

## RELIABILITY OF PANORAMIC RADIOGRAPHS TO DETERMINE GONIAL AND FRANKFURT MANDIBULAR HORIZONTAL ANGLES IN DIFFERENT SKELETAL PATTERNS

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### ABSTRACT

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**Background:** Gonial and Frankfurt mandibular plane angles are two of the most important measurements required for orthodontic treatment and orthognathic surgery.

Currently, lateral cephalograms are used for the determination of Go and FMA angles; however, in this method, measuring individual gonial angles becomes difficult due to the superimposed images of anatomical structures in a lateral cephalogram.

**Objectives:** The aim of the present study is to check the possible application of panoramic radiograph to determine gonial and Frankfurt mandibular plane angles.

**Material and Methods:** A total of 90 panoramic and 90 cephalometric radiographs were obtained retrospectively from patients who attended our orthodontic clinic. The mean age of the patients was  $18.9 \pm 5.9$  years. Gonial and Frankfurt mandibular angles were determined on both lateral cephalograms and OPGs and the patients were divided into three groups of horizontal, normal, and vertical growers. Pearson's correlation coefficient was used for data evaluation.

**Results:** Pearson's correlation coefficient showed that there were significant correlations between the means of Gonial and Frankfurt mandibular plane angles determined by OPG and Lateral cephalograms. ( $p < 0.01$ )

**Conclusion:** Panoramic radiograph can be reliably used to determine of gonial and Frankfurt mandibular angle and thus reduce the need for obtaining further cephalometric images from patients.

**Keywords:** orthopantomograms, lateral cephalograms, Gonial angle (Go), Frankfurt mandibular plane angle (FMA), skeletal patterns evaluation.

### 1. Introduction

Gonial angle (Go) and Frankfurt mandibular plane angle (FMA) are two of the most important measurements required for orthodontics, dentofacial orthopedics and orthognathic surgery. Go and FMA are commonly used to indicate the vertical or horizontal growth pattern of patients.

Go and FMA having mean values of  $130^\circ \pm 7^\circ$  and  $25^\circ \pm 5^\circ$ , respectively, are good indicators of vertical and horizontal growth pattern. Increased values of these angles show downward and backward

rotation of the mandible which is characteristic of high angle patients; while their decreased values would be indicative of upward and forward rotation of the mandible which is in return characteristic of horizontal growers.<sup>1</sup> Recognizing the growth pattern of patients is of utmost importance in the treatment planning phase.

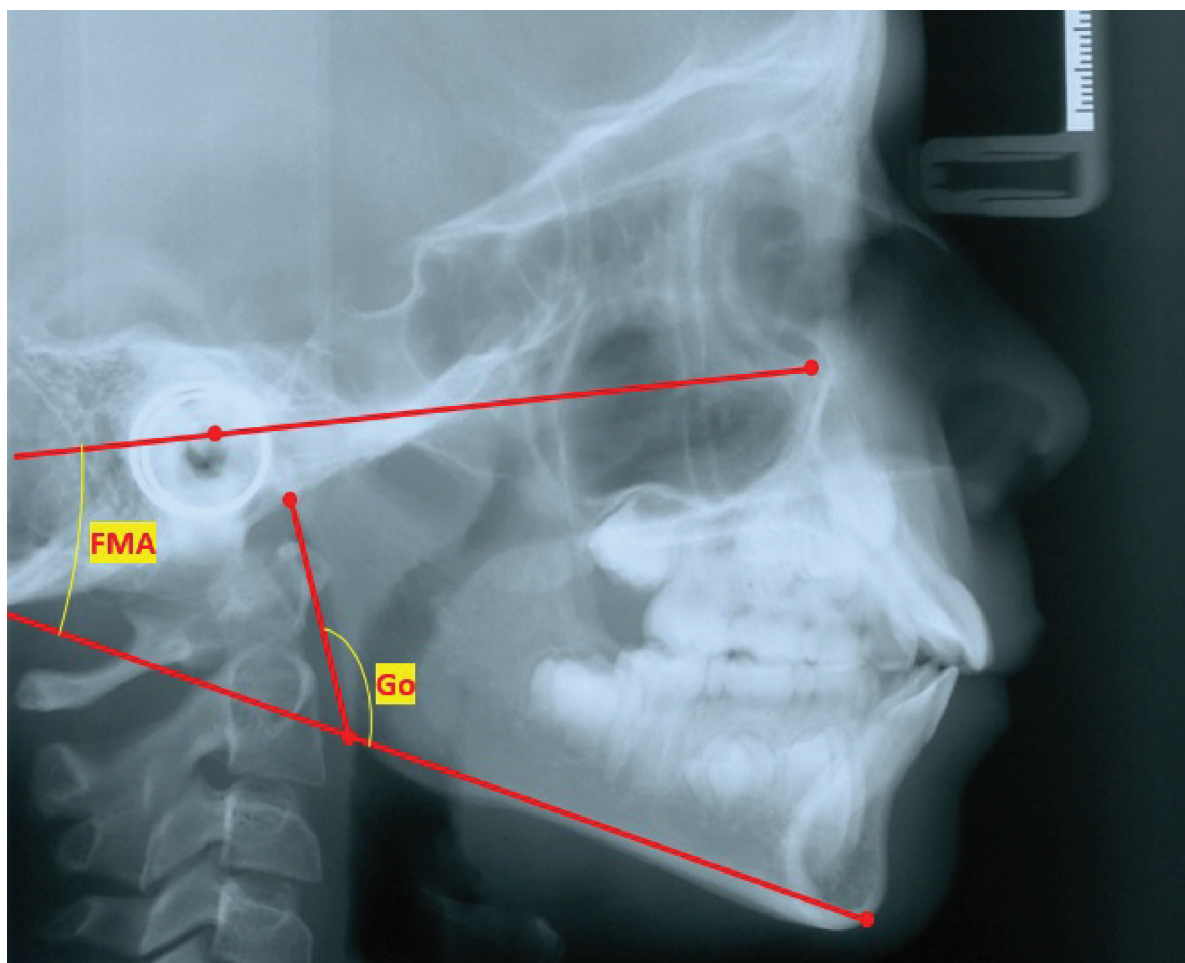
Currently, lateral cephalograms are used for the determination of Go and FMA angles; however, with this method, measuring individual gonial angles becomes difficult due to the superimposed images of anatomical structures in a lateral

