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Ravi Ranjan Kumar Rajak
Kantipur Dental College Teaching Hospital & Research Center

Rabindra Man Shrestha
Kantipur Dental College-Kathmandu University

Sushmit Koju
Kantipur Dental College

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Cover Page Footnote

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ORIGINAL ARTICLE

Reliability of Panoramic Radiography in Assessing Gonial Angle Compared to Lateral Cephalogram in Patients with Class I Malocclusion

Ravi Ranjan Kumar Rajak [a,*], Rabindra Man Shrestha [a], Sushmit Koju [b]

[a] Department of Orthodontics, Kantipur Dental College Teaching Hospital and Research Center, Kathmandu, Nepal
[b] Department of Oral Pathology, Kantipur Dental College Teaching Hospital and Research Center, Kathmandu, Nepal

ABSTRACT

Purpose: **To investigate whether panoramic radiograph can be used as an alternative to lateral cephalogram for measuring the gonial angle in skeletal Class I patients.**

Patients and methods: **Panoramic radiograph and lateral cephalogram were collected from the pretreatment records of 100 patients of the age 16-30 years from the Department of Orthodontics. Radiographs were manually traced and the gonial angle was measured. Paired t-test was used to find the difference in mean gonial angle between the panoramic radiograph and lateral cephalogram. A simple regression analysis was performed to find the relationship between the gonial angles in two different radiographs.**

Results: **The mean gonial angle in lateral cephalogram was greater in panoramic radiograph, which was statistically significant ($P < 0.05$). The mean gonial angle in female was found to be greater than the male patients in all radiographs. No significant difference was found between the mean gonial angle in lateral cephalogram and right panoramic radiograph. Linear regression analysis showed that, with a one-degree change in mean gonial angle in lateral cephalogram, the mean gonial angle in panoramic radiograph increases by 0.804°.**

Conclusion: **Right sided panoramic view can be used to determine the gonial angle as accurately as lateral cephalogram in Nepali sample. Regression equation was derived to find the relationship of gonial angle between panoramic radiograph and lateral cephalogram. *Taiwanese Journal of Orthodontics 2021;33(2):53−59***

Keywords: Gonial angle; Lateral cephalogram; Orthopantomogram; Mandible

INTRODUCTION

The mandibular angle or jaw angle is usually referred to as "gonial angle." It is a valuable indicator for assessing vertical growth pattern and symmetry of facial skeleton,[1] and rotation of mandible.[2] With the aid of gonial angle, the extraction pattern in Class II patients,[3] and the decision to perform orthognathic surgery in Class III skeletal base patients can also be evaluated.[4] In addition, it may also be related to facial esthetics, sleep disorders, risk for mandibular angle fracture and in forensic science.[5,6] Hence, gonial angle is an important parameter for orthodontic/orthognathic treatment planning.

Panoramic radiograph or orthopantomogram (OPG) and lateral cephalogram are generally recommended in the diagnosis of dental and skeletal disharmony.[7] Panoramic X-ray technology is widely available and is used routinely to assess the mandibular structures.[8] The advantages of decreased superimposition of the anatomical structure, as well as benefit of permitting the measurement of both right and left sides favor the use of panoramic radiography.[9]

Mattila K et al[10] showed that OPG is a more applicable choice in the determination of gonial

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* Corresponding author at:
E-mail address: ravirajak2075@gmail.com (R.R. Kumar Rajak).

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angle than lateral cephalogram. However, it depends on the different methods of measurements like clinical, cadaveric-based or radiographic examination.[10,11] This study seeks to compare the gonial angle from two different radiographs; panoramic and lateral cephalogram in skeletal Class I patients and to check the reliability of panoramic radiograph in assessing the gonial angle.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted in the patients with skeletal Class I malocclusion by using the lateral cephalogram and OPG. The radiographs were obtained from the archives of the Department of Orthodontics, Kantipur Dental College, Kathmandu, Nepal. Subjects with ANB angle ranging from 0 to 4° which were diagnosed as skeletal Class I,[12] and good quality radiographs with the presence of all permanent teeth (excluding third molars) were included. Patients with craniofacial deformity or evidence of congenitally missing and extracted teeth, retained dental root, and history of orthodontic/orthognathic treatment were excluded.

