Original Article

Comparison Of Orthopantamogram And Lateral Cephalogram For Mandibular Measurements

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Abstract

Aim: The aim of the present study is to clarify the possible application of orthopantomogram (OPG) for evaluating craniofacial specifications such as angular and linear measurements of the mandible by comparing with lateral cephalogram.
Materials & Methods: OPG and lateral cephalogram of 100 patients of age group 16–28 years will be selected from the orthodontic records of Rama Dental College and Hospital, Kanpur.Linear measurements (body length and ramus height) and angular measurement (gonial angle) were assessed both in lateral cephalogram and OPG. Independent t-test was performed for comparison of OPG and lateral cephalogram using SPSS with a probability level of $P < 0.05$ considered to be statistically significant.
Results: The results of the present study show that there is no statistically significant difference in ramus height and gonial angle when compared between OPG and lateral cephalogram while statistically significant difference exists for body length between OPG and lateral cephalogram.
Conclusion: It may be concluded that panoramic radiography can be used to determine the gonial angle and ramus height as accurately as a lateral cephalogram. However, clinicians should be vigilant when predicting horizontal measurement from OPGs.

Keywords: OPG, Lateral Cephalogram, Gonial Angle, Ramus Height, Body Length

Introduction

In orthodontics, data from diagnostic tools including clinical examinations, study models, and related radiographs like panoramic radiographs and lateral cephalograms are used to determine the diagnosis and plan the course of treatment.[1] In orthodontic practice, an orthopantomogram (OPG) is considered an essential diagnostic aid for the gross assessment of dental and skeletal framework. In 1961 Prof. YrjöPaatero introduced panoramic radiography.[1] It is routinely utilised to offer vital information regarding the teeth and their axial inclinations, maturation periods, and surrounding tissue in the shortest possible time, with the least amount of radiation to the patient and the operator.[1,2-6] Dentofacial abnormalities may be examined by orthodontists thanks to the development of the lateral cephalogram in 1931 by Broadbent in the United States and Hofrath in Germany.[1] On a lateral cephalogram, the

gonial angle is defined as the tangent's junction to the mandible's lower border and the posterior ramus.[6,7] In hyper-divergent or high angle cases, the gonial angle is found obtuse, which interprets the downward and backward rotation of the mandible. In hypodivergent or low angle individuals, gonial angle values are acute and interpret upward and forward rotation of the mandible. Larheim & Svanaes observed inaccuracy and difficulty in measuring gonial angle using lateral cephalogram because of the superimposition of right and left images. Also, the gonial angle values measured from OPG were the same as measured from dried human mandibles. Mattila et al. (1977)[6] also concluded that gonial angle measurements from OPG were the same as from lateral cephalogram. Several investigators determined gonial angle using OPG and lateral cephalogram and found OPG as a reliable and accurate tool in determining the gonial angle. On the other hand, other studies proposed that the interpretation of the vertical aspect of craniofacial structures can be reliably obtained via OPG but other diagnostic information are more reliably achieved via lateral cephalogram. Therefore, the focus of this work is on the clinical utility of panoramic radiographs for assessing craniofacial specifications, such as the angular and linear measurements of the mandible, and creating a relationship between those measurements and lateral cephalograms.

Materials & Method

100 Standardised pre-treatment Orthopantomogram (OPG) and lateral cephalogram (44 males and 56 females) were selected from existing & new patient records who were enrolled for treatment at Department of Orthodontics and Dentofacial Orthopaedics, Rama Dental College Hospital & Research Centre, Kanpur. The inclusion criteria for the radiographs were as follows: enough sharpness and contrast of radiographs for good visualization and identification of the structures; no radiographic distortions; all radiographs should be taken by same apparatus and in natural head position (NHP); no prior orthodontic treatment history. The exclusion criteria for the radiographs were as follows: any history of trauma; any earlier record of facial/mandibular surgery.

Method

The radiographs were manually traced on 0.003inch matte acetate sheets. The following osteometric landmarks[8] were used for the present study: Gonion (Go), Menton (Me), Condylion (Co). A scale and protractor were used to make the linear and angular measurements, and readings were taken to the closest 0.5 mm and half degree, respectively.