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**Figure 1.** Gonial and Frankfurt mandibular plane angles shown on lateral cephalogram

cephalogram. However, panoramic images have got the advantage of reduced superimposition of anatomical structures.

Mattila et al.<sup>2</sup> reported that gonial angle can be determined from panoramic radiography with the same degree of accuracy as from lateral cephalogram; while, Fischer-Brandies et al.<sup>3</sup> stated that in determining the gonial angle, the lateral cephalometric radiograph should be preferred.

The aim of the present study is to check the possible application of panoramic radiograph to determine gonial and Frankfurt Mandibular plane angles.

## 2. Material and Methods

A total of 90 patients with the mean age range of  $18.9 \pm 5.9$  years who attended our orthodontic clinic were retrospectively selected for the current study. The radiographic data of the patients included lateral cephalometric and panoramic radiographs taken with the same digital machines. (Cranex D, Sordex Dental Imaging, Germany). The samples were allocated into three equal groups of 30 subjects based on the measurement of their Go angle on lateral cephalogram:

1. Horizontal growers:  $Go < 120^\circ$
2. Normal growers:  $120^\circ \leq Go < 130^\circ$
3. Vertical growers:  $130^\circ \leq Go$

The criteria for the selection of the patients

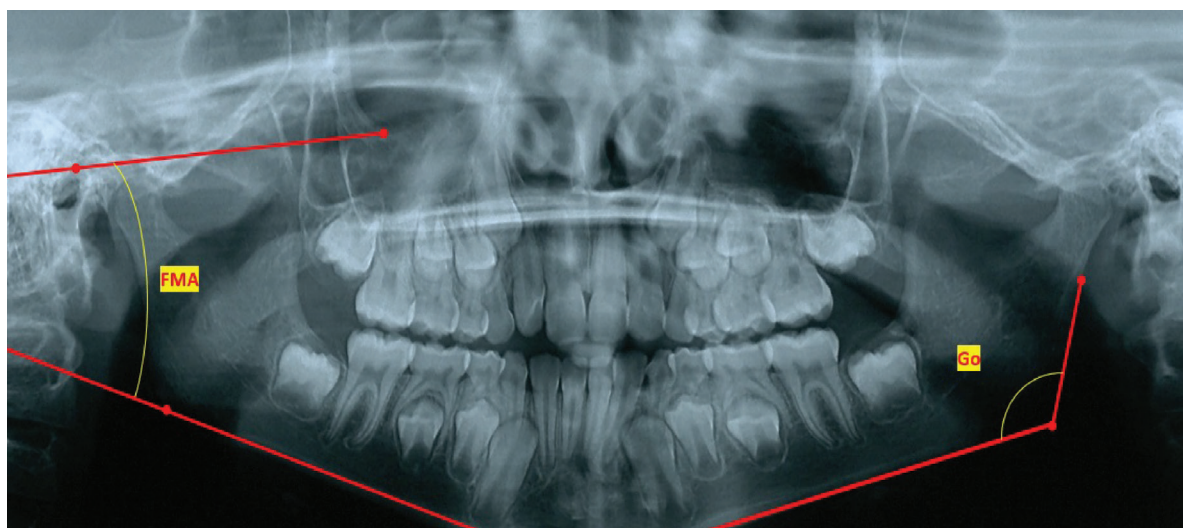
radiographs had to be high quality and sharpness, and all radiographs had to be taken by the same apparatus and same technician, with patients in the natural head position.

