Comparison of orthopantomogram and lateral cephalogram for mandibular measurements

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Abstract

Aim: The aim of the study is to clarify the possible applications of orthopantomogram (OPG) for evaluating craniofacial specifications such as angular and linear measurements of the mandible by comparing with lateral cephalogram.

Materials and Methods: OPG and lateral cephalogram were taken from 100 patients of age-group 16-35 years from Department of Oral Medicine and Radiology, Govt. Dental College and Hospital, Srinagar, J&K. Linear measurements (body length and ramus height) and angular measurements (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 study show that there is no statistically significant differences in ramus height and gonial angle when compared between OPG and lateral cephalogram while statistically significant difference exits 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 OPG.

Keywords: Orthopantomogram, lateral cephalogram, mandibular measurements

Introduction

Professor Yrjo Paatero, in 1961, first introduced the Orthopantomography (OPG) [1]. Panoramic radiography is an extra oral radiography technique that provides two-dimensional information about the teeth and the maxillofacial skeleton. It is a valuable adjunct for diagnosis and treatment planning as it facilitates one-time imaging of all teeth, the mandible, parts of maxilla including a large part of the maxillary sinus, hard palate and temporomandibular joints (TMJs). Indications for panoramic radiography imaging are: Periodontal disease with simultaneous evaluation of all teeth and the extent of periodontal bone defects, Orthodontic evaluation including presence of teeth germs, developmental stage of the dentition and the presence of retained, supernumerary or impacted teeth, Impacted third molars, Dental age estimation, Lesions such as tumors, cysts, and other bone diseases that cannot be entirely imaged by periapical radiographs, Mandibular trauma, Implant planning [2].

In 1931, the emergence of lateral cephalogram by Broadbent in United States and Hofrath in Germany provided both a clinical and a research tool to assess the underlying skeletal disproportions.

Various cases of asymmetry require accurate measurements of structures on each side such as hemifacial microsomia, unilateral condylar hyperplasia, so that a proper diagnosis can be achieved and therefore these conditions can be properly treated by any type of surgery or distraction osteogenesis.
For this purpose, lateral cephalograms cannot be reliably used. However, OPGs does not show this difficulty. For detecting asymmetry in the cases, Posteroanterior cephalogram can also be used. But it is less reliable due to the problem posed by the superimposing structures and the difficulty in reproducing natural head posture.

On OPG, right and left side structures can be studied easily, avoiding any overlapping or superimposing structures found on the lateral cephalogram. However, measurements on panoramic radiographs have been called into question because of considerable methodological errors.

The accuracy of cephalometric measurements when determined on an OPG is still doubtful. Thus, the purpose of this study is to clarify the possible applications of OPG for evaluating craniofacial specifications such as angular and linear measurements of the mandible by comparing with lateral cephalogram.

Materials and Methods
The ethical committee clearance has been obtained from the Institutional Ethical Committee of Govt. Dental College and Hospital Srinagar on 11/03/2022. The ethical committee clearance number is ECC-GDC/0063. This prospective study included OPG and lateral cephalogram of 100 patients of age group 16-35 years that reports to the Department of Oral Medicine and radiology

Inclusion criteria
- Healthy patients without any history of systemic diseases
- Patients in the age group of 16-35 years.
- Patients advised for lateral cephalmatic radiographs for orthodontic treatment.

Exclusion criteria
- Individuals with congenital defects in the craniofacial region like clefts and malformations
- History of craniofacial fractures
- Patients suffering from disorders of bone, nutritional deficiencies and endocrinical disturbances.

All the radiographs selected were of high quality and sharpness and were taken by the same apparatus with standard exposure conditions and in the Natural Head Position (NHP). The selected radiographs were traced, landmarks located, lines, and angles were drawn, and the following variables measured [Figures 1a and b, 2a and b].

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OPG Left [n=100]</th>
<th>OPG Right [n=100]</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Ramus height (mm)</td>
<td>53.78</td>
<td>5.92</td>
<td>56.18</td>
</tr>
<tr>
<td>Body length (mm)</td>
<td>85.49</td>
<td>6.54</td>
<td>85.54</td>
</tr>
<tr>
<td>Gonial angle (degree)</td>
<td>120.66</td>
<td>6.50</td>
<td>122.15</td>
</tr>
</tbody>
</table>

Result
Comparison between right and left sides of orthopantomogram
Mean values and standard deviation of left and right sides of OPGs were calculated and tabulated [Table 1] for all the parameters. No statistically significant difference was found. Thus, there is no difference in the right and left side values of the OPG parameters.

