



Can Orthopantomogram (OPG) be a Reliable Diagnostic Aid for Mandibular Measurements over Lateral Cephalogram: A Cross-Sectional Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To find the reliability of OPG over Lateral Cephalogram for Mandibular Body Length, Mandibular Ramal Height and Total Mandibular Length.

Materials and Methods: Pre-treatment lateral cephalogram and orthopantomogram of 60 patient records within the age group of 12 to 25 years were selected from the department of orthodontics and dentofacial orthopaedics, Noorul Islam College of dental science. The linear measurements of mandible such as Ramal height are measured from Condylion(Co) to Gonion(Go), total mandibular length from Condylion(Co) to Menton(Me) and body length from Gonion(Go) to Menton(Me). To improve the measurement accuracy, a digital vernier calliper will be used to measure and record the values.

Statistical Analysis: Study data obtained were entered into Microsoft Excel Software and exported to Statistical Package for Social Sciences (SPSS) Version 21, IBM Statistics, USA. Descriptive

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Statistics (Mean, Standard Deviation and Percentages) were obtained. Intergroup F quantitative analysis was done using the Independent-t-Test and Mann-Whitney Test with the level of significance set at 5% ($p < 0.05$ = Statistically Significant)

Results: The average age of the entire study group was 18.2 years. Average Mandibular body Length (ML), Ramal Height (RH), and Total Mandibular Length (TML) were traced on OPG with the Mean and Standard Deviation calculated at 87.14 ± 4.14 , 52.97 ± 5.92 and 121.26 ± 5.31 respectively. Whereas for the Lateral Cephalogram ML, RH, and TML were 70.16 ± 4.70 , 52.14 ± 5.27 , 107.31 ± 5.80 respectively. Upon statistical analysis there was a significant mean difference between mandibular body length (ML) and total mandibular length (TML) with P value of 0.01 for both the parameters respectively. However, Ramal height (RH) showed no statistical difference in OPG and lateral cephalogram with P value of 0.41.

Conclusion: It can be concluded that Orthopantomogram (OPG) can be used as a reliable diagnostic aid for measuring Ramal Height compared to lateral cephalogram while OPG cannot be used as a reliable diagnostic aid for measuring mandibular body length and total mandibular length.

Keywords: Mandibular; cephalogram; orthopantomogram.

1. INTRODUCTION

Precise Diagnosis is one of the core components while establishing and specifying a Robust Treatment Plan for a Patient undergoing Orthodontic evaluation. Defining the relation between skeletal, dental, facial, and functional constituents turns a vital factor to specify individuals' characteristics and prioritising their felt and needs while designing the treatment modality [1].

Mandibular dimensions which include Ramal height (Condylion-Gonion), Mandibular Body length (Gonion-Menton) and Total Mandibular length (Condylion-menton) are one of the key parameters which outline the course of the Procedure planned by an Orthodontist [2].

The most commonly used diagnostic assistances in orthodontics are lateral cephalograms and panoramic radiographs (OPG) [3].

For the evaluation of skeletal relations, lateral cephalograms are usually used. However, the credibility of lateral cephalogram while measuring the right and left sides of the cranial landmarks individually may be an area of concern, due to the superimposition of both the sides. To add to it, utilisation of Lateral Cephalogram in cases like hemifacial microsomia, and unilateral condylar hyperplasia which requires precise measurements of structures on each side, diagnosing and planning surgeries can pose a challenge [4].

Panoramic radiography delivers a wide-ranging view of maxillofacial structures with comparatively lesser radiation exposure than

other investigatory tools. It has been commonly used in orthodontic practice to offer significant evidence about Dental and maxillofacial structures. It evades superimposing structures, unlike a lateral cephalogram image. However being technique sensitive, panoramic radiograph measurements have raised questions among the researchers and the clinicians. The technique is rather sensitive to positioning errors because of a relatively narrow image layer [5].