Measurements

The following two linear and one angular measurement were analysed:
Linear Measurements[8] (in mm): 1. Gonion-Menton (Go-Me): It is drawn from selected point gonion to menton. It represents the body length of the mandible. 2. Condylion-Gonion (Co-Go): It is drawn from selected point Condylion to Gonion. It represents the ramus height of the mandible. Angular Measurements[8] (in degree): 1. Gonial angle: It is the angle formed by the intersection of the tangent drawn to lower border of mandible and tangent drawn to ramus of mandible.

Figure 1: Lateral cephalogram showing body length (Go-Me)and ramus height (Co-Go) . Landmarks depicted: Co-Condylion, Go-Gonion,Me-Menton

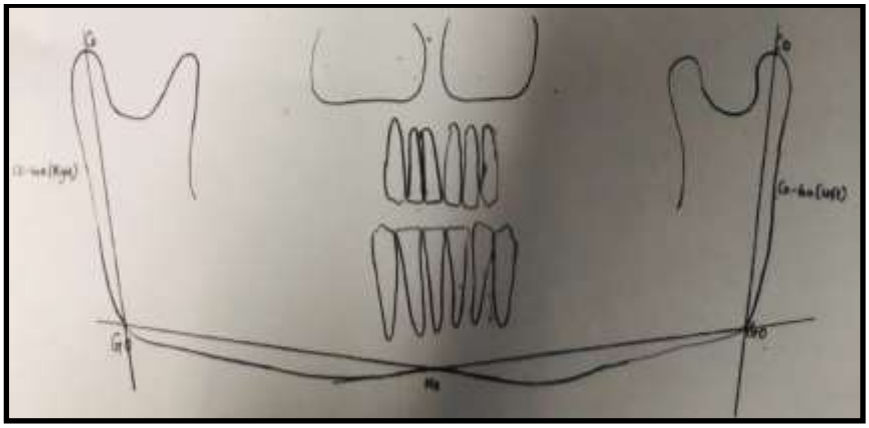


Figure 2: Orthopantomogram showing body length (Go-Me) and ramus height (Co-Go) on both sides. Landmarks depicted: Co-Condylion, Go-Gonion,Me-Menton

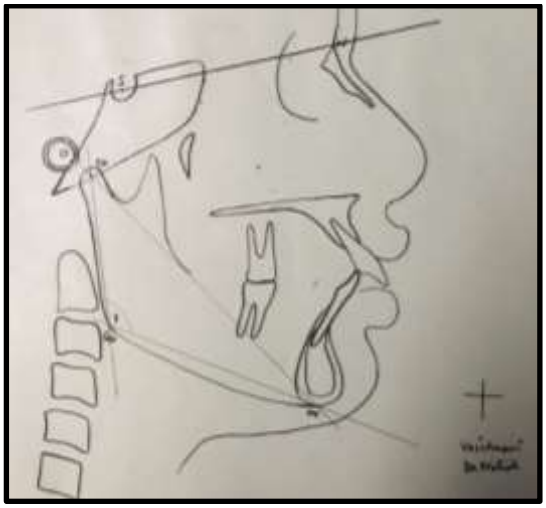


Figure 3: Lateral cephalogram showing Gonial angle. Landmarks depicted: Co-Condylion, Go-Gonion,Me-Menton 1. Gonial angle