Comparison of gonial angle, ramus height, and mandibular body length between lateral cephal and orthopantomogram (right and left sides)
Mean and standard deviations were calculated for the gonial angle, ramus height, and mandibular body length measured from lateral cephal, OPG are tabulated in Tables 2 and Table 3. Mean values of each of the three parameters on the left side of the OPG was compared with the lateral cephal and the same was done for the right side of the OPG. P-value is calculated for all three parameters between lateral cephalogram and right and left OPG separately. No statistically significant difference was found between OPG and lateral ceph for gonial angle and ramus height. A significant difference was found when the panoramic measurement is compared with lateral cephalogram for body length.
Fig 1: Comparison of various parameters between left and right sides OPG

Table 2: Comparison of various parameters between left side of OPG and lateral Ceph

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OPG Left [n=100]</th>
<th>Lateral Ceph [n=100]</th>
<th>P-value</th>
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<tr>
<td></td>
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<tr>
<td>Ramus height (mm)</td>
<td>53.78</td>
<td>5.92</td>
<td>53.48</td>
</tr>
<tr>
<td>Body length (mm)</td>
<td>85.49</td>
<td>6.54</td>
<td>68.26</td>
</tr>
<tr>
<td>Gonial angle (degree)</td>
<td>120.66</td>
<td>6.50</td>
<td>122.51</td>
</tr>
</tbody>
</table>

Fig 2: Comparison of various parameters between left and right sides OPG

Table 3: Comparison of various parameters between right side of OPG and lateral Ceph

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OPG Right [n=100]</th>
<th>Lateral Ceph [n=100]</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Ramus height (mm)</td>
<td>56.18</td>
<td>6.29</td>
<td>53.48</td>
</tr>
<tr>
<td>Body length (mm)</td>
<td>85.54</td>
<td>7.95</td>
<td>68.26</td>
</tr>
<tr>
<td>Gonial angle (degree)</td>
<td>122.15</td>
<td>8.88</td>
<td>122.51</td>
</tr>
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</table>
Discussion
This study was performed to compare both the mandibular linear and angular measurement between OPG and lateral cephalogram in randomly selected samples. Even though, there are many studies comparing gonial angle measurements between OPG and lateral cephal there are only a few reported studies comparing linear mandibular measurements between OPG and lateral cephalogram.

The results of our study show that there is no statistically significant difference in ramus height and the gonial angle between OPG and lateral cephalogram. Whereas, statistically significant difference exists for body length between OPG and lateral cephal. Thus, OPG can be used to measure the gonial angle and vertical measurements individually on the right and left sides while it may not be reliably used for horizontal measurements, which is in agreement with previous studies. Mattila et al. 1977 [4] in took measurements of gonial angle on cephalograms, panoramic radiographs and dried skulls. They reported that right and left gonial angles from panoramic images were equal to the angles measured on dry skulls. They also reported that the right and left gonial angles can be quite easily determined individually from orthopantomogram, thus avoiding the disturbing influence of the superimposed images found on lateral cephalograms. They concluded that the orthopantomogram is more obvious choice for determination of the gonial angles.

Tronje et al. 1981 [5] concluded that on films exposed with rotational panoramic radio graph, distortion effects are often apparent. The distortion of the outer contour of three-dimensional model objects has been analyzed mathematically. The applied mathematical expressions for coordinate transformation between object and film were confirmed experimentally. The distortion of the outer contour is dependent on the basic form of the object; the more rounded the object is, the less marked is! The distortion. It is concluded that for practical clinical purposes the correctly exposed panoramic film is reliable when the form of rounded objects is assessed.

Fischer-Brandies et al. 1984 [6] stated that in the orthopantomogram a reproducible determination of the gonial angle is possible. When comparing two orthopantomograms of the same patient, which were taken during routine clinical examination, a variation of the arithmetic mean of the gonial angle by 1 degrees was found. The value of the gonial angle measured in the orthopantomogram is 2.2 degrees to 3.6 degrees smaller than in the lateral cephalometric radiograph. In single cases, however, a wider range occurred. Therefore in determining the gonial angle, the lateral cephalometric radiograph should be preferred.

However, Larheim and Svanaes 1986 [7] 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.

