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Original Article

Is There Any Difference Between Gonial Angle Values Measured on Digital Lateral Cephalograms and Orthopantomograms?

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ABSTRACT

Objective: To determine whether there is a difference between the gonial angle (GoAng) values measured on digital lateral cephalograms (Lat Cephs) and orthopantomograms (OPGs) using a software.

Methods: This study was conducted by examining the digital Lat Cephs and OPGs of 51 patients (9 males, 42 females) who received orthodontic treatment. The mean age of the patients was 19.51±4.92 years. All digital radiographs were acquired with the same machine. The GoAng measurements were performed digitally using TotalCeph software. In order to evaluate the difference between the GoAngs measured on the digital Lat Cephs and OPGs, a paired t-test was used. To compare the two techniques (digital Lat Ceph and OPG) in terms of GoAng measurement, Bland-Altman analysis was used. The differences between the right and left GoAngs measured on the digital OPGs were evaluated using a paired t-test. The intraobserver reliability was assessed with the intraclass correlation coefficient (ICC) for repeated measurements.

Results: The intraobserver reliability was 0.99 for repeated measurements. There were no statistically significant differences between the GoAngs measured on digital Lat Cephs and OPGs (p=0.1). Bland-Altman analysis showed high levels of agreement between digital Lat Cephs and OPGs with a bias value of –0.4° for GoAng measurement. Moreover, the differences between the right and left GoAngs measured on the digital OPGs were not statistically significant (p=0.73).

Conclusion: The results of this study demonstrated that the digital OPGs were as reliable as the digital Lat Cephs for measuring Go angles using a software.

Keywords: Digital, Gonial angle (GoAng), lateral cephalogram (Lat Ceph), orthopantomogram (OPG), software

Main points:
- There were no statistically significant differences between the GoAngs measured on digital Lat Cephs and OPGs.
- The levels of agreement between the digital Lat Ceph and OPG were high for GoAng measurement.
- The differences between the right and left GoAngs measured on digital OPGs were not statistically significant.

INTRODUCTION

The gonial angle (GoAng) is an important measurement for diagnosis and treatment planning in orthodontics. It is used for evaluating mandibular rotation, diagnosing growth patterns, determining tooth extraction patterns in Class II patients, planning orthognathic surgery in Class III patients, and predicting age in forensic medicine (1-5).

Usually, GoAng is measured on lateral cephalograms (Lat Cephs). However, the accuracy of GoAng measurements may be affected by the superimposition of the patient's right and left sides (6). To measure the GoAng accurately, orthopantomograms (OPGs) are used instead as the right and left GoAngs are not superimposed and can be measured individually (7). Conflicting results have been published regarding whether there is a dif-

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ference between these radiographs (7-11). Some authors have reported that OPGs are more accurate than Lat Cephs, whereas others have reported no statistically significant difference (7-9). Araki et al. (10) studied dry skulls and found that the GoAngs measured on OPGs were slightly smaller than those measured on Lat Cephs. In these studies, different mandibular or ramal planes were used and measurements were made manually on printed images (7-11).

The different techniques used to obtain measurements make it difficult to compare the results of different studies. Therefore, the purpose of this study was to determine whether there was a difference between GoAng measurements, constructed by using easily identifiable mandibular and ramal planes, on digital Lat Cephs and OPGs using a software.

METHODS

The present study was approved by the Ethics Committee of Hacettepe University Medical School with the approval number GO 18/65-24. Patients were informed about the study in detail and written informed consent forms were obtained from the patients who agreed to take part in the study.

The study was conducted using the digital Lat Cephs and OPGs of 51 patients (9 males and 42 females) who underwent orthodontic treatment at the Oral and Dental Health Care Clinic, Gün Hospital, Hacettepe University, between August 2016 and December 2017. The mean age of the patients was 19.51±4.92 years. Digital Lat Cephs and OPGs were acquired using Castellini X Radius Trio 2D (version 6.2; iRYS Imaging, Italy) by the same technician using the same device for all the patients in the natural head position. All radiographs were viewed and evaluated, and only high quality radiographs were included in the study. The exclusion criteria for this study were a history of trauma, surgery, syndromes, and asymmetry related to the face or jaw.

