Frontiers in Dentistry

Comparison of Panoramic Radiography and Lateral Cephalometry for Angular Measurements in Different Skeletal Classes

Mehrdad Panjnoush[1], Soroush Ebrahimi[*2]

1. Department of Dentomaxillofacial Radiology, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
2. Department of Orthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

Article Info

Article type:
Original Article

Article History:
Received: 25 Jun 2025
Accepted: 27 Dec 2025
Published: 20 Jun 2026

**** Corresponding author:***
Orthodontics Department, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

Email: Soroushebrahimi1995@gmail.com

A B S T R A C T

Objectives: This study evaluated the reliability of panoramic radiography in comparison with lateral cephalometry for angular measurements in different skeletal classes.

Materials and Methods: In this retrospective study, the gonial angle, the angle formed between the palatal plane and the Frankfort plane (palatal plane inclination), and the angle formed between the incisal edge of the upper incisor and the Frankfort plane (upper incisor vertical index) were measured on panoramic and lateral cephalometric radiographs of 278 patients in three skeletal classes. Intraclass correlation coefficient (ICC) was calculated to compare panoramic and lateral cephalometric radiographs. Paired t-test was used for comparison of the right- and left-side angles on panoramic radiographs.

Results: The ICCs were 0.941