Each patient was exposed to X-ray at 74Kv, 12 mA for 14.3 seconds in panoramic radiograph and 80Kv, 10 wmA for 2 seconds in cephalometric radiograph at by Carestream (CS9300) machine (Carestream LLC, Atlanta, USA). In panoramic X-ray, patient's head positioning was done according to the manufacturer's specified position. The patients were positioned as standing completely upright, with an elongated neck, shoulders down, straight back, feet together, head immobilized and on chin rest, biting on a bite block, tongue against hard palate and head with Frankfort plane parallel to the floor and median sagittal plane perpendicular to the ground during exposure of the radiographs. For cephalometric radiographs, patients were placed in natural head position with the eyes straight ahead, the teeth in centric occlusion and the lips in relaxed contact. The patients were positioned with ear rods of cephalostat exerting moderate pressure on the external auditory meatus and Frankfort horizontal plane parallel to the floor.

Non-probability convenient sampling technique was used. The sample size was determined based on the number of patients seeking the orthodontic treatment using the given formula:

$$n = \frac{\frac{z^2 pq}{e^2}}{\left[1 + \frac{z^2 pq}{e^2 \cdot N}\right]}$$

where, z = 1.96, p = 79.33%,[13] q = (100 − p) = 100%− 79.33% = 20.67%, e = 5% (margin of error), and N = number of patients visiting the department with skeletal Class I relation in a period of 6 months = 166. Thus, the sample size for the study was calculated as 100.

All radiographs were traced manually on matte acetate paper with 2B sharp pencil over the view box using transilluminated light by a single observer (Principal Investigator).

In the lateral cephalograms, the gonial angle was measured at the point of intersection of the plane tangential to the lower border of the mandible and another line tangent to the distal border of the ascending ramus and the condyle. The gonial angle at the intersection of these planes was measured (Figure 1).

In the panoramic radiograph, the gonial angle was measured by drawing a line tangent to the lower border of the mandible and another line tangent to the distal border of the ascending ramus and the condyle on both sides (Figure 2). Geometric protractor was used to measure the angles.

The statistical analysis was done using the Statistical Package for Social Sciences (SPSS) Version 21.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics were presented in the form of mean and standard deviation. Data of the mean angle in

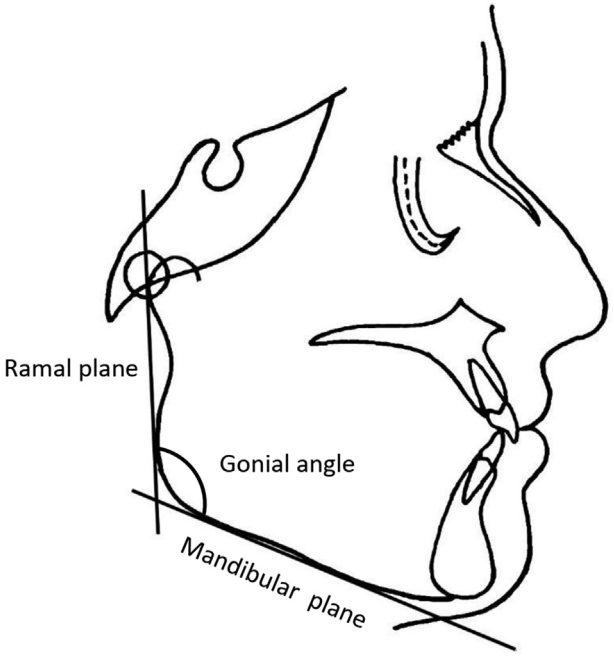

Figure 1. Measurement of gonial angle in lateral cephalogram.

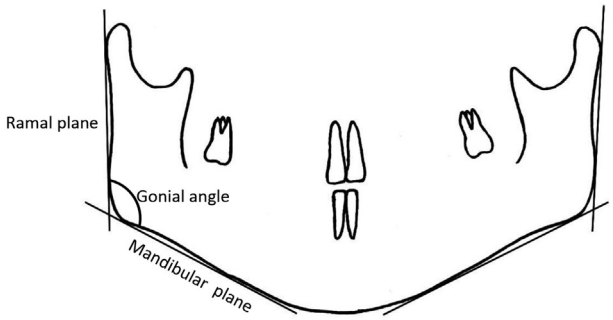

Figure 2. Measurement of Gonial angle in orthopantomogram.

panoramic right, panoramic left, and lateral cephalograms were normally distributed according to the test of normality using Shapiro-Wilk test. Paired t-test was used to find the difference in mean gonial angle between the OPG and lateral cephalogram. A simple regression analysis was performed to assess the relationship between the gonial angle in two different radiographs.