The GoAng measurements were obtained digitally using the 1.2.0 version of TotalCeph software (Torc Software Solutions, Istanbul, Turkey). The software allows free measurement. Digital images of each Lat Ceph and OPG were imported directly into the TotalCeph software for on-screen digitalization. On both radiographs, lines tangential to the mandibular lower border (mandibular plane) and those tangential to the posterior border of the ramus and condyle (ramal plane) were drawn. Anatomic landmarks required for constructing the tangential lines were determined by using a ruler and then digitized. The software automatically measured the GoAng at the point of intersection of these two lines (Figures 1 and 2). On the OPGs, the GoAng was measured for both left and right sides. The measurements were conducted twice over an interval of one month.

The Statistical Package for Social Sciences version 22.0 software (IBM Corp.; Armonk, NY, USA) was used for data analysis. The normality of the data was tested with the Kolmogorov-Smirnov test. In order to evaluate the difference between the GoAngs measured on the digital Lat Cephs and OPGs, a paired t-test was used. To compare the two techniques (digital Lat Ceph and OPG) in terms of GoAng measurement, Bland-Altman analysis was used (12). In addition, the difference between the right and left GoAngs measured on the digital OPGs was evaluated using a paired t-test. A p value less than 0.05 was considered to be statistically significant. The intraobserver reliability was assessed with the intraclass correlation coefficient (ICC; type 3, 1) for repeated measurements.

RESULTS

The intraobserver reliability was 0.99 for repeated measurements, which indicated excellent reliability.

The mean values of the GoAngs were 123.71°±6.88° and 123.30°±6.47° for digital Lat Cephs and OPGs, respectively (Table 1).

