Assessment of the validity of orthopantomographs in the evaluation of mandibular steepness in Libya

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Abstract:

AIM: The value of gonial angle indicates the range of steepness as well as the direction of mandibular growth. Exact measurement of right (R) and left (L) gonial angles from a lateral cephalometric radiograph is challenging due to the superimposition of both sides. Thus, the aim of the present study was to assess the potential of determining accurate measurement of R and L gonial angles by employing orthopantomographs (OPGs) and to compare the findings with the measurements obtained from lateral cephalometric radiographs.

MATERIALS AND METHODS: A total of 125 standardized panoramic as well as lateral cephalometric radiographs of Libyan subjects were obtained from the orthodontic clinical records (36 males and 89 females). Mandibular inclination was computed by averaging the R and L gonial angles produced by drawing tangents to the inferior border of the mandible and to the distal aspect of the ascending ramus and the condylon on each OPG. Moreover, similar steps were followed to extract the gonial angle from the cephalometric radiographs.

RESULTS: Student's paired t-tests revealed no significant discrepancies between the R and L gonial angle values extracted from the OPG (123.88° ± 6.53° and 123.27° ± 6.55°) at $P = 0.070$. The mean values of the gonial angle (average of the R and L mean values) extracted from the OPG (123.58° ± 6.38°) and cephalometric radiographs (125.14° ± 6.23°) were not significantly different ($P = 0.084$). Furthermore, Pearson's correlation coefficient revealed strong correlation between the value of the gonial angle measured in the cephalometric radiograph and the mean value extracted from the OPG ($r = 0.897$ at $P < 0.001$).

CONCLUSION: OPGs are as useful as lateral cephalometric radiographs in the assessment of mandibular inclination and steepness in Libyan subjects. They have the added advantage of reducing patient exposure to radiation by cutting the number of radiographs required during diagnosis.

Keywords:
Gonial angle, lateral cephalometric radiographs, Libyan, orthopantomographs

Introduction

Orthopantomography is a widely used assessment tool in orthodontic diagnosis and treatment planning, as well as in surgical orthodontic procedures. It offers the opportunity to explore the presence, absence, location, and general health of the teeth and their supporting tissues in a single view and with a moderately low radiation exposure. It is generally recognized that orthopantomographs (OPGs) are blurred in the anterior region, where the clarity of the incisors might be compromised by disparity in the anterior focal trough. However, image definition improves significantly in the region lateral to the incisors.

A more traditional method of defining anatomical landmarks and evaluating angular and linear measurements of the teeth and associated structures is lateral and antero-posterior cephalometry. This

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technique involves standardized and reproducible radiographs that provide quantitative, comprehensive information that are used to define anatomical landmarks and evaluate angular and linear measurements. Such quantitative calculations can provide comprehensive information on the relationships between skeletal, dental, and soft tissue structures within the craniofacial region. However, superimposition of bilateral structures can compromise the reliability of landmark identification. The gonial angle (constructed by the intersection of the mandibular plane and ramal plane) reflects the mandibular steepness, and thus, it is frequently taken into account during orthodontic diagnosis and treatment procedures. An increased gonial angle compared to its average value is observed when the growth direction of the mandible is backward and downward, while a reduced gonial angle implies a forward growth direction. Observing a change in this angle during growth might be useful in implying growth direction as well as in evaluating the symmetry of the mandible. Computing separate right and left gonial angles from a lateral cephalometric radiograph can be problematic due to superimposition of both sides of the mandible in the radiograph; in contrast, in an OPG, the right and left sides of the mandible are separate and measurement of both gonial angles is straightforward and repeatable.

Numerous researchers have demonstrated the effectiveness of OPGs in defining mandibular morphology and in computing the three-dimensional parameters of the mandible, i.e., gonial angle, ramus height, and bigonial width. Moreover, a number of studies have explored the correlation between the gonial angles measured from both OPGs and lateral cephalometric radiographs in different populations.

There is no consensus among researchers on the reliability of computing gonial angles from panoramic radiographs. Mattila et al. observed that the gonial angle can be calculated from an OPG with a similar level of precision to that from a lateral cephalometric radiograph. Other studies have concluded that right and left gonial angles can be independently calculated from panoramic radiographs using a simple and repeatable procedure with only one degree difference between two successive measurements. Despite this, Fischer-Brandies et al. favored calculating the gonial angle from lateral cephalometric radiographs rather than from OPGs, because the values measured were found to be 2.2–3.6° smaller when using the latter technique. Therefore, the aim of the present study was to assess the accuracy of measurements of right and left gonial angles derived from panoramic radiographs and to compare these findings with measurements obtained from lateral cephalometric radiographs.

