COMPARISON OF ORTHOPANTOMOGRAM AND LATERAL CEPHALOGRAM IN ASSESSING GONIAL ANGLE, RAMAL HEIGHT, RAMAL HEIGHT AND BODY LENGTH

Farheen Sajid[1], Nabila Anwar[2], Multazam Ahmad[1], Muhammad Uzair[1], Aneela Baseer[1], Asad-ur-Rehman[1]

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[2]Supervisor and HOD, Department of Orthodontics, Rehmat Memorial Hospital Abbottabad

Correspondence

[1]Farheen Sajid, Trainee Medical Officer, Department of Orthodontics, Rehmat Memorial Hospital Abbottabad
: +92-336-9918701
: farheensajid97@gmail.com

ABSTRACT

OBJECTIVES

This study aimed to obtain an orthopantomogram (OPG) and a lateral cephalogram to measure the gonial angle, ramus height, and mandibular body length.

METHODOLOGY

This cross-sectional comparative study was conducted at Rehmat Hospital, Abbottabad, and Peshawar, and included 160 participants selected through nonprobability consecutive sampling. Patients aged 16 to 40 years, of Pakistani nationality, with both OPG and lateral cephalogram in their orthodontic records were included. Radiographs of poor quality or patients with craniofacial anomalies, facial asymmetry, trauma, cancer, or previous head radiotherapy were excluded. Ramus height was measured from condylion to gonion, body length from gonion to menton, and the gonial angle was determined by the intersection of tangents along the lower and posterior borders of the mandible. Data were analyzed using a paired t-test to compare measurements between the two radiographic techniques.

RESULTS

The mean age of participants was 24.93 ± 7.18 years, with 82 females (51.3 percent) and 78 males (48.8 percent). Significant differences were found between OPG and cephalogram measurements. The mean ramus height was 65.46 ± 10.40 mm on OPG and 50.21 ± 7.96 mm on cephalogram ($p < 0.001$). The mean body length was 95.99 ± 11.41 mm on OPG and 64.75 ± 7.85 mm on cephalogram ($p < 0.001$). The mean gonial angle was smaller on OPG (116.73 ± 6.85°) compared with the cephalogram (119.10 ± 8.31°, $p < 0.001$).

CONCLUSION

Panoramic radiographs tend to overestimate linear measurements but underestimate angular values compared with lateral cephalograms.

KEYWORDS: *Lateral Cephalograms, Ramus Height, Body Length, Gonial Angle, Mandible*

INTRODUCTION

The lateral cephalogram is an important tool in orthodontics for diagnosis and treatment planning. It offers a reproducible view of the craniofacial structures, helping in the assessment of skeletal relationships, dental angulations, and the soft-tissue profile.[1] Clinicians can evaluate anteroposterior and vertical discrepancies, growth patterns, and occlusal relationships, all of which are crucial for creating tailored treatment plans through cephalometric analysis.[2] It can also allow the monitoring of craniofacial development and treatment progress.[3] Mandibular asymmetry is when the two sides of the lower jaw differ in size, shape, or position. Mandibular asymmetry can affect facial appearance, occlusal alignment, and jaw function.[4] Its etiology is multifactorial, ranging from developmental issues, congenital conditions like hemifacial microsomia, trauma, to abnormal growth such as unilateral condylar hyperplasia.[5] Proper diagnosis can help achieve an accurate diagnosis and plan treatment, and select adequate options among orthodontic correction, orthognathic surgery, or distraction osteogenesis.[6] Accurate evaluation of the mandibular morphology is important in orthodontics and maxillofacial practice. Measurements such as the gonial angle, ramal height, and mandibular body length can provide information on facial balance, skeletal development, and any asymmetry. Lateral cephalograms have been the most commonly used radiographs for these assessments. However, one limitation of lateral cephalograms is that they superimpose the mandibular halves, making it difficult to accurately assess differences between the right and left sides. Orthopantomograms (OPGs) provide a broad view of the entire mandible, allowing both the right and left sides to be seen clearly and separately. This makes them useful for assessing

