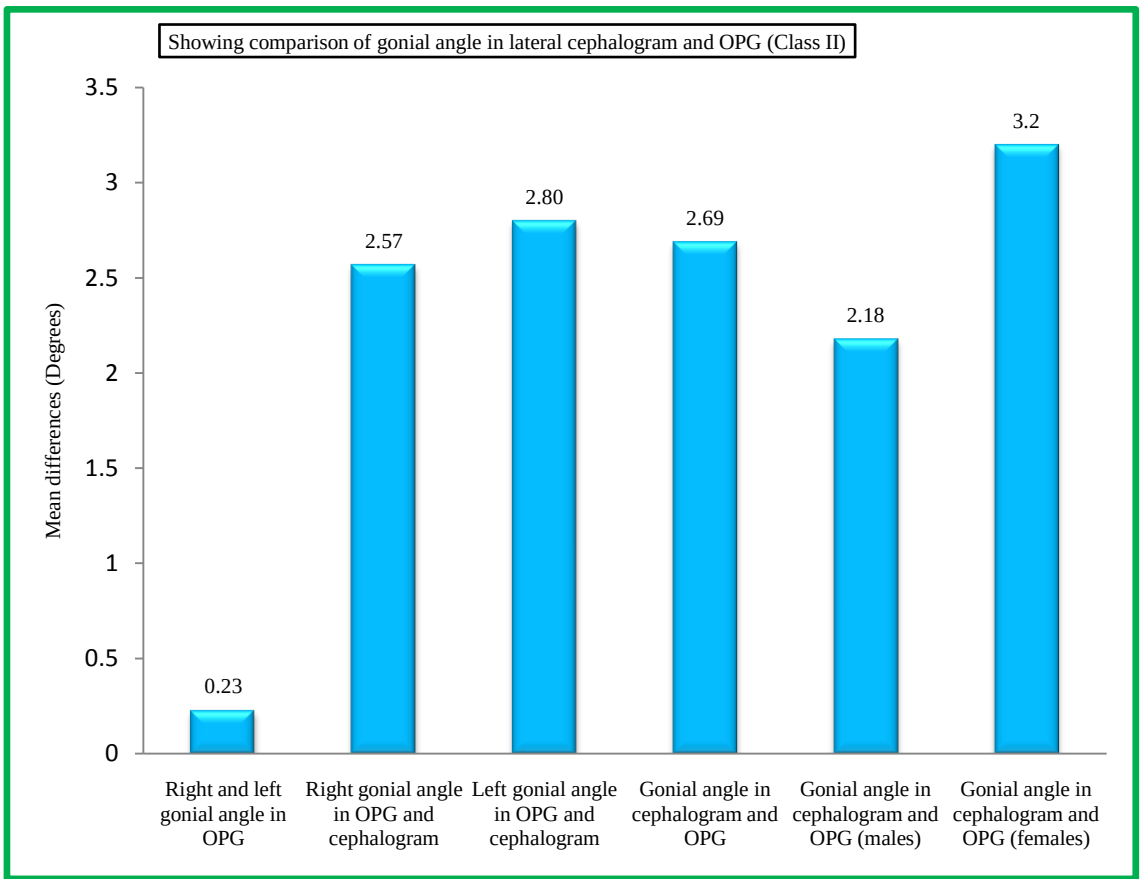
Table 2: Showing comparison of gonial angle in lateral cephalogram and OPG (Class I)		
Variable	Mean differences (Degrees)	P-value
Right and left gonial angle in OPG	0.83	0.269
Right gonial angle in OPG and cephalogram	0.95	0.327
Left gonial angle in OPG and cephalogram	0.13	0.880
Gonial angle in cephalogram and OPG	0.54	0.512
Gonial angle in cephalogram and OPG (males)	1.13	0.489
Gonial angle in cephalogram and OPG (females)	1.65	0.054

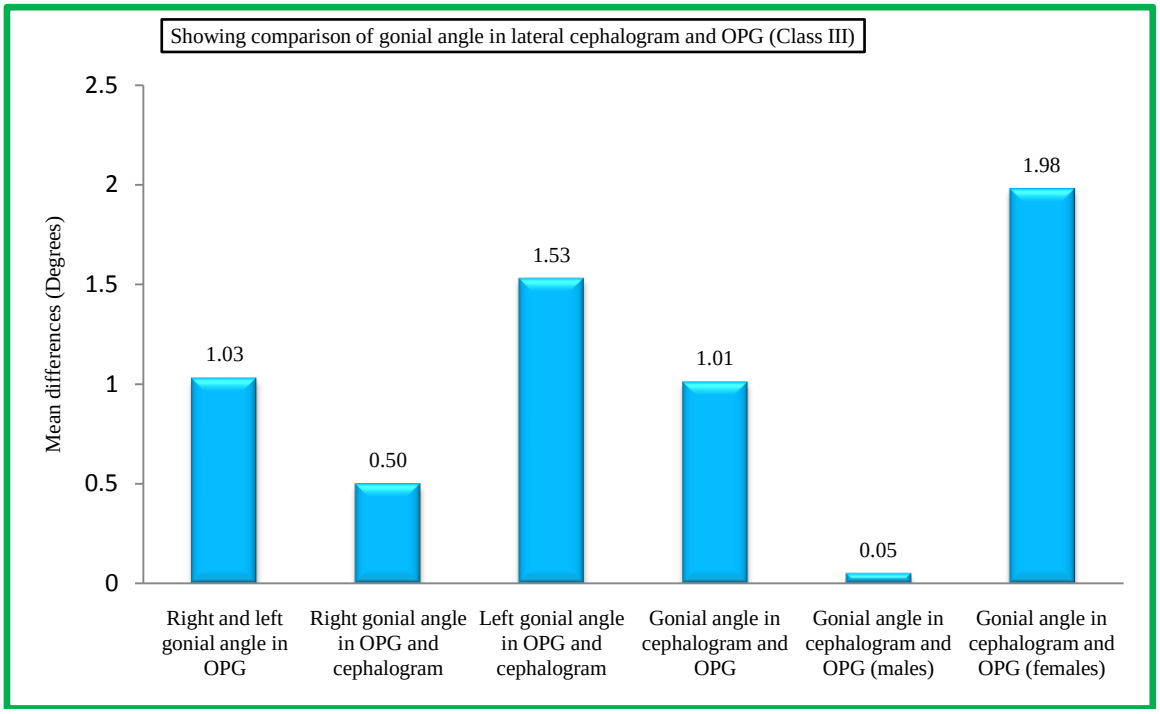
Table 3: Showing comparison of gonial angle in lateral cephalogram and OPG (Class II)		
Variable	Mean differences (Degrees)	P-value
Right and left gonial angle in OPG	0.23	0.794
Right gonial angle in OPG and cephalogram	2.57	0.002*
Left gonial angle in OPG and cephalogram	2.80	0.006*
Gonial angle in cephalogram and OPG	2.69	0.001*
Gonial angle in cephalogram and OPG (males)	2.18	0.035*
Gonial angle in cephalogram and OPG (females)	3.2	0.017*

Table 4: Showing comparison of gonial angle in lateral cephalogram and OPG (Class III)		
Variable	Mean differences (Degrees)	P-value
Right and left gonial angle in OPG	1.03	0.171
Right gonial angle in OPG and cephalogram	0.50	0.486
Left gonial angle in OPG and cephalogram	1.53	0.128
Gonial angle in cephalogram and OPG	1.01	0.199
Gonial angle in cephalogram and OPG (males)	0.05	0.967
Gonial angle in cephalogram and OPG (females)	1.98	0.057




Showing comparison of gonial angle in lateral cephalogram and OPG (Class I)
Mean differences (Degrees)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.83
0.95
0.13
0.54
1.13
1.65
Right and left gonial angle in OPG
Right gonial angle in OPG and cephalogram
Left gonial angle in OPG and cephalogram
Gonial angle in cephalogram and OPG
Gonial angle in cephalogram and OPG (males)
Gonial angle in cephalogram and OPG (females)


Showing comparison of gonial angle in lateral cephalogram and OPG (Class II)
Mean differences (Degrees)
3.5
3
2.5
2
1.5
1
0.5
0
0.23
2.57
2.80
2.69
2.18
3.2
Right and left gonial angle in OPG
Right gonial angle in OPG and cephalogram
Left gonial angle in OPG and cephalogram
Gonial angle in cephalogram and OPG
Gonial angle in cephalogram and OPG (males)
Gonial angle in cephalogram and OPG (females)



V. Discussion

The gonial angle is the representation of the form of the mandible. This angle has an important role in predicting growth and it also has specific effects initially on growth, profile changes and the position or inclination of the anterior teeth of the lower jaw. Assessment of the angle on the right and left side in panoramic radiographs makes it possible to accurately evaluate the changes after orthodontic treatment.[13] Panoramic radiography has been reported to have potential in measuring mandibular inclination and gonial angle. It has been successfully used for determining gonial angle which is a good indicator of mandibular steepness and growth direction. As OPG is routinely requested by clinicians or orthodontists during dental examination, it seems to be a useful feature of this modality for determining growth direction, so that the orthodontist can detect vertical growth problems. This study was performed to assess and compare the measurement of gonial angle from panoramic radiographs and lateral cephalograms in adult patients with different types of malocclusion. The age of the study sample ranged from 18 to 30 years and the subjects in late adult age group were not selected so as to avoid the effect of various age related changes that occur in late adult group subjects. Mattila reported a gonial angle of 127.8° in the panoramic radiograph and 128.6° in the lateral cephalogram.[7] Although both means were greater than those of the present study, the difference between the two means in his study was also insignificant.[7] Larheim and Svanaes also stated that both panoramic radiographs and lateral cephalograms were accurate in determining the gonial angle and there was no significant difference between the right and left sides in panoramic radiography.[8] Fisher-Brandies et al. indicated that the gonial angle obtained by panoramic radiography was 2.2-3.6 degrees less than that of lateral cephalogram.[14] They observed significant differences in the gonial angle obtained by the two different radiographs, which was in contrast to the results reported in this study. The disparity in the results could be because the type of malocclusion and age of the samples was not specified in the above mentioned study, while the present study was performed in adults divided in equal sample of Class I, Class II and Class III malocclusion groups.[14]

On comparison of right gonial angle in OPG between males and females no significant difference was found in any malocclusion group. Similarly on comparison of left gonial angle in OPG between males and females no significant difference was found in any malocclusion group. Gender based comparison of gonial angle in lateral cephalogram showed no significant difference.[15] This is in agreement with the results reported by Altonen.[16]

Difference in the gonial angle of the two sexes has been found in the previous studies. The general trend was that the gonial angles in males are greater than those measured in females. Usually the mean angle is 3–5° greater in males. This is consistent with the knowledge that males generally have a larger mandible than females. Findings concerning gender differences may also be explained by the fact that, on average, men have greater masticatory force than women. However, the present study showed no correlation between genders with gonial angle, and this is in agreement with Salonen MA and Ceylan et al.[17,18] Wafa Al-Faleh could not establish any significant difference between sexes and gonial angle, further supporting the findings of our study. Raustia

et al. claimed that gender had insignificant impact on the size of the gonial angle.[17] Some previous studies have reported a difference in gonial angle between the two genders.[17,18,19] Gungor et al. showed a difference in the left gonial angle between the two genders.[20]

On comparison of external gonial angle of right and left side in OPG, no significant difference was found in Class I and Class III subjects. On comparing right gonial angle in OPG and gonial angle in lateral cephalogram no significant difference was found in Class I and Class III subjects but significant difference was found in Class II subjects. Similarly on comparing left gonial angle in OPG and gonial angle in lateral cephalogram no significant difference was found in Class I and Class III subjects but significant difference was found in Class II subjects. On comparing mean of gonial angle in OPG (half of sum of right and left angles) and gonial angle in lateral cephalogram no significant difference was found in Class I and Class III subjects but significant difference was found in Class II subjects. Gender based comparison of gonial angle in OPG and lateral cephalogram showed no differences in Class I and Class III subjects where as statistically significant difference was found in Class II subjects.

VI. Conclusion

This article demonstrates that the size of the gonial angle can be determined from the orthopantomogram with the same degree of accuracy as from the generally used lateral cephalogram in class I & III. But in case of class II subjects it also shows that the right and left gonial angles can be more accurately determined from orthopantomograms, thus avoiding the disturbing influence of the superimposed images found on lateral cephalograms & comparison of gonial angle between males and females didn't show any significant difference in any malocclusion groups.

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