Though substantial evidence documents the precision and reliability of OPG and Lateral Cephalogram individually, there is a dearth of literature supporting the reliability and accuracy of mandibular linear measurements such as Mandibular Body Length, Mandibular Ramal Height and Total Mandibular Length using OPG over the Lateral Cephalogram. The current study aims to explore the likelihood of utilising the panoramic radiograph which has been an indispensable and readily available instrument for dental diagnosis, over Lateral Cephalogram while the formulation of Orthodontic protocol for a patient in need.

To achieve the aforementioned, aim the study extends to explore the following objectives:

1. To find the diagnostic reliability of OPG over Lateral Cephalogram for measuring mandibular body length, Ramal height and total mandibular length.
2. To compare the mandibular ramal height, body length and total mandibular length in right and left sides of OPG.
3. To compare the mean difference of mandibular linear measurements

obtained from OPG and Lateral Cephalogram.

2. METHODOLOGY

An Observational, Cross-Sectional Study Design was formulated including a Pre-treatment lateral cephalogram and orthopantomogram of 60 patient records satisfying the inclusion criteria of the age group of 12 to 25 years were selected from the department of orthodontics and dentofacial orthopaedics, Noorul Islam College of dental science. Ethical Clearance was obtained prior to the study. Patients with facial and mandibular asymmetry, condylar hyperplasia or aplasia, craniofacial malformations and syndromes were excluded from the study.

2.1 Sample Size Calculation

2.1.1 Sample size calculation

Based on Hypothesis Testing Two Mean using n-master 2.0 Sample Size Calculator Software

Formula

$$n = \frac{2s_p^2 [Z_{1-\alpha/2} + Z_{1-\beta}]^2}{\mu_d^2}$$

$$s_p^2 = \frac{s_1^2 + s_2^2}{2}$$

Where,

s_1^2 : Standard deviation in the first group

s_2^2 : Standard deviation in the second group

μ_d^2 : Mean difference between the samples

α : Significance level

$1 - \beta$: Power

S_1^2	= 6.54
S_2^2	= 6.47
μ	= 3.36
α	= 5 %
$1 - \beta$	= 80 %
Sample Size	= 60 per Group

3. MATERIALS AND METHODS

OPG device was used (VATECH, PAX-i version 2.5.0,75 Kvp,10 mA,10.1 seconds) under the standard configuration defined by the manufacturer. The lateral cephalogram device (VATECH, PAX-i version 2.5.0,12.9 seconds) was used with the standard settings.

Orthopantomogram and lateral cephalogram of patients were taken at natural head position. Patients were positioned upright with shoulders relaxed, having straight back, feet closed, head straight over chin rest, biting on a bite block, tongue against the hard palate and head with Frankfort plane parallel to the floor and the median sagittal plane perpendicular to the ground while radiographic exposure. For cephalometric radiographs, patients were placed in a 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. The quality and sharpness of the radiographic images were evaluated.

The armamentarium used for the study was: Acetate tracing paper, Lead pencil, Adhesive taper, X-ray viewer, Vernier calliper, and Ruler. Selected lateral cephalograms and orthopantomograms were manually traced using 0.5mm lead pencil and tracing sheets. The selected landmarks such as Gonion (Go), Condylion (Co), and Menton (Me) were marked in lateral cephalogram and orthopantomogram. The linear measurements of the mandible which included Ramal height were measured by drawing lines from Condylion (Co) to Gonion (Go), and total mandibular length from Condylion (Co) to Menton (Me) and mandibular body length from Gonion (Go) to Menton (Me). To improve the measurement accuracy, a digital vernier calliper was used to measure and record the readings.

3.1 Intra Observer Reliability

All measurements were carried out by a single Researcher who was calibrated to assure accurate measurements using the devices included in the study. Each series of panoramic and lateral cephalograms were evaluated on separate occasions by drawing reference lines and points and measuring mandibular variables directly on contact copies of the film.

The repeatability coefficient is an accuracy measure which represents the value below which the absolute difference between two repeated test results may be expected to fall with a probability of 95% [6].