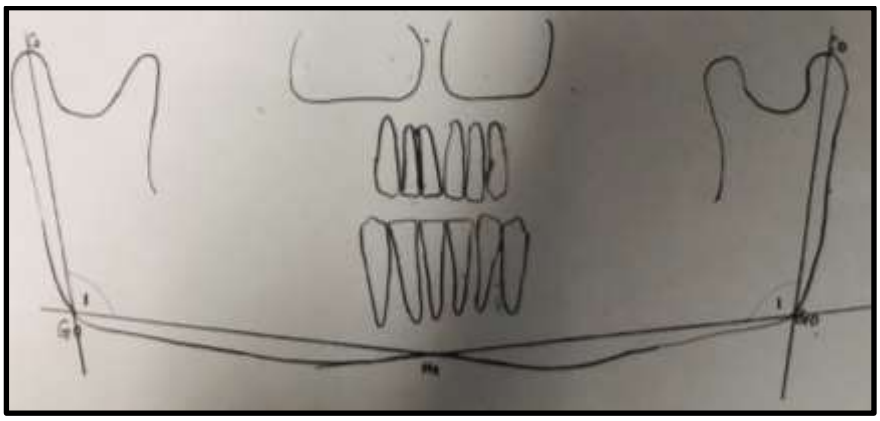


Figure 4: Orthopantomogram showing Gonial angle on both the sides. Landmarks depicted: Co-Condylion, Go-Gonion,Me-Menton 1. Gonial angle

Statistical Analysis

The data were double entered and analysed in STATA 14.2 software. The continuous variables, such as age, angle and lengths were presented as mean and standard deviation along with range. The normal distribution of the variables was analysed using Shapiro-Wilk test. The gender of the participants was expressed in the form of numbers and percentages. The comparison between OPG right and left was done using Mann-Whitney U-test and comparison between OPG (right and left) and Lateral Cephalogram was done with same test separately. A p-value of <0.05 was considered statistically significant.

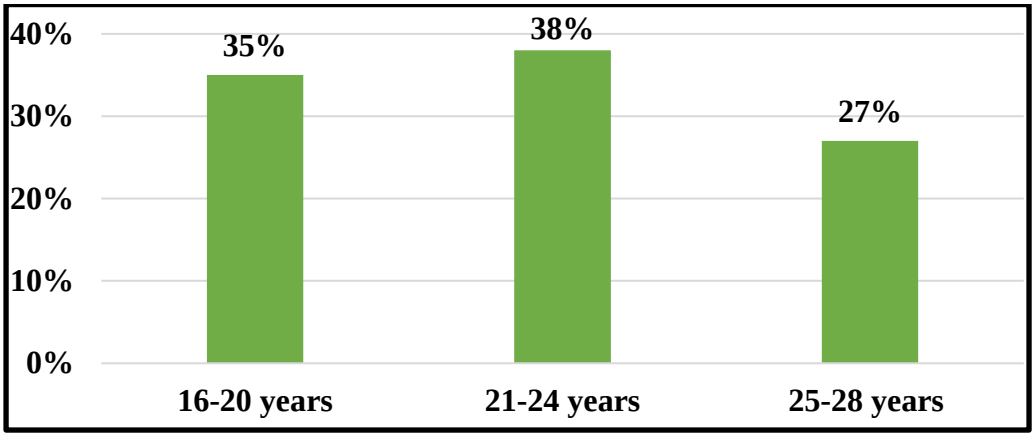
Results

The analysis was performed on observations recorded from 100 patients. There were no missing values considered in the study. As given in Table 1, the mean age of the participants was 21.6 ± 1.2 years, ranging from 16 to 28 years. There were 35% participants in 16-20 years, 38% in 21-24 years and 27% in 25-28 years. There were 44% male and 56% female participants. As given in Table 2, the mean Gonial Angle in OPG Left was 116.3 ± 5.6 degrees, OPG Right was 115.1 ± 5.3 degrees and in Lateral Cephalogram was 120.1 ± 6.9 degrees. There was no statistically significant difference observed between the OPG left and right. While, comparing OPG left and right and lateral cephalogram, there was a statistically significant difference observed. As given in Table 3, the mean ramus length of mandible in OPG Left was 60.1 ± 7.4 mm, OPG Right was 63.5 ± 6.8 mm and in Lateral Cephalogram was 57.6 ± 7.2 mm. There was a statistically significant difference observed between the OPG left and right. While, comparing OPG left and right and lateral cephalogram, there was a statistically significant difference observed. As given in Table 4, the mean body length of mandible in OPG Left was 98.9 ± 9.1 mm, OPG Right was 97.9 ± 7.9 mm and in Lateral Cephalogram was 70.1 ± 5.8 mm. There was no statistically significant difference observed between the OPG left and right. While, comparing OPG left and right and lateral cephalogram, there was a statistically significant difference observed.

