ORIGINAL RESEARCH

Assessing reliability of mandibular planes in determining gonial angle on lateral cephalogram and panoramic radiograph

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ABSTRACT

Introduction: Gonial angle is used widely in orthodontic tracing and is a significant indicator to diagnose the growth pattern in patients. Lateral cephalograms and panoramic radiographs both effectively determine the gonial angle. A definite variation exists when the gonial angle is determined using three different mandibular planes as described by Tweed, Steiner, and Down, respectively. The aim of this study was to evaluate, which gonial angle (obtained from Tweed's, Steiner's or Down's mandibular plane) on lateral cephalogram has the value closest to that obtained on a panoramic radiograph. **Materials and Methods:** A total of 300 patients between 12 and 29 years of age were selected. Panoramic and lateral cephalometric radiographs were obtained. On panoramic radiograph, gonial angle was determined by tangent of inferior border of mandible and most distal aspect of ascending ramus and condyle and compared with the value of each gonial angle obtained using three mandibular planes as described by Tweed, Steiner and Downs on lateral cephalogram. Levene's and Independent samples *t*-test were done for comparison. **Results:** Difference between gonial angles determined by Tweeds mandibular plane on lateral cephalogram and panoramic radiograph was statistically insignificant ($P > 0.05$). **Conclusion:** Of the three commonly used mandibular planes in measuring gonial angles, the value obtained with Tweeds mandibular plane seems to be more reliable.

Key words: Gonial angle, lateral cephalogram, orthodontics, panoramic radiograph

Introduction

Orthodontic diagnosis and treatment planning requires comprehensive data derived from diagnostic aids such as a general observation, clinical examination, study models and related radiographs. Cephalometrics has established itself as one of the pillars of comprehensive orthodontic diagnosis and also a valuable tool in treatment planning. Cephalometrics can be employed for descriptions of morphology, for knowledge of growth, for outlining objectives of treatment planning and utilizing advantages of different treatment techniques. Cephalometrics makes use of certain landmarks or points on the skull that are used for quantitative analysis and measurements. The landmarks used may be anatomic or derived. Gonion, a derived landmark, is a constructed point at the junction of ramal plane and mandibular plane. Mandibular plane is a horizontal plane used in cephalometrics. Based on the type of analysis, several mandibular planes are constructed.[1] The most commonly used ones are:

a. Tweed's — tangent to the lower border of the mandible.
b. Steiner's — line connecting gonion and gnathion
c. Down's — line connecting gonion and Menton.[1]

On account of these three different types of mandibular planes used, there is a definite variation in the gonial angle corresponding to that particular plane used.

Gonial angle is widely used in orthodontic cephalogram tracing. It is a significant indicator to diagnose the growth pattern of patients. Shahabi *et al*.[2] showed a great individual variation in gonial angle, that was affected by

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age and in different type of malocclusion. Gonial angle also determines the rotation of the mandible. The downward and backward rotation is called as a high angle and these patients showed increased gonial angle. Contrary to this, upward and forward direction of mandible is called as a low angle and these patients showed a decrease in gonial angle.[3] Thus, it becomes one of the most important angles for determining orthodontic or surgical plans in a patient. Nanda[4] showed that this parameter affects the extraction of teeth in Angle's Class II patients and Tahmina *et al*.[5] showed the need to undergo orthognathic surgery in Angle's Class III patients.

Lateral cephalogram is the most commonly used radiograph in orthodontics. When cephalometric measurements are made, the determination of gonial angle is difficult owing to the superimposition of the left and right angles. Panoramic radiographs have been used in orthodontic practice to provide information about the gonial angles and carry the added advantage of visualizing both the right and left angles without any superimposition. Mattila *et al*.[6] stated that the gonial angle can be determined from panoramic radiography with the same degree of accuracy as from lateral cephalogram.

Until date, to the best of our knowledge, no study has been done to determine gonial angle using different mandibular planes on lateral cephalogram and compared it with the gonial angle obtained on the panoramic radiograph.