In lateral cephalograms, the gonial angle was determined in the intersection of the ramal plane (Ar-Go) and mandibular plane (Go-Gn) using a protractor with 1 degree accuracy. FMA was also determined as the angle formed by the intersection of Frankfurt Horizontal plane (FH) and the Mandibular Plane (Go-Gn). (Fig. 1)

In panoramic radiographs, the gonial angle was determined from two tangents which were drawn from the inferior border of the mandible and posterior borders of condyle and ramus of both sides. And FMA was determined as the intersection of the porion-orbitale line and mandibular plane (Go-Gn). (Fig. 2) One week after the first measurements, the tracings and measurements were repeated by the same investigator. Intraclass correlation coefficients (ICC) were used to measure the reliability of the results. ICC coefficients ranged from 0.813 to 0.92 indicating excellent reliability of the measurements.

## 3. Results

In this cross-sectional study, the agreement between Go and FMA measured in panoramic and lateral cephalometric radiographs was analyzed.



**Figure 2.** Gonial and Farnakfort mandibular plane angles shown on panoramic radiograph

**Table 1.** Mean and standard deviation of Go and FMA on lateral cephalograms and OPGs

	Gonial Angle				FMA Angle			
	Lateral Ceph.		OPG		Lateral Ceph.		OPG	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Horizontal	115.5	3.3	113.8	4.3	21.3	3.9	20.5	3.9
Normal	123.3	2	121.1	2.4	25.8	3.1	25	3.2
Vertical	132.7	2.9	128	4	31	4.2	29	3.7
Total	123.8	7.6	121	6.9	26	5.5	24.9	5

**Table 2.** Correlation coefficient between lateral and OPG for Go angle

	Pearson's Correlation Coefficient	p Value
Horizontal	0.733	0.01
Normal	0.399	0.05
Vertical	0.425	0.05
Total	0.896	0.01

The mean value of the gonial angle in lateral cephalograms and OPGs were  $123.8^{\circ} \pm 7.6^{\circ}$  and  $121^{\circ} \pm 6.9^{\circ}$ , respectively. The same value for FMA was  $26^{\circ} \pm 5.5^{\circ}$  and  $24.9^{\circ} \pm 5^{\circ}$ , respectively. (Table 1) Pearson's correlation showed a significant correlation between the means of the gonial angle in the lateral cephalogram and OPG for all three groups of horizontal, normal and vertical growers. In horizontal growers  $r$  was 0.733 ( $P < 0.01$ ), in normal growers it was 0.399 ( $P < 0.05$ ) and in vertical growers it was 0.425 ( $P < 0.05$ ). (Table 2) According to Table 3 there were significant correlations between the means of FMA determined by OPG and Lateral cephalograms ( $P < 0.01$ ).

#### 4. Discussion

The current study was performed to evaluate the measurements of gonial and FMA angles in panoramic radiographs and lateral cephalograms. The analysis of the two techniques suggests that

Go and FMA can be reliably determined from the panoramic radiograph. The finding of the current study corresponds with the results of the studies done conducted by Larheim and Svanaes<sup>4</sup> and Oksayan et al.<sup>5</sup> Panoramic radiography is frequently used in orthodontic practice to provide important information about the teeth and their axial inclinations. Thus, this technique would allow a reduction in the patient radiation doses before or during orthodontic treatment. Go and FMA have important roles in predicting growth direction and are good indicators for mandibular steepness. Go and FMA also act as a valuable diagnostic landmarks to determine a patient's growth pattern.<sup>6,7</sup> Since OPGs are routinely requested by dentists and orthodontists during clinical examination, being able to determine Go and FMA from OPGs would omit the need for further radiographic images such as lateral cephalograms. Matilla et al.<sup>2</sup> reported that the accuracy of the measurement of the gonial angle on panoramic radiograph is