Turp et al. 1996 [8] compared the vertical linear measurements on the condyle and the ramus obtained from OPGs of 25 macerated skulls with true values obtained from the direct measurement of the skull and found a low correlation between the two. Fatahi and Babouei 2007 [9] concluded that The FHP can be used reliably for dentoskeletal measurements performed on panoramic radiographs. Clinicians should always keep in mind that mandibular condyles can be asymmetric, so that possibility must be considered when using panoramic radiographs. With standard exposure conditions and high image quality, panoramic radiographs can provide information on the vertical dimensions of craniofacial structures; however, they are not reliable enough to give acceptably accurate additional information compared with lateral cephalograms. Fatahi and Babouei 2007 [10] revealed that all the five measurements (except length of the body of the mandible) in panoramic radiographs were close to actual degrees in dry skulls. Correlation tests showed the highest correlation between panoramic and cephalometric radiographs in gonial angle (r=0.89, p<0.001) whereas the least correlation was seen in the length of mandibular body. In different growth patterns, it was seen that gonial angle and ramus height showed the highest correlation between the two radiographs Nohadani and Ruf 2008 [11] compared longitudinal vertical facial and dentoalveolar changes using.

Fig 3: Comparison of various parameters between left and right sides OPG
panoramic radiographs with measurements on lateral cephalometric radiographs and reported that panoramic radiographs cannot be recommended for evaluating vertical facial parameter changes during time though OPG delivers a moderate approximation to the situation depicted on lateral cephalogram. Kurt et al. 2008 [12] concluded that acceptable results can be achieved with panoramic radiographs. They studied to evaluate the condylar and ramal mandibular asymmetry in a group of patients with class II subdivision malocclusion to identify possible gender differences between male and female subjects. Kambylaftas et al. 2006 [13] studied to evaluate the accuracy of panoramic radiographs for diagnosing the vertical asymmetry of the posterior mandible. This study suggested that the panoramic radiographs can be used to evaluate vertical posterior mandibular asymmetry, but there will be some under diagnosis Ongkosuwito et al. 2009 [14] studied the dry skull and concluded that an OPG is as reliable as a lateral cephalogram for linear measurements of the mandible, with vertical measurement having a better correlation than horizontal.

Katti G et al. 2016 [15] studied to investigate whether OPGs can be used as an alternative to lateral cephalogram for measuring the gonial angle. They concluded that panoramic radiography can be used to determine the gonial angle as accurately as lateral cephalogram. In addition, it is easy to determine the right and left gonial angles of a patient in an OPG without interferences due to superimposed images of anatomical structures in lateral cephalogram. Zangouei-Booshehri M et al. 2012 [16] concluded that panoramic radiography can be used to determine the gonial angles accurately as a lateral cephalogram. Furthermore, in panoramic radiography the right and left gonial angle scan is measured easily without superimposition of anatomic landmarks, which occurs frequently in a lateral cephalogram. Therefore, it seems that panoramic radiography which is a simple, inexpensive and available radiologic technique can be used for determination of the left and right gonial angles. Kumar, et al. 2017 [17] 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. Pillai Devu Radhakrishnan et al. 2017 [18] concluded that panoramic radiography can be considered reliable for measuring the gonial angle, particularly in cases where the outlines of the 2 sides are not clearly visible on a lateral cephalogram and in patients presenting with asymmetry, as the right and the left gonial angles can be accurately visualized in a panoramic radiograph without any interference due to superimposed images. Horizontal measurements have been shown to be particularly unreliable because of the nonlinear variation in the magnification at different object depths. In panoramic radiography, the focus of projection in the horizontal dimension differs from that of the vertical dimension. In the horizontal dimension, the rotation center serves as the functional focus, whereas in the vertical dimension the X-ray source serves as the focus. Shape and size distortion of the radiographic images in the vertical plane is function of projection factors. These include factors such as alignment of film, object and X-ray source, object to X-ray source and film to X-ray source distances. Since the X-ray source serves as the functional focus, the vertical dimension is unaffected by the rotation of the beam in the horizontal plane. In the horizontal dimension; however, both projection and motion factors influence size and shape distortion.

Conclusion
Panoramic radiographs may not always have pinpoint accuracy in measuring the angular and vertical measurements, but they do have the advantage of giving a higher diagnostic yield on a single film when compared to lateral cephalogram. They showed an increased coverage of the dental arches with reduced radiation exposure to the patients. Furthermore, OPG being an easier tool for measuring the right and left side of the patient without any interference due to superimposed structures it may be a better choice, especially in asymmetry cases. Though panoramic radiographs are as reliable as a lateral cephalogram for vertical and angular measurements of the mandible, clinicians should be vigilant when predicting horizontal measurement from OPGs.

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Conflicts of interest: There are no conflicts of interest.