Materials and Methods

A total of 300 patients between age group of 12 and 29 years, with various malocclusions, visiting the Department of Orthodontics were selected. These patients were further subdivided into three subgroups according to the Angle based malocclusion as Class I (160 patients), Class II (125 patients) and Class III (15 patients).The subjects with the previous history of facial or mandibular surgery or syndromes affecting the jaw or face were excluded from the study. Panoramic and lateral cephalometric radiographs were obtained from these patients. The quality of radiographs was checked according to radiographic standards and radiographs with technical, exposure or fixation faults were excluded from the study. All radiographs were obtained at the Oral and Maxillofacial Radiology Department. Panoramic and cephalometric images were acquired with a Sirona, Orthophos XG 5, X-ray unit (Sirona VillaIndia, India). They were obtained with a constant 12 mA, 80 kVp and 14.9 s exposure through 2.5 mm Al filtration with a focal spot size 0.5 mm using a CCD sensor. The radiographs of size 8″ × 10″ were obtained using Konica Minolta DRYPRO model 832 digital image printer. The radiographs were viewed and evaluated by two expert radiologists (Dr. Pal R and Dr. Singh A). The gonial angle is the intersection of the ramal plane (Ar-Go) and mandibular plane. Three different mandibular planes as described by Tweed (tangent to lower border of the mandible), Steiner (line connecting gonion and gnathion) and Downs (line connecting gonion and Menton) were used on the lateral cephalogram tracing was done on paper and measured using a protractor with 1 degree accuracy [Figure 1]. On the panoramic radiograph, gonial angle was obtained from the two tangents, which were drawn from the inferior border of the mandible and posterior borders of the condyle and ramus, on both sides [Figure 2]. All data were subjected to statistical analysis using SPSS 20.0 version software. Descriptive analysis was performed by using Independent samples *t*-test. The mean values were compared with which Levene's test was applied to obtain *P* value.

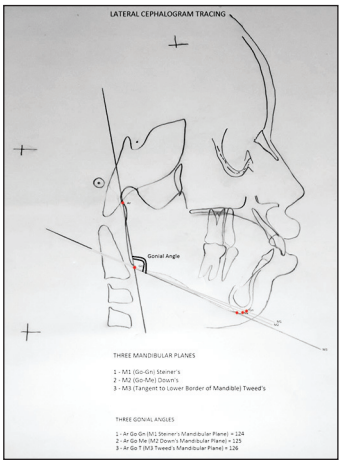

Figure 1: Cephalometric tracing on the lateral cephalogram showing the gonial angle determined using three different mandibular planes as described by Tweed's, Steiner's and Down's

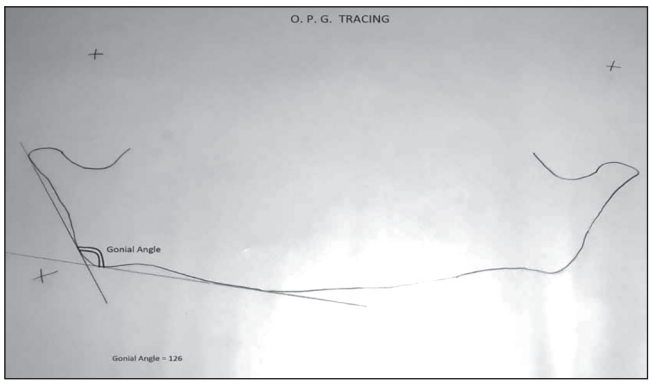

Figure 2: Cephalometric tracing on a panoramic radiograph showing the gonial angle determined from two tangents drawn from the inferior border of the mandible and the posterior borders of the condyle and ramus on both sides

Results

The study group consisted of 300 subjects (140 males, 160 females) with various malocclusions and were divided into three subgroups according to the Angle based malocclusion type as follows: Class I, 160 subjects (80 males, 80 females), Class II 125 subjects (50 males, 75 females), Class III, 15 subjects (10 males, 05 females) [Table 1].

In Class I patients, the mean value of the gonial angle, on the lateral cephalogram was 125.35° by Tweeds, 124.27° by Downs and 124.37° by Steiners and that on the panoramic radiograph was 125.58°.

In Class II patients, the mean value of the gonial angle, on the lateral cephalogram was 123.37° by Tweeds, 123.46° by Downs and 122.78° by Steiners and that on the panoramic radiograph was 124.07°.

In Class III patients, the mean value of the gonial angle, on the lateral cephalogram was 127.02° by Tweeds, 126.18° by Downs and 125.15° by Steiners and that on the panoramic radiograph was 127.05°.