RESULTS

The study group consisted of 100 subjects (50 male, 50 female) with an age range of 16-30 years (mean 21.33 ± 3.23 years). The mean gonial angle was higher in lateral cephalogram (121.67 ± 7.50°) as compared to the one in OPG (120.79 ± 6.93°) and was found to be statistically significant ($P = 0.02$) (Table 1).

There was no statistically significant difference between the mean gonial angles in lateral cephalogram and in right OPG ($P > 0.05$) (Table 2). The mean gonial angle was greater in the lateral cephalogram than in the left OPG among the study participants (121.67 ± 7.50° and 120.73 ± 7.11°, respectively). This difference was found to be statistically significant ($P = 0.03$). A statistically significant difference among the mean gonial angle in

Table 1. Comparison of the mean gonial angle between lateral cephalogram and OPG.

Variable	Gonial angle in lateral ceph (Mean ± SD°)	Gonial angle in OPG (Mean ± SD°)	t-value	95% Confidence Interval		*P* Value
				Lower Bound	Upper Bound	
Overall	121.67 ± 7.50	120.79 ± 6.93	2.363	0.141	1.614	0.02*
Male	119.99 ± 8.29	119.24 ± 7.12	1.353	−0.367	1.877	0.18
Female	123.35 ± 6.25	122.35 ± 6.43	2.020	0.005	1.995	0.05

* Significant at $P < 0.05$.

Table 2. Comparison of the mean gonial angle between lateral cephalogram and right OPG.

Variable	Gonial angle in lateral ceph (Mean ± SD°)	Gonial angle in right OPG (Mean ± SD°)	t-value	95% Confidence Interval		*P* Value
				Lower Bound	Upper Bound	
Overall	121.67 ± 7.50	120.86 ± 7.35	1.877	−0.047	1.677	0.06
Male	119.99 ± 8.29	119.03 ± 7.42	1.621	−0.229	2.149	0.11
Female	123.35 ± 6.25	122.68 ± 6.88	1.046	−0.618	1.958	0.30

Table 3. Comparison of the mean gonial angle between lateral cephalogram and left OPG.

Variable	Gonial angle in lateral ceph (Mean ± SD°)	Gonial angle in left OPG (Mean ± SD°)	t-value	95% Confidence Interval		*P* Value
				Lower Bound	Upper Bound	
Overall	121.67 ± 7.50	120.73 ± 7.11	2.264	0.116	1.764	0.03*
Male	119.99 ± 8.29	119.44 ± 7.24	0.875	−0.713	1.813	0.39
Female	123.35 ± 6.25	122.02 ± 6.79	2.446	0.237	2.423	0.02*

* Significant at $P < 0.05$.

Table 4. Linear regression analysis to assess the relationship between gonial angle in panoramic radiograph and lateral cephalogram.

Variable	Unstandardized Coefficients (B)	95% Confidence Interval	Standardized Coefficients (Beta)	*T* Value	*P* Value
Constant	22.92	11.808-34.033	0.871	4.093	<0.001**
Gonial angle in lateral Ceph	0.804	0.713-0.896		17.512	<0.001**

** Significant at $P < 0.001$.

lateral cephalogram and left OPG was also observed among the female patients ($P = 0.02$) (Table 3).

Pearson's correlation (r) between mean values of gonial angle in OPG and lateral cephalogram was found to be statistically significant ($P < 0.001$) and there existed a strong correlation between the two variables (r = 0.871). Hence, the regression equation could be derived and was presented in a linear function. A simple linear regression was calculated to predict the dependent variable based on the independent variable. The equation for the line ($y = mx + c$) for using lateral cephalogram to predict gonial angle in OPG is $y = 0.804x+22.92$ which can be written as,

$$\text{GoA (OPG)} = 0.804 \times \text{GoA (LC)} + 22.92$$

Where, y (dependent variable) = gonial angle in OPG = GoA (OPG).

m (slope) = 0.804

x (independent variable) = gonial angle in lateral cephalogram = GoA (LC).

c (y-intercept) = 22.92.

Linear regression analysis indicated that, with a 1° change in mean gonial angle in lateral cephalogram, the mean gonial angle in OPG increases by 0.804 (Table 4, Figure 3).

Bland-Altman Plot showed that there is an agreement between the mean gonial angle in lateral cephalogram and right OPG in measuring the gonial angle (Figure 4).