To assess the reproducibility of measurements, 20 OPGs and lateral cephalograms were randomly selected and re-traced at a gap of 15 days after the initial tracings. There was no significant measurement difference observed. The intraclass correlation coefficient was found to be high >0.8 as per Cronbach's alpha-internal consistency-table [7] showing good test-retest reliability.

3.2 Statistical Analysis

Study data obtained were entered into Microsoft Excel Software and exported to Statistical Package for Social Sciences (SPSS) Version 21, IBM Statistics, USA. Descriptive Statistics (Mean, Standard Deviation and Percentages) were obtained. Intergroup F quantitative analysis was done using the Independent-t-Test and Mann-Whitney Test with the level of significance set at 5% ($p < 0.05$ = Statistically Significant)

4. RESULTS

The average age of the entire study group was 18.2 years. Average Mandibular body Length (ML), Ramal Height (RH), and Total Mandibular Length (TML) were traced on OPG with the Mean and Standard Deviation calculated at 87.14 ± 4.14 , 52.97 ± 5.92 and 121.26 ± 5.31 respectively. Whereas for the Lateral Cephalogram ML, RH, and TML were 70.16 ± 4.70 , 52.14 ± 5.27 , 107.31 ± 5.80 respectively.

4.1 Comparative Analysis between right and left sides of OPG among the study subjects (Table 1)

Mean values and standard deviation of OPG Right vs OPG left were tabulated for all the Three parameters. ML mean and SD for the right and Left half was 87.08 ± 4.49 and 87.21 ± 4.13 respectively where the mean difference amongst the subject using quantitative inferential statistical analysis with Unpaired T Test was found to be non-significant (p value- 0.86). Similar results were obtained for Ramal Height and Total Mandibular Length for right and left halves with a non-significant Mean Difference. (P-value 0.71 and 0.31 respectively)

4.2 Comparative Analysis of Linear Mandibular Measurements between Lateral Cephalogram and Average OPG Measurements (Table 2)

Comparative analysis of the mean and SD for Ramal Height amongst the two Investigation modalities was found to have non-significant mean differences with a P-value of 0.41.

However, OPG average and lateral cephalogram when compared for mandibular body length and total mandibular length, The mean difference was found to be highly statistically significant for both the parameters. ($p < 0.01^{**}$).

4.3 Comparative Analysis of Linear Mandibular Measurements between Lateral Cephalogram and Right and Left OPG Measurements separately. (Table 3)

Similar to the inferential statistics obtained in Table 2 Right and Left OPG when compared with Lateral cephalogram for Mandibular body Length and Total Mandibular Length, the mean difference was found to be highly significant ($p < 0.01^{**}$). Whereas Comparative analysis of the mean and SD for Ramal Height amongst right and left OPG and Lateral Cephalogram were found to have a non-significant mean difference with the P-value of 0.48 and 0.37 respectively.

5. DISCUSSION

The results of the current study show that there is no statistically significant difference in ramus height between OPG and lateral cephalogram. whereas a statistically significant difference exists for Mandibular Body Length and Total Mandibular Length between OPG and lateral cephalogram. A possible explanation for the difference may be because of overlap between the right and left condyle in the lateral cephalogram, which affects measurements involving the condyle [4].

It has been well documented that an OPG can provide comprehensive information on the vertical dimensions of the craniofacial unit, whereas lateral cephalogram marks for a holistic view [8].

Measurements with accuracy and reproducibility on lateral cephalogram have been reported to be more reliable than the OPG [9].