mandibular measurements without the superimposition issue that occurs in lateral cephalograms.[7] Though OPGs are commonly used in clinical practice, their accuracy for linear and angular measurements has been questioned due to possible magnification and distortion errors.[8] OPGs are also valuable for assessing mandibular asymmetry. Because they record both sides of the mandible in a single view, OPGs make it easier to compare the right and left sides without requiring additional radiation exposure.[9] This makes them a convenient and widely available option in everyday clinical practice. Considering the advantages and limitations of both OPGs and lateral cephalograms, it is important to assess whether OPGs can provide measurements that are as reliable as those from lateral cephalograms. This study aimed to compare the two radiographic methods in measuring the gonial angle, ramal height, and mandibular body length.

METHODOLOGY

This cross-sectional comparative study was conducted at Orthodontics, Rehmat Hospital, Abbottabad, and Peshawar, on 160 cases using a non-probability, consecutive sampling technique. Written informed consent had already been obtained from all orthodontic patients or their guardians, allowing the use of their anonymized records for research purposes. Ethical approval was obtained from the hospital‘s ethical review committee. Using the WHO sample size calculator, the required sample size was determined to be 160 at a 95% confidence level, with a population mean of 126.107[10], a population standard deviation of 7.034, and an absolute precision of 1. The study included patients aged 16-40 years who were Pakistani nationals, confirmed by their _Form B‘ or CNIC. Both male and female patients were eligible to participate. Only clear and high-quality radiographs were included, and both an orthopantomogram (OPG) and a lateral cephalogram were required as part of the orthodontic records. Patients with any craniofacial malformations or facial asymmetry, identified through clinical examination, were excluded. Those with a history of facial trauma, cancer, or radiotherapy to the head region were also not included in the study. Data on the inclusion and exclusion criteria, as well as demographic information such as age and gender, were collected from the patients‘ record files. Mandibular measurements were taken from both the orthopantomogram (OPG) and lateral cephalogram. The mandibular ramus height was measured as the distance between the condylion (Co), which is the highest point on the mandibular condyle, and the gonion (Go), located where the posterior border of the ramus meets the lower border of the mandible. The mandibular body length was measured from the gonion (Go) to the menton (Me), which is the lowest point on the mandibular symphysis. The mandibular gonial angle was determined by the intersection of two tangents, one drawn along the lower border of the mandible and the other along the posterior border of the ramus, and recorded in degrees**.** Measurements were taken only on the right side. Data were analyzed using R software version 4.3.3. The mean and standard deviation were calculated for numerical variables, such as age and mandibular measurements (ramus height, body length, and gonial angle), on both sides and for both radiographs. Frequencies and percentages were determined for the qualitative variable, gender. A paired t-test was used to compare mandibular measurements between the orthopantomogram (OPG) and lateral cephalogram. Gender was treated as an effect modifier and controlled for by stratification, followed by a post-stratification paired t-test. A p-value of ≤ 0.05 was considered statistically significant. Reliability was tested with Pearson‘s correlation coefficient. An R value of 0.80 or higher was considered excellent agreement between the observations.

RESULTS

A total of 160 participants were included in the study, with a mean age of 24.93 ± 7.18 years. Of these, 82 (51.3%) were females, and 78 (48.8%) were males. Most participants (60.0%) were in the 16–25-year age group, while 40.0% were between 26 and 40 years of age. (Table 1). A significant difference was found between measurements obtained from lateral cephalograms and orthopantomogram (OPGs). The mean ramus height was 50.21 ± 7.96 mm on cephalograms and 65.46 ± 10.40 mm on OPGs ($p < 0.001$). Similarly, the mean mandibular body length was 64.75 ± 7.85 mm on cephalograms compared with 95.99 ± 11.41 mm on OPGs ($p < 0.001$). In contrast, the mean gonial angle was slightly smaller on OPGs (116.73 ± 6.85°) than on cephalograms (119.10 ± 8.31°, $p < 0.001$). (Table 2 & Fig 1). Among females, the mean ramus height and body length measured on OPG (63.22 ± 7.79 mm and 91.98 ± 10.26 mm, respectively) were significantly greater than those on cephalogram (47.88 ± 6.22 mm and 62.56 ± 5.67 mm; $p < 0.001$ for both). Similarly, in males, OPG showed higher mean values for ramus height (67.82 ± 12.19 mm vs. 52.67 ± 8.85 mm) and body length (100.21 ± 11.08 mm vs. 67.05 ± 9.11 mm), both of which were statistically significant ($p < 0.001$). For the gonial angle, females showed a significantly lower mean value on OPG compared with cephalogram (115.34 ± 6.61 mm vs. 119.66 ± 8.56 mm; $p < 0.001$), whereas in males, the difference between the two methods was not