Table 1: Age and gender of the participants

Characteristics		**Values (N=45)**
Age in Years	Mean ± SD	21.6 ± 1.2
	Range	16 – 28
Age Group	16-20 years	35 (35%)
	21-24 years	38 (38%)
	25-28 years	27 (27%)
Gender	Male	44 (44%)
	Female	56 (56%)

Graph 1: Age group distribution of the participants in percentage



Graph 2: Gender distribution of the participants in percentage

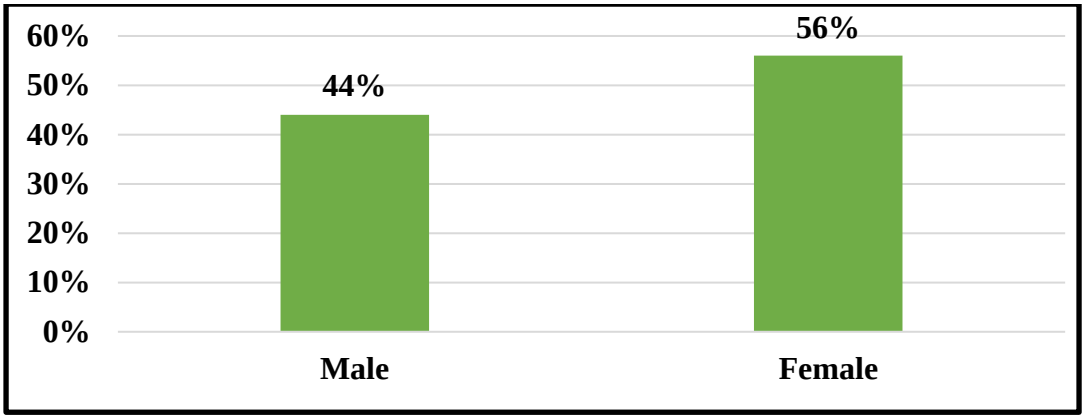


Table 2: Gonial Angle (degrees) in OPG right and left side and lateral cephalogram

Radiograph	OPG Left	OPG Right	Lateral Cephalogram
Gonial Angle (Mean ± SD)	116.3 ± 5.6	115.1 ± 5.3	120.1 ± 6.9
Gonial Angle (Range)	104-134	104-134	103-145
p-value (OPG Left vs Right)	0.763		
p-value (OPG Left vs Lat Ceph)	<0.001		
p-value (OPG Right vs Lat Ceph)	<0.001		

Graph 3: Mean Gonial Angle (degrees) in OPG right and left side and lateral cephalogram

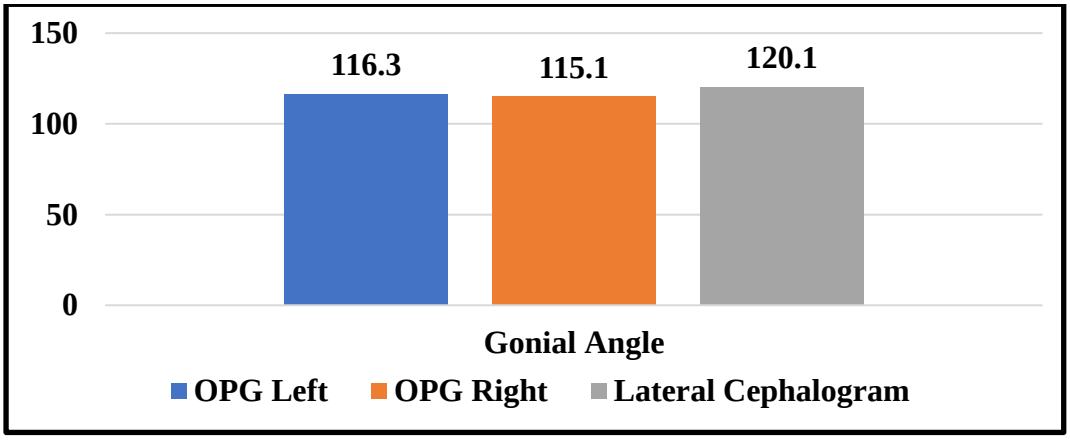


Table 3: Ramus length of mandible (mm) in OPG right and left side and lateral cephalogram