DISCUSSION

The primitive animals consisted of a simple cartilaginous jaw that has now become a complex system containing the temporomandibular joint.[14]

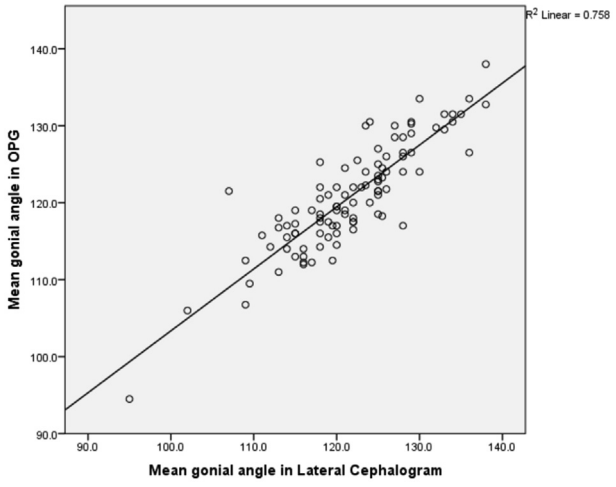

Figure 3. Scatter plot showing the correlation between mean gonial angle in OPG and lateral cephalogram.

In anthropoids, it is influenced by the jaw functions, attached muscles, change in posture, and differential growth of the skull.[14] In humans, the transition is due to the aging process, dentition loss, and numerous other factors that can be clinically or radiographically measured.[15] The revolutionary advancement in the field of radiology provides an accurate insight into the complex human body. Professor Yrjo Paatero, in 1961, first introduced OPG.[16] Since then, it has been used extensively in dentistry for evaluating the dentition, temporomandibular joints, sinuses and pathologies related to the orofacial region.

The gonial angle is a good indicator of mandibular steepness and growth direction and therefore is required for various orthodontic treatment and orthognathic surgery.[17] Gonial angle has been found to decrease in patient who has undergone surgical procedure for mandibular excess.[18] Marcello et al. found that smaller gonial angle less than 125° has a greater risk of relapse after the surgical procedures.[18] According to Brodie, the gonial angle is the posterior-inferior angle region of the mandible.[15] Whereas Broca considered it as the angle formed by a ramal plane and the mandibular plane.[19] The tangent to the condyle and the mandibular angle region forms the ramal plane, while the mandibular plane is formed by the lower mandibular boundary. There is a pronounced notching of the lower border of mandible in conjunction with a steep mandibular plane and a large gonial angle.[20] Enlow stated that as the gonial angle opens, the antegonial notch is accentuated.[21] The antegonial notch is closely associated with the growth pattern of an individual. The antegonial angle decreases with the advancing age and thereby increases the antegonial depth.[22] However, measurement of ante-notch or its angle was not taken into consideration in the current study.

In the present study, mean gonial angle in female was found to be greater than in male patients in all samples. The mean gonial angle for male patients were 119.99 ± 8.29° in lateral cephalogram and 119.24 ± 7.12° in OPG. Whereas for female patients, it was 123.35 ± 6.25° in lateral cephalogram and 122.35 ± 6.43° in OPG. A similar result was reported by Shahabi et al where the gonial angle was 125.04° in female and 124.90° in male patients with no significant difference between the groups.[23] Ghosh et al,[22] Bhardwaj et al,[24] and Huumonen et al[25] reported that female patients had larger gonial angle. According to Ringqvist, variation in the bite force could explain the variation in the gonial angle, which might be due to the impact of masticatory force.[26] Jensen et al concluded that female have 3-5°