The differences between gonial angle measurements in lateral cephalogram by using Tweeds, Steiners and Downs mandibular planes was statistically insignificant ($P > 0.05$) in Class I and Class III patients when compared with that in the panoramic radiographs. However the difference in the gonial angle measurements in Class II patients using the Steiners and Downs mandibular plane was statistically significant ($P = 0.049$ and $P = 0.003$ respectively where $P < 0.05$) but using Tweeds mandibular plane it was statistically insignificant ($P = 0.242$ where $P > 0.05$), to that obtained in the panoramic radiograph.

Table 1: Mean values of gonial angle measured with lateral cephalogram and panoramic radiograph

Groups	Tweeds	Downs	Steiner's	OPG	SD	F	*P* value
Class I	125.35			125.58	0.408	0.553	0.485
		124.27		125.58	0.408	0.984	0.359
			124.37	125.58	0.408	4.187	0.08
Class II	123.37			124.07	0.095	1.687	0.242
		123.46		124.07	0.095	23.0	0.003*
			122.78	124.07	0.095	6.041	0.049*
Class III	127.02			127.05	0.129	9.62	0.21
		126.18		127.05	0.129	2.91	0.139
			125.15	127.05	0.129	5.87	0.05

SD: Standard deviation, OPG: Orthopantomogram, *Clinically significant

Discussion

The gonial angle is also the representation of the form of the mandible. This angle has an important role in predicting growth and has specific effects initially on growth, profile changes and the condition of the anterior teeth of the lower jaw. This study was performed to evaluate, which gonial angle (obtained from using Tweed, Steiner or Downs mandibular planes) on a lateral cephalogram had a value closest to that obtained on a panoramic radiograph in patients aged 12-29 years. Mattila *et al.*,[6] Zangouei-Booshehri *et al.*[7] and Oksayan *et al.*[8] studied the use of panoramic radiography in the determination of the gonial angle, and the results have shown that gonial angle measurement on the panoramic radiograph is an accurate and repeatable criterion. This study however calculated the gonial angle in the lateral cephalogram by taking three different mandibular planes (Tweeds, Steiner and Downs) under consideration. We were able to state that the gonial angle obtained with the Tweeds mandibular plane correlates most precisely with the gonial angle obtained from a panoramic radiograph in Class I, II and III patients while Steiner and Downs mandibular plane gonial angle correlates in only Class I and Class III patients. The chin is more prominent in Class II Division 2 patients as compared with Class II Division 1 a finding which has been reported by Pancherz *et al.*[9] and Isik *et al.*[10]

The chin prominence might be attributed to the more prognathic mandible in Class II/2 or to normal development of the base of mandible which is not restrained by the effect of retroclined upper incisors. The variation in the gonial angles obtained using Downs and Steiners mandibular planes in Class II patients on the Lateral cephalogram, and panoramic radiograph may be attributed to this anatomic variation (prognathism) of the chin.

Since Gnathion (Steiners Mandibular Plane) and Menton (Downs mandibular plane), the two landmarks used here both rest on the chin, we can state that it leads to a variation when Class II patients are involved, and the gonial angle on the lateral cephalogram will not correspond accurately with that on the panoramic radiograph.

Hence we can state that if a comparative analysis is made on the two most used radiographs (Lateral cephalogram and panoramic radiograph) to determine the gonial angles using Tweeds, Steiner and Downs mandibular planes, the Tweeds mandibular plane is the most reliable one in Class I, Class II and Class III patients as it considers the tangent to the lower border of the mandible. It is independent of the anatomic variation of the chin. It corresponds

accurately with the gonial angle obtained on the panoramic radiograph. However, we also recommend studies with a larger sample size to ascertain the same.Our study is also in accordance with other studies[7,8] and can state that a panoramic radiograph is as effective as a lateral cephalogram in determining the gonial angle in orthodontic patients.

Conclusion

Gonial angle is a significant indicator to diagnose the growth pattern in patients. Both lateral cephalometric radiographs and panoramic radiographs are effective in determining the gonial angle in orthodontic patients. Of the three mandibular planes used to determine gonial angles on lateral cephalogram, the Tweeds mandibular plane seems to be more reliable.

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