Radiograph	OPG Left	OPG Right	Lateral Cephalogram
Ramus length (mm) (Mean ± SD	60.1 ± 7.4	63.5 ± 6.8	57.6 ± 7.2
Ramus length (mm) (Range)	42-81	51-80	40-76
p-value (OPG Left vs Right)	<0.001		
p-value (OPG Left vs Lat Ceph)	<0.001		
p-value (OPG Right vs Lat Ceph)	<0.001		

Graph 4: Mean Ramus length (mm) in OPG right and left side and lateral cephalogram

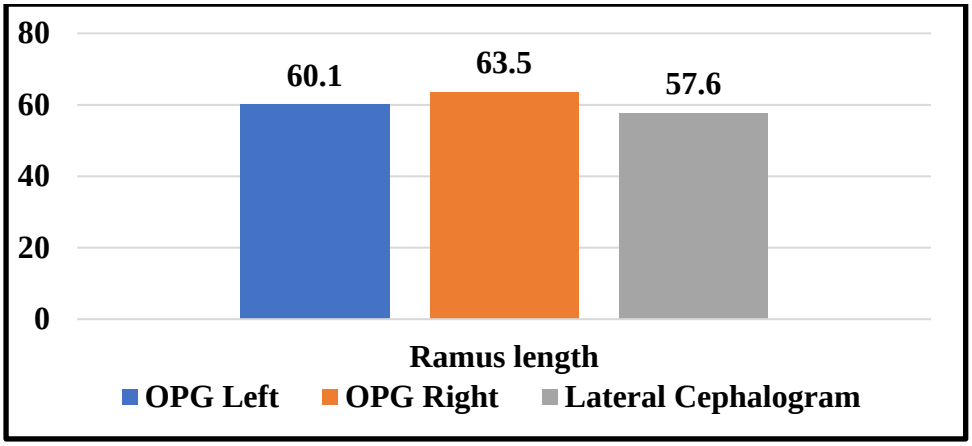
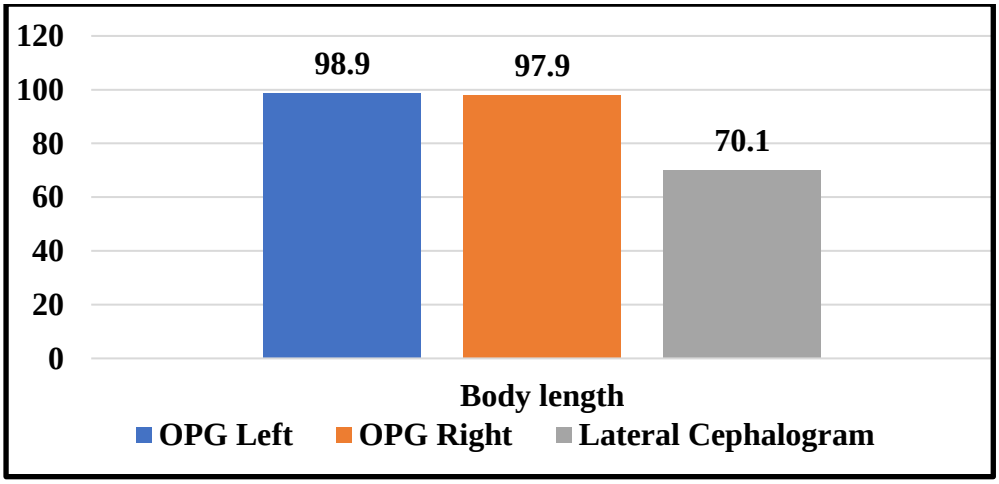


Table 4: Body length of mandible (mm) in OPG right and left side and lateral cephalogram

Radiograph	OPG Left	OPG Right	Lateral Cephalogram
Body length (mm) (Mean±SD)	98.9 ± 9.1	97.9 ± 7.9	70.1 ± 5.8
Body length (mm) (Range)	72-120	70-113	52-83
p-value (OPG Left vs Right)	0.816		
p-value (OPG Left vs Lat Ceph)	<0.001		
p-value (OPG Right vs Lat Ceph)	<0.001		