statistically significant (118.18 ± 6.83 mm vs. 118.51 ± 8.04 mm; $p = 0.8$). (Table 3). Excellent inter- and intra-reliability was observed (R value> 0.8). (Table 4)

Table 1: Descriptive Statistics of Age and Gender of the Participants

Characteristic	N = 160
Age (years)	24.93 ± 7.18
Gender	
Female	82 (51.25)
Male	78 (48.75)
Age group(years)	
26-40	64 (40.00)

Mean ± SD; n (%)

Table 2: Comparison of Mandibular Measurements between Cephalogram and Orthopantomogram (OPG)

Characteristic	Lateral Cephalogram Mean ± SD	Panoramic Radiograph Mean ± SD	p value
Ramus height(mm)	50.21 ± 7.96	65.46 ± 10.40	<0.001
Body length(mm)	64.75 ± 7.85	95.99 ± 11.41	<0.001
Gonial Angle(mm)	119.10 ± 8.31	116.73 ± 6.85	<0.001

*Paired t-test

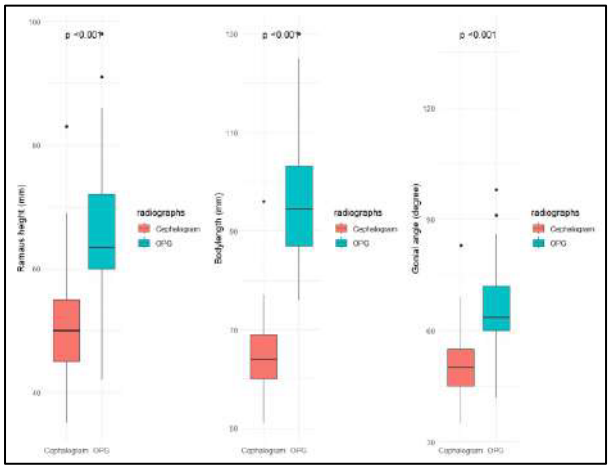

Figure 1: Comparison of Mandibular Measurements between Cephalogram and Orthopantomogram (OPG)

Table 3: Comparison of Mandibular Measurements between Cephalogram and Orthopantomogram (OPG) Stratified by Gender

Characteristic	Female			Male		
	Cephalogram N = 82	OPG N = 82	p-value*	Cephalogram N = 82	OPG N = 82	p-value*
Ramus height(mm)	47.88 ± 6.22	63.22 ± 7.79	<0.001	52.67 ± 8.85	67.82 ± 12.19	<0.001
Body length(mm)	62.56 ± 5.67	91.98 ± 10.26	<0.001	67.05 ± 9.11	100.21 ± 11.08	<0.001
Gonial Angle(mm)	119.66± 8.56	115.34 ± 6.61	<0.001	118.51 ± 8.04	118.18 ± 6.83	0.8