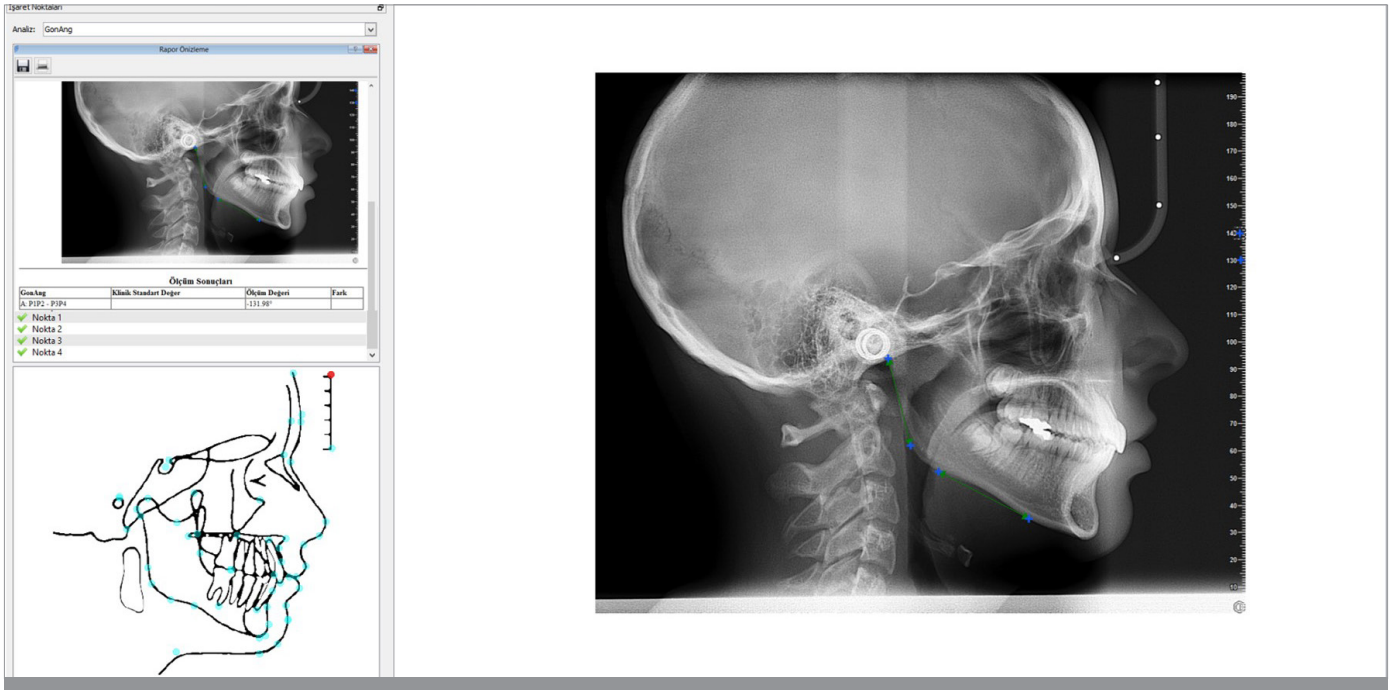

Figure 1. Gonial angle measurement on a digital lateral cephalogram.

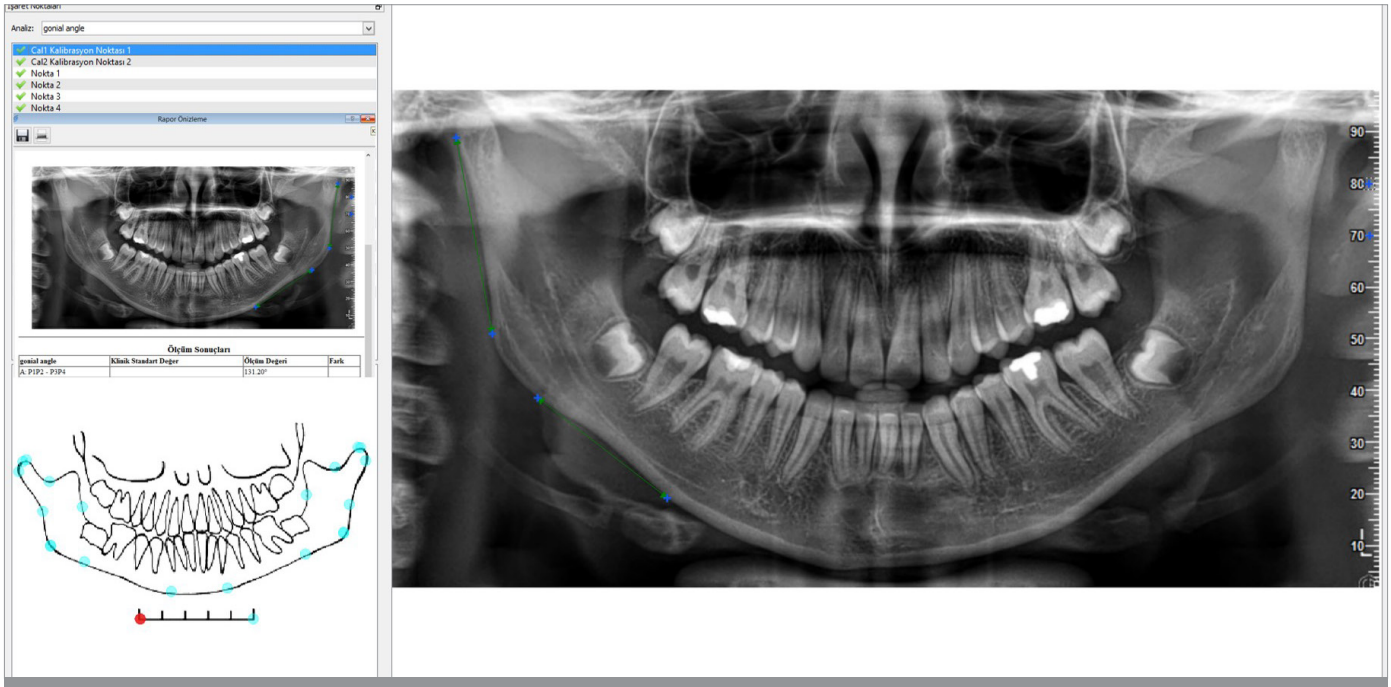

Figure 2. Gonial angle measurement on a digital orthopantomogram.