Graph 5: Mean body length (mm) in OPG right and left side and lateral cephalogram



Discussion

The main purpose of this study was to investigate the panoramic radiograph's capability to assess craniofacial structures in order to maximize its clinical applicability. Only a few studies have used panoramic radiographs to evaluate dentoskeletal structures and estimate gonial angles, despite numerous publications on the drawbacks of utilising them due to image distortion and magnification. The findings of the current investigation show that the values of gonial angle assessed on lateral cephalogram and OPG do not differ statistically significantly (Table-2/Graph-3). As a result, OPG can be used to measure the gonial angle with the same accuracy as a cephalogram. As both the right and left gonial angles may be viewed individually and clearly on the OPG, it may be preferable to measure the gonial angles there. This fact was established in a prior study conducted by Mattila et al. in which the gonial angle of cephalograms, panoramic radiographs and dry skulls were measured.[6] They asserted that the results of the measurements on cephalograms and OPG demonstrate that the measurements on OPG are more

accurate. But even so, cephalograms rather than OPGs are frequently used to measure gonial angles. The present study's findings show that OPG can be utilised to obtain these measurements just as frequently as lateral cephalograms, particularly in situations when the outlines of two sides are obscured and in asymmetry cases prior to the recording of PA cephalograms. The current findings are consistent with the works by Larheim and Svanaes[9] and Akcamet al.[5] (Table-2/Graph-3) The gonial angle was evaluated in panoramic and lateral cephalometric radiographs of all three skeletal groups in the study by Oksayanetal.[10], and none of the skeleton classes showed any discernible differences. The outcomes of this study are consistent with those of the current study. (Table-2/Graph-3)

Similar to the findings of the current investigation, Chalipa et al.[11] reported that in patients with division II malocclusion, there was no statistically significant difference between the gonial angle in panoramic radiography and the lateral cephalometric radiography. (Table-2/Graph-3) The gonial angles (left and right) were not statistically significant in our study (P = 0.763), which is concurrent with the results of previous studies by Mattila et al.[6] and Altonenet al.[12] (Table-2/Graph-3). According to Akcamet al.[5], skeletal cephalometric values from panoramic radiographs have a lower predictability than the vertical dimensions of craniofacial components, hence practitioners should exercise caution when making these predictions. By using an orthopantomograph and a lateral cephalogram, Shahabi et al.[13] compared the gonial angle values in class I malocclusion. They concluded that there was no significant difference between the two values and that, in agreement with the findings of the current investigation, panoramic radiography is just as reliable as lateral cephalograms for estimating the gonial angle. (Table-2/Graph-3) Alhaija[14] carefully studied the value of an orthopantomogram in determining the angulation and steepness of the lower border of the jaw. Their research revealed that the gonial angle can be precisely calculated from both lateral cephalograms and panoramic radiographs, and it also showed that the gonial angle may be a possible growth-direction indicator. This is crucial because, during normal dental examinations, the majority of oral health care experts advise orthopantomograms. According to research by Dahan et al.[15], the measurement method utilised to determine the gonial angle is mostly what influences the judgement. A line contacting the gnathion point or the horizontal side of the gonial angle obtained by the tangent to the lower border of the mandible may be used to measure the gonial angle. In order to avoid this issue, the horizontal plane of the gonial angle in both types of radiographs was made by a line drawn tangentially to the inferior border of the body of the mandible. As a result, gnathion can be easily determined on a lateral cephalogram but it is difficult to identify on an orthopantomogram.