*Paired t-test

Table 4: Reliability Score

	R-value	P-value
Inter-observer	0.82	0.000
Intra-observer	0.85	0.000

DISCUSSION

This study assessed mean mandibular ramus height, body length, and gonial angle using panoramic radiographs (OPG) and lateral cephalograms. We found statistically significant differences in ramus height and body length between the two imaging methods. These differences should be interpreted with caution, as panoramic radiography is known to be affected by magnification and geometric distortion inherent to its imaging technique. Although several studies have evaluated gonial angle measurements between these modalities, only a few have compared linear mandibular parameters such as ramus height and body length. Panoramic radiographs are produced by rotational imaging, in which the X-ray source and detector rotate around the patient. Because of this geometry, the magnification factor is not uniform across the image and varies with the position of anatomical structures within the focal trough. The rotation center determines the horizontal projection, while the vertical projection is determined by the X-ray source.[11] Both horizontal and vertical dimensions may be affected by distortion, particularly when the object is positioned outside the optimal focal layer or when slight variations in head positioning occur. The horizontal dimension is affected by both projection geometry and motion, leading to variations in image size and shape.[12] These characteristics may partly explain the larger linear measurements observed on OPG in the present study. Therefore, the observed differences between the two modalities likely reflect methodological and projection-related factors rather than true anatomical variation. Our findings align with those of Zulfiqar et al.[13], who evaluated the gonial angle, ramus height, and mandibular body length in a sample of 195 Pakistani individuals aged 16-35 years. Their study also found significantly greater values for ramus height and body length on orthopantomograms (OPGs) than on lateral cephalograms, whereas the gonial angle showed no statistically significant difference between the two imaging modalities. Similarly, Kumar et al.[14] investigated 100 Indian subjects and observed no significant differences in the gonial angle or ramus height; however, significant variation was noted in mandibular body length. These findings support the notion that horizontal linear measurements are more prone to distortion in panoramic radiography, due to the inherent projection geometry, and should be interpreted cautiously. In

contrast, Khan et al.[7] evaluated 100 subjects aged 13-20 years and reported nearly identical gonial angle measurements on both orthopantomograms and lateral cephalograms (mean values of 122.4° and 122.6°, respectively). They concluded that panoramic radiographs provide reliable estimates for angular assessment. This observation partially concurs with our results in male participants, in which the difference in gonial angle between the two radiographic techniques was not statistically significant, suggesting that gender-related anatomical variation and mandibular morphology may influence the degree of angular consistency across imaging modalities. Pillai et al.[15] examined 242 individuals aged 6-80 years and identified a significant difference in gonial angle measurements between orthopantomograms and lateral cephalograms, particularly on the left side, along with notable gender-related variations. Their results reinforce the existence of angular discrepancies between the two imaging modalities,[16,17] consistent with our finding of a smaller gonial angle on panoramic radiographs among female participants. The broad age range and heterogeneity of their sample may partly account for these variations, as mandibular remodeling and morphological adaptations occur progressively across different growth and adult stages. A study compared three cephalometric techniques for determining the gonial angle and compared them with OPG values in a sample of 178 individuals aged 12-39 years.[18] They found significant differences between cephalometric and panoramic measurements, suggesting that variations in landmark identification can affect measurement consistency. Our findings align with theirs, as even slight differences in head positioning or tracing of reference points can produce noticeable discrepancies in two-dimensional radiographic measurements.

LIMITATIONS

This study has several limitations. Its cross-sectional design limits the assessment of temporal changes, and the use of non-probability consecutive sampling may affect generalizability. Measurements were derived from two-dimensional radiographs, which are subject to magnification, distortion, and positioning errors, particularly in orthopantomograms. Additionally, only the right side of the mandible was evaluated, limiting assessment of bilateral asymmetry. The absence of comparison with three-dimensional imaging modalities such as CBCT, and the potential for observer variability in manual landmark identification, may also influence the accuracy of the findings.

CONCLUSIONS

This study found significant differences in mandibular measurements between lateral cephalograms and orthopantomograms. The values for ramus height and body length were consistently higher on panoramic radiographs, while the gonial angle was slightly smaller. These results indicate that panoramic images may exaggerate linear dimensions but show lower angular measurements compared with cephalograms.

CONFLICT OF INTEREST: None

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AUTHORS CONTRIBUTION

Farheen Sajid *- Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Final Approval*

Nabila Anwar *- Concept & Design; Data Acquisition; Drafting Manuscript; Supervision; Final Approval*

Multazam Ahmad- *Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Final Approval*

Muhammad Uzair *- Concept & Design; Data Acquisition; Drafting Manuscript; Final Approval*

Aneela Baseer *- Concept & Design; Data Acquisition; Drafting Manuscript; Critical Revision; Final Approval*

Asad-ur-Rehman *- Concept & Design; Data Acquisition; Drafting Manuscript; Critical Revision; Final Approval*

The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.