**Table 3.** Correlation coefficient between lateral and OPG for FMA angle

	Pearson's Correlation Coefficient	pValue
Horizontal	0.798	0.01
Normal	0.538	0.01
Vertical	0.587	0.01
Total	0.827	0.01

similar to lateral cephalograms. Oksayan et al also reported that panoramic radiograph results were as reliable as lateral cephalometric radiograph in all angle classifications and mentioned that panoramic radiography can be used as an alternative radiographic technique to detect gonial angle in orthodontic patients. Shahabi et al.<sup>8</sup> also concluded that panoramic radiography can be used to determine the gonial angle as accurately as lateral cephalogram. They also mentioned that in panoramic radiography the right and left gonial angles can be easily measured easily without superimposition of anatomic landmarks, which occurs frequently in lateral cephalograms. However, in a study reported by Akcam et al,<sup>9</sup> regression analysis showed that the forecasting capability of vertical measurements on panoramic radiographs is 11-20% of lateral cephalograms. They stated that even though panoramic radiographs provide information on the vertical dimensions of craniofacial structures, clinicians should be cautious when predicting skeletal cephalometric parameters from panoramic radiographs, because of their lower predictability. Fischer-Brandies et al.<sup>3</sup> also reported that, the lateral cephalometric radiograph should be preferred in determining the gonial angle. They found gonial angle on panoramic radiograph 2.2-3.6 degrees less than lateral cephalograms, also these results showed significant difference between two radiographs. Shahabi et al.<sup>8</sup> mentioned that the discrepancy in the results could be because of the type of

malocclusion and age of the samples while their study was performed in adults with Class I malocclusion. Oksayan<sup>5</sup> also mentioned that their study was different in that it was constructed by either adult or adolescent patients. Moreover, various studies unanimously reported that effects of the age and gender on the gonial angle was very limited.<sup>5,8,10</sup> Determining landmarks and discrepancies from on single OPG would reduce the patients' radiation doses.<sup>11</sup> As an illustration, Gupta and Jain<sup>12</sup> used OPG as a preliminary tool in diagnosing mandibular asymmetry. Puricelli<sup>13</sup> also suggested a method for determining mandibular measurements on panoramic radiographs. Thus, a single OPG can be reliably used for various assessments which in the past would require other forms of radiographic images.

## 5. Conclusion

- Panoramic radiographs can be used as a reliable alternative to lateral cephalometric images for determination of Go and FMA.
- Panoramic radiographs can be used to predict the patients' growth pattern.
- Use of panoramic radiographs to determine Go and FMA can reduce patient radiation doses before or during orthodontic treatment.

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## CV

Dr. Ali Maghsoudi Nejad received his DDS from the Islamic Azad University of Tehran, dental branch, in 2012.

He is currently planning to continue his education in the United State of America.

He has participated in several oral presentations in national and international congresses.

One of his main research interest is orthodontics.

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## Questions

### Which one is the definition of gonial angle in lateral cephalogram?

- ☐ a. Intersection of the ramual plane and mandibular plane;
- ☐ b. Intersection of the ramual plane and occlusal plane;
- ☐ c. Intersection of the ramual plane and Frankfort mandibular plane;
- ☐ d. None of them.

### Which one is the definition of Frankfort mandibular plane angle in OPG?

- ☐ a. Intersection of the palatal plane and mandibular plane;
- ☐ b. Intersection of the porion-orbitale line and mandibular plane;
- ☐ c. Intersection of the porion-orbitale line and occlusal plane;
- ☐ d. Intersection of the porion-orbitale line and palatal plane.

### Which angle is used to determine vertical growth pattern?

- ☐ a. FMA;
- ☐ b. Gonial Angle;
- ☐ c. 1 and 2;
- ☐ d. ANB.

### Which one is the normal value of FMA?

- ☐ a.  $20^\circ \pm 5^\circ$ ;
- ☐ b.  $15^\circ \pm 5^\circ$ ;
- ☐ c.  $30^\circ \pm 5^\circ$ ;
- ☐ d.  $25^\circ \pm 5^\circ$ .