Kattiet al.[16] examined over 100 lateral cephalogram and OPG radiographs of subjects with Angle's Class I malocclusion, whose ages ranged from 15 to 30. On both the panoramic and cephalometric radiographs, the measured gonial angles were found to be statistically comparable and is in agreement with the present study. (Table-2/Graph-3) The gonial angle (left and right) determined by panoramic radiography was found to be 2.2–3.6° less than that of a lateral cephalogram in a study conducted by Fisher-Brandies et al[17]. In contrast to the findings of this investigation (Table-2/Graph-3), they found substantial differences in the gonial angle on the two distinct radiographs. The fact that the age and type of malocclusion of the samples were not indicated in the above mentioned study, while the investigation was conducted on adults with Class I malocclusion, could be the source of the discrepancy in the results. Masao Araki[18] evaluated the measurements of the gonial angle on dry skulls obtained using an orthopantomogram and a lateral cephalogram. Although the mean gonial angle assessed on a lateral cephalogram was less than the mean gonial angle estimated by panoramic radiography, the difference was not statistically significant. This discrepancy was related to the head position, the mandibular body's angle of inclination, and the X-ray beam's direction. A hospital-based survey by Adil et al[19] was done on 80 patients with Class I malocclusions. They evaluated the accuracy of the gonial angle measurements made using the OPG and lateral cephalogram. They came to the conclusion that although there was a substantial difference when measured using a lateral cephalogram, the gonial angle of both the right and left side OPGs was reliable. Gungor, Sagir and Ozer (2007)[20] compared gonial angle symmetry and sexual dimorphism in ancient Anatolian population. They came to the conclusion that there is no asymmetry between the degree of the right and left gonials in people of the same sex.

Radhakrishnan, Varma and Ajith (2017)[21] evaluated the accuracy of measurement of gonial angle of Class I malocclusion patients using both lateral cephalogram and panoramic radiograph. They found no statistical significant difference between gonial angle measurements using OPG or lateral cephalometric radiographs and

the results of the present investigation are concurrent with this study. (Table-2/Graph-3) Nohadani and Ruf[22] claim that panoramic radiograph angular values are more trustworthy. No discernible variations were identified in the gonial angle's value between measurements taken from lateral cephalometric and panoramic radiographs, according to Zangouei et al.[23] The average gonial angle measured in the Zangouei[23] study was 127.5 ± 6.67, 127.36 ± 6.88, and 126.77 ± 6.10 in the right and left panoramic radiographs, respectively. In the current study, the mean values for this angle were 119.3 ± 5.6, 118.1 ± 5.3, 120.1 ± 6.9, respectively. (Table-2/Graph-3) Despite the measures being remarkably comparable, there is a little discrepancy in these values, which may be caused by the different radiography equipment or minute amounts of measurement error. In an Indian study[24], conducted using 1060 panoramic radiographs, a significant difference was reported between right and left gonial angles which is in contrast with the result of the current study. (Table-2/Graph-3) Also, a morphometric study[25] done on dry mandibles reported a significantly smaller right gonial angle than the left, a finding which is in contrast to the present study. (Table-2/Graph-3) Ul-Haq, Memon and Agha (2018)[26] compared three methods to determine gonial angle on cephalogram and orthopantomogram among three groups i.e. hypodivergent, normodivergent and hyperdivergent of 178 radiographs. They concluded that OPG cannot be an alternative choice for gonial angle. The outcomes of the present investigation are in conflict with this study. (Table-2/Graph-3) The accuracy of cephalometric measures obtained from an OPG was assessed by Fatahi and Babouei.[27] Actual measurements taken from dry skulls and panoramic radiography measurements were compared, and it was found that the gonial angle had the strongest correlation between the two types of radiographs, whilst the length of the mandibular body had the lowest correlation. Gonial angle and ramus height were shown to have the highest association between the two radiographs in various growth patterns. They came to the conclusion that it should be possible to establish the direction of growth from the OPG because the majority of dentists request one during a patient's normal dental examination. The present study results are in the agreement with this study conducted by Fatahi and Babouei.[27](Table-2/Graph-3),(Table-3/Graph-4), (Table-4/Graph-5) Bibi, Rasool and Khan[28] studied 100 radiographs of patients with the mean age of 18 years. Their result showed a significant correlation between OPG and lateral cephalometric values. They also concluded that OPG is a reliable and versatile tool as lateral cephalogram for assessing vertical facial pattern. The present study results are in the agreement with the above study. (Table-2/Graph-3) Regarding the ramus height and gonial angle, Kumar SS et al.[8] claimed that there is no obvious distinction between an orthopantomogram and a lateral cephalogram which is in agreement with the present study. (Table-3/Graph-4) (Table-2/Graph-3) OPGs were used by Kurt et al.[29] to measure the condylar, ramal, condylar-ramal, and gonial angles in Class II subdivision malocclusion patients in order to assess mandibular asymmetry. They came to the conclusion that panoramic radiography can produce respectable outcomes. Panoramic radiographs also offer the added benefits of being non-invasive, having a good cost-benefit ratio, and subject exposure to relatively low radiation levels. Turpet al[30]stated that vertical linear measurements on the condyle and the ramus are not reliable for patients with macerated skulls. Likewise, Larheim and Svanaes[26] emphasized that horizontal measurements were unreliable. Therefore, only angular measurements were made on the panoramic radiographs. Hence, this study is also in support with the results of the present investigation. (Table-2/Graph-3) (Table-4/Graph-5) According to Tronjeet al[31].'s mathematical analysis of the precision of panoramic measurements, provided the patient is properly positioned, the panoramic film can be used for vertical measures in clinical practise up to a point. Additionally, they found that the horizontal dimension is inconsistent. Although no comparison was conducted with lateral cephalograms, Larheim and Svanaes[9] similarly came to the same conclusion that vertical measurements on OPGs were reliable. This study is in concurrent with the present study. (Table-3/Graph-4) The panoramic radiograph can be used to assess total ramal height, however there will be some underdiagnosis, according to Kambylafkaset al[32]study's. Jena et al.[33]concluded that OPGs can be used for vertical and angular measurements as well as evaluation of side to side mandibular asymmetry. For linear assessments of the mandible, such as condylion-gonion, gonion-menton, and condylion-menton, Ongkosuwitoet al.[34] came to the conclusion that an OPG is as trustworthy as a lateral cephalogram. This study is in concurrent with the results of the current study. (Table-3/Graph-4) A cross-sectional study was conducted by Lone and Mushtaq[35] on 90 patients separated into the Class I, Class II, and Class III groups. They came to the conclusion that measuring the gonial angle using an OPG was just as accurate as using a lateral cephalogram. In the current investigation, the gonial angle on the lateral cephalogram and OPG were examined, and the readings on both radiographs showed a strong association. The values of the total gonial angle with respect to the OPG and the lateral cephalogram did not differ in a statistically significant way. (Table-2/Graph-3) The present study clearly showed the reliability and versality

of panoramic radiographs other than its routine dental use. The findings of our study indicate that the ramus height and gonial angle between an OPG and a lateral cephalogram are not significantly different (Table-2/Graph-3). While the body length of OPG and lateral cephalogram differ statistically significantly (Table-4/Graph-5). Thus, in agreement with previous studies[9,31,34], OPG can be used to measure the gonial angle and vertical measurements separately on the right and left sides, however it may not be able to do so precisely for the body length measurements of the mandible. (Table-2/Graph-3),(Table-3/Graph-4),(Table-4/Graph-5). Our study clearly showed the reliability and versatility of panoramic radiographs other than its routine dental use. Also the results are comparable to the findings of other researchers which strengthens our conclusion. OPG is an important diagnostic tool and this study confirms its reliability as an alternative diagnostic tool to lateral cephalogram for determining gonial angle however, it cannot substitute lateral cephalogram in the information contained in it.

Conclusion

The results of the present study led us to the following conclusions:

1. There was no statistically significant difference found between both types of radiographs (lateral cephalogram and orthopantomogram) in determination of gonial angle.
2. Also, there was no statistically significant difference found between the measurements of the ramus height of mandible on OPG and lateral cephalogram.
3. Furthermore, the measurements of body length of mandible in OPG and lateral cephalogram differed statistically significantly.
4. Hence, an OPG can be a better choice than a lateral cephalogram for the determination of the ramus height and gonial angle but it may not be able to do so precisely for the body length (horizontal) measurements of the mandible.

Although lateral cephalograms and panoramic radiographs are equally trustworthy for measuring the mandible's vertical and angular dimensions, clinicians should exercise caution when making horizontal measurement predictions from OPGs. Thus, the present study supports the prospect of increasing the clinical adaptability of the panoramic radiograph, which serves as an indispensable tool for dental diagnosis.

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