**Materials and Methods**

Ethical authorization and approval for the study were granted from the Faculty of Dentistry, University of Benghazi, Libya prior to data collection. This cross-sectional retrospective study was undertaken on the records of 125 orthodontic patients (36 males and 89 females) at the Faculty of Dentistry, University of Benghazi, Libya. None of the subjects had a history of craniofacial surgery syndromes or tooth extraction. All radiographs were examined according to the standard radiographic procedures. OPGs and cephalometric radiographs were acquired with a Vatec Co. Ltd radiographic unit, South Korea using a standardized technique. The default magnification was 8.0%.

The gonial angle in each cephalometric radiograph was determined by the intersection of the line drawn from gonion to menton (mandibular plane) and the line linking articulare and gonion (ramal plane). The lines were traced on tracing paper using 0.5 mm 2H pencil led. A protractor with 1° accuracy was used to measure the angles. All measurements were made by an expert orthodontist (T.G). The data obtained were inserted in an Excel spreadsheet for further analysis.

**Assessment of method error**

To assess the reproducibility of measurements, 25 randomly selected OPGs and lateral cephalometric radiographs were re-traced after a 2-week interval, and any disagreement was found to be no more than 0.5°. The intraclass correlation coefficient was found to be >0.90, indicating an excellent level of reproducibility between both measurements.

**Statistical analysis**

Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS, Chicago, IL; version 17) software. Kolmogorov–Smirnov tests...
of normality revealed that the data were normally distributed. Descriptive statistics were carried out to compute means and standard deviations for all variables. Paired t-tests were performed to detect any statistically significant discrepancy between the mean values of the gonial angles obtained from the right and left sides of the OPGs. The Pearson’s correlation coefficient test was undertaken to assess the correlation of different variables. Statistical significance was set at \( P < 0.05 \).

**Results**

There was no significant difference between the mean values of the right (123.88°, SD = 6.53°) and left (123.27°, SD = 6.55°) gonial angles measured from the OPGs (\( P > 0.05 \)). Combining the right and left gonial angles calculated from the OPGs gave a mean value of 123.58° (SD = 6.38°) [Table 1]. When lateral cephalometric radiographs were used, the mean gonial angle obtained was 124.14° (SD = 6.23°).

Pearson’s correlation coefficient test revealed a significant correlation between the right and left gonial angles measured from the OPGs (\( r = 0.904, P < 0.001 \)). Moreover, when the mean gonial angles derived from the OPGs and the lateral cephalometric radiographs were compared, they were found to be highly correlated (\( r = 0.897, P < 0.001 \)) [Table 2].

**Discussion**

Panoramic radiographs are frequently requested by dental specialists for screening the maxilla-mandibular region, allowing an evaluation of the general health of the teeth and their supporting structures with a moderately low radiation dosage.\(^4\) A common drawback of panoramic radiographs is magnification and distortion of the image, especially in the anterior region. According to Akcam \textit{et al.},\(^19\) although panoramic radiographs offer information on the vertical parameters of craniofacial configurations, experts should be cautious about estimating vertical dimensions. These authors performed a regression analysis and found the predictability of vertical dimensions on panoramic radiographs to be 11–20% of the corresponding cephalometric values. This problem is usually minimized by taking the radiograph in a standard position. On the contrary, both the Akcam \textit{et al.}\(^19\) and Larheim and Svanaes\(^9\) studies stated that angular measurements are more reliable and that the mean value of the gonial angle computed from a OPGs was nearly equal to that measured on the mandible of a dried skull.

The gonial angle reflects the form of the mandible and its value can be used to predict mandibular direction of growth. It also influences facial profile, lip seal and competence, as well as angulation of the lower anterior teeth.\(^1,20\) Furthermore, reassessment of the gonial angle after orthodontic treatment can provide valuable information about treatment outcome and stability.\(^18\)

The high correlation between the gonial angle measured from lateral cephalometric and panoramic radiographs agrees with previous similar studies undertaken on Americans,\(^5\) Jordanians,\(^12\) Iranians,\(^6\) Pakistanis,\(^17\) and Indians.\(^21\) The significance of these findings is that panoramic radiographs are frequently requested by dentists and their availability makes it possible to assess the mandibular growth direction from the same radiograph, thereby avoiding the exposure of patients to extra radiation as well as providing a cost saving.

**Conclusion**

OPGs are as useful as lateral cephalometric radiographs in the assessment of mandibular inclination and steepness in Libyan subjects. They have the added advantage of reducing patient exposure to radiation by cutting the number of radiographs required during diagnosis.
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Conflicts of interest
There are no conflicts of interest.

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