Table 1. The minimum, maximum, and mean values of gonial angles (GoAngs) measured on digital lateral cephalograms (Lat Cephs) and orthopantomograms (OPGs).

GoAng	Min (degree)	Max (degree)	Mean±SD (degree)	p value
Digital Lat Ceph	107.4	140.6	123.71±6.88	0.10
Digital OPG	107.4	136.9	123.32±6.47	
Digital OPG (Right)	107.1	137.7	123.25±7.04	0.73
Digital OPG (Left)	107.7	138.7	123.44±6.54	

Min: minimum value; Max: maximum value; SD: standard deviation; significant at p<0.05

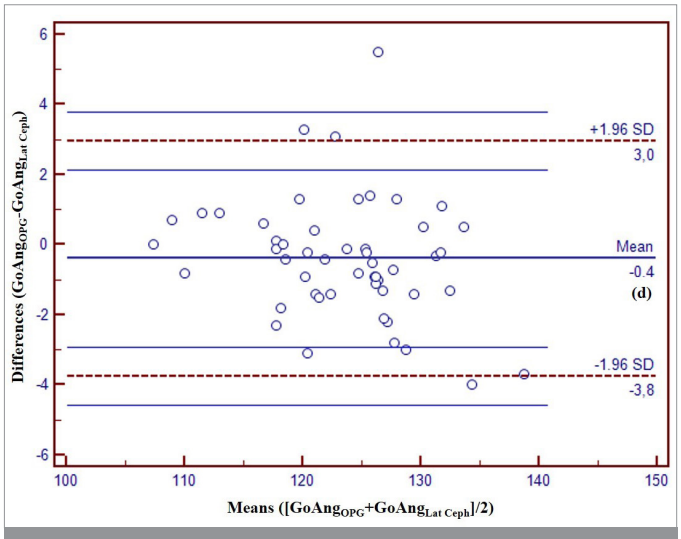

Figure 3. This plot represents the differences between the gonial angles measured using lateral cephalogram digital orthopantomogram (OPG) versus their mean values. In the plot the thick horizontal plane represents the mean values of all differences, *d*, a quantity known as the *bias*. The dashed lines represent the 95% limits of agreement and they enclose 95% of the experimental points. The thin solid lines next to the limits of agreement depict 95% confidence intervals. Differences and means were represented as one point for each patient.

There was no statistically significant difference between the measured GoAngs (p=0.1) (Table 1). According to Bland-Altman analysis, the levels of agreement between the digital Lat Ceph and OPG were high for GoAng measurement, with a bias value (95% levels of agreement) of –0.4° (figure 3). The mean values of the right and left GoAngs on the digital OPGs were 123.25°±7.04° and 123.44°±6.54°, respectively. The difference between these measured angles was also not statistically significant (p=0.73) (Table 1).

DISCUSSION

The purpose of this study was to determine whether there was a difference between the Gonial angles, constructed using easily identifiable mandibular and ramal planes, measured on digital Lat Ceph versus digital OPG using the 1.2.0 version of TotalCeph software. Only radiographs obtained between August 2016 and December 2017 were included in this study because radiographs recorded in our clinic before August 2016 were not digital.

The GoAng is measured at the point of intersection of the mandibular and ramal planes. It has been reported that the GoAng value varies depending on the type of mandibular or ramal plane used (7, 13). The mandibular plane could be assessed either by using a line tangential to the mandibular lower border or by drawing a line between the gonion and gnathion or the