Table 1. Comparative Analysis between right and left sides of OPG among the study subjects

	OPG RIGHT	OPG LEFT	P-value
Mandibular Body Length(ML)	87.08±4.49	87.21±4.13	0.86
Ramal Height(RH)	53.17±6.06	52.77±5.85	0.71
Total Mandibular length(TML)	121.72±6.60	120.80±4.70	0.37

Table 2. Comparative Analysis of Linear Mandibular Measurements between Lateral Cephalogram and Average OPG Measurements

	OPG AVG	LATERAL CEPH	P value
Mandibular Body Length(ML)	87.14±4.14	70.16±4.70	<0.01**
Ramal Height(RH)	52.97±5.92	52.14±5.27	0.41
Total Mandibular length(TML)	121.26±5.31	107.31±5.80	<0.01**

Table 3. Comparative Analysis of Linear Mandibular Measurements between Lateral Cephalogram and Right and Left OPG Measurements separately (Table 3)

	OPG Right	OPG Left	LATERAL CEPH	P value
Mandibular Body Length(ML)	87.08±4.49	87.21±4.13	70.16±4.70	<0.01**
Ramal Height(RH)	53.17±6.06	52.77±5.85	52.14±5.27	0.48, 0.37 respectively
Total Mandibular length(TML)	121.72±6.60	120.80±4.70	107.31±5.80	<0.01**

Comparing the mandibular linear measurements on the right and left half of an OPG, it was noted that mandibular body length had obtained a mean value of 87.08±4.49 on the right side and 87.21±4.13 on the left side of an OPG with a P-value of 0.86, which is statistically significant. The Ramal Height Measurements obtained were a mean value of 53.17±6.06 on the right side and 52.77±5.85 on the left side of the OPG with a P-value of 0.71 showing a statistically non-significant value. The Total mandibular length on the right and left halves of an OPG showed a mean value of 121.72±6.60 and 120.80±4.70 respectively with a P-value of 0.37 which shows a statistically non-significant value. These results were in agreement with the study conducted by Kumar et al. [10]. Comparing the mean and standard deviation for linear measurements of Ramal height in lateral cephalogram and OPG, the values obtained were 52.14±5.27 and 52.97±5.92 respectively, with a P-value of 0.41 which was statistically insignificant. These findings were in agreement with a study conducted by Akcam et al [11] Kumar et al [10], and Ongkosuwito et al. [4] Comparing the Mandibular Body Length and Total mandibular

length on lateral cephalogram with Right and left halves of OPG separately, the mean value for mandibular body length was 70.16±4.70, 87.08±4.49, 87.21±4.13 respectively and 107.31±5.80, 121.72±6.60, 120.80±4.70 for total mandibular length. P-value obtained for Mandibular Body length and total mandibular length was 0.01 showing a highly statistically significant value. These results were in agreement with Kumar et al [10] where mandibular body length cannot be reliable on OPG over a lateral cephalogram.

As per the researchers, an OPG is affected by both magnification errors and displacement causing image distortion. The technique remains sensitive to subject positioning due to the comparatively narrow image layer [12]. While skeletal landmarks within the sharply described plane are free of distortion, structures outside the plane appear distorted due to the difference between film velocity and the projection velocity of the entity on the film [13].

Horizontal measurements have been documented as undependable because of the

non-linear variation in the magnification at different object depths; while vertical measurements have been presented as relatively reliable [14]. Laster et al, 2005 have documented a concern while performing Absolute measurements or relative comparisons on an OPG as shifted skull positions may affect the panoramic precision [15].

According to Larheim and Svanaes as well Vertical and angular measurements were reproducible whereas horizontal scales were undependable [16,17].

6. CONCLUSION

It can be concluded that Orthopantomogram (OPG) can be used as a reliable diagnostic aid for measuring Ramal Height compared to lateral cephalogram while OPG cannot be used as a reliable diagnostic aid for measuring mandibular body length and total mandibular length. Further studies with a larger sample size are required to strengthen the findings of the present study. OPG may not accurately measure Horizontal measurements, but they do have the lead of giving advanced diagnostic yield when compared to lateral cephalogram. With Less exposure for panoramic coverage of the dental arches and ease to measure the right and left side with less superimposition, the importance of OPG as a diagnostic aid must not be neglected by the clinicians, especially in cases with skeletal asymmetry.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. This study was approved by the Institutional Review Board of NIMS Ethics Committee Registration number: ECR EC/NEW/INST/2022/KL/0068.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial

interests OR personal relationships that could have appeared to influence the work reported in this paper.

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