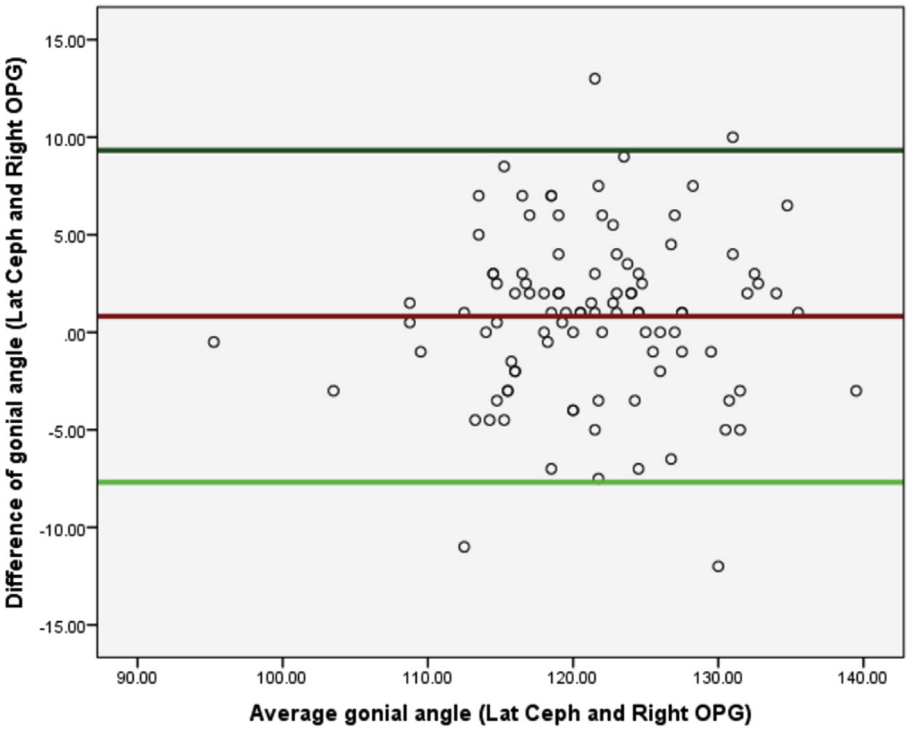

Figure 4. Bland-Altman Plot for lateral cephalogram and right OPG.

greater gonial angle than the male patients.[14] Our study also observed a statistically significant difference between the gender groups in mean gonial angle between lateral cephalogram and left OPG ($P = 0.02$). However, when gender was considered individually, no significant differences was observed between the two radiographs studied ($P > 0.05$). This finding is supported by the study of Ohm and Silness who claimed that the gender had little effect on size of the gonial angle.[27]

The mean difference in gonial angles between lateral cephalogram and OPG was found to be statistically significant ($P = 0.02$). In a similar study, Shahabi et al compared gonial angle using lateral cephalogram and panoramic radiograph of Class I patients and concluded that panoramic radiography could be used for determining the gonial angle accurately.[23] Their study also showed no significant difference in the gonial angle on right and left sides in panoramic radiograph ($P = 0.670$).

Araki et al found that the gonial angle measurements were slightly lesser on panoramic radiograph than on the lateral cephalogram.[28] This was also observed in our study where the gonial angle in OPG was slightly less than on lateral cephalogram. Linear regression analysis showed that with a 1° change in mean gonial angle in lateral cephalogram, the mean gonial angle in OPG increases by 0.804°. This finding further supports that the observed gonial angle in panoramic radiograph is less than in lateral cephalogram. Fischer-Brandies et al indicated that the value of the gonial angle measured in panoramic radiograph was 2.2-3.6° lesser than that in the lateral cephalogram.[29] Another study by Larheim and Svanaes showed that the gonial angle obtained from panoramic radiograph was similar to that measured directly on dried mandible.[30]

Nanda showed that the gonial angle does not differ between facial types and it continues to decrease proportionally from age 4 to 18 years.[3] However, Mangla et al found that the gonial angle significantly increased in hyperdivergent group when compared with the hypodivergent group.[31] The facial profile was not taken into consideration as this study only included patients with skeletal Class I malocclusion.

In the present study, there was no significant difference in mean gonial angle between the lateral cephalogram and right OPG ($P > 0.05$). This signifies that the gonial angle obtained from the right OPG can also be a reliable tool for measurement in Nepali sample. According to Nohadani and Ruf, angular values from panoramic radiographs are more reliable.[32]

CONCLUSION

There was no statistically significant difference in mean gonial angle in panoaramic radiograph and lateral cephalogram between male and female Nepali samples. The relationship between the gonial angle measurements in panoramic and lateral cephalogram in skeletal Class I malocclusion patients can be represented by the equation 'GoA (OPG) = 0.804 × GoA (LC) + 22.92' in a linear function. Also, there was no statistically significant difference in the gonial angle between the lateral cephalogram and right orthopantomogram. Hence, the right panoramic radiograph can be used as a reliable tool for the measurement of gonial angle.

Conflict of Interest Statement

The authors declare no conflicts of interest.

ETHICAL APPROVAL

This study was approved by the Institutional Review Board of Kantipur Dental College Teaching Hospital & Research Center, Kathmandu, Nepal. (No. 30/020).

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