gonion and menton. The ramal plane could also be assessed at different points, such as the articulare and gonion or by using a line tangential to the posterior border of the ramus and condyle. The points of the gnathion, menton, and articulare can be easily identified on Lat Ceph but not on OPG (7). Erroneous identification of these anatomic points on OPGs may result in inaccurate measurements. The lines tangential to the mandibular lower border and posterior border of the ramus and condyle can be easily identified on both radiographs and are, therefore, considered to be acceptable for comparison of the GoAngs measured on Lat Ceph and OPG (7). Thilagarani et al. (14) concluded that GoAngs constructed using Tweed's mandibular plane (a line tangential to the mandibular lower border) on Lat Cephs were highly correlated with those obtained on OPGs. Therefore, in this study, to obtain accurate measurements, GoAngs were measured at the point of intersection of the lines tangential to the mandibular lower border and those tangential to the posterior border of the ramus and condyle on both types of radiographs. The measurements on both radiographs were performed digitally using the TotalCeph software. The use of the software in radiograph analysis is simpler and less time consuming when compared with manual measurements. To the best of the author's knowledge, to date, there has been no study assessing the differences between the GoAngs measured on digital Lat Ceph and OPG using a software. All measurements were conducted twice to test the reliability of the observer. The intraobserver reliability was excellent, indicating that the GoAng can be measured precisely.

In practice, the GoAng is generally measured on Lat Cephs. The left and right gonial regions are superimposed on these radiographs, which can result in inaccurate measurements (6). The GoAng measurement on a Lat Ceph is the arithmetic mean of the superimposed right and left GoAngs. Any distortion of the right or left gonial regions affects the value of the measured GoAng (15). Concerns regarding the superimposition of the right and left gonial regions on Lat Cephs, which are made worse by any distortion of these regions prompted researchers to measure the GoAng on OPGs because the right and left gonial regions are not superimposed; therefore, GoAngs can be measured separately regardless of the possible effect of image distortion on the measurements (7-11, 14, 16).

In this study, the mean values of the right and left GoAngs measured on digital OPGs were slightly smaller than those reported by Shahabi et al. (8), who used the same mandibular and ramal planes for GoAng measurements as were used in this study. There were no statistically significant differences between the right and left GoAngs on the digital OPGs; this was in accordance with the results of prior studies (8, 9). The values from the digital OPGs were slightly smaller than those obtained from the digital Lat Cephs. However, the differences were not statistically significant, a finding that was also consistent with the results of Shahabi et al. and Radhakrishnan et al. (8, 9). Araki et al. (10) had results similar to those in this study, although they used different mandibular and ramal planes. Moreover, it has been demonstrated in previous studies that the correlation between measured GoAngs on Lat Ceph and OPG is high (17). In contrast, Fisher-Brandies et al. (11) reported that the GoAng measured on OPGs was 2.2°-3.6° less than the angle measured on Lat Cephs, which was statistically significant; they preferred Lat Ceph for GoAng measurement. Mattila et al. (7) stated that the GoAngs measured on OPGs were more accurate than those measured on Lat Cephs and OPGs of dry skulls. The differences between the results of these studies may be due to the sample sizes, patient ages, or the different methods used for GoAng measurement. This study demonstrated that the two techniques (digital OPG and Lat Ceph) gave similar results in terms of GoAng measurement. The measurement precision is important for comparing the two techniques. In this study, the measurement precision was 0.5°. The bias value of 0.4° was clinically irrelevant from the point of view of clinical practice. Nonetheless, the reliability of this result depends on the clinic discretion of the orthodontist.

The gender differences between the measured GoAngs from each type of radiograph were not evaluated, as the number of male patients was low in this study. Furthermore, previous studies have failed to demonstrate any statistically significant gender differences in the GoAngs obtained from either type of radiograph, so this was not evaluated in this study (8, 18, 19).

The results of this study imply that the digital OPGs are as reliable as the digital Lat Cephs for GoAng measurements using TotalCeph software. The decision regarding the type of radiograph to be used for GoAng measurement depends on the orthodontist's preference. Right and left GoAngs can be measured individually on digital OPGs, as the left and right sides are not superimposed, which is a significant advantage over Lat Cephs. This is especially important when planning orthognathic surgery in patients with asymmetries. However, further studies with larger sample sizes are required to improve the precision of the data.

CONCLUSION

The digital OPGs were as reliable as the digital Lat Cephs for measuring GoAngs using a software.

Ethics Committee Approval: This study was approved by the Ethics Committee of Hacettepe University Medical School with the approval number GO 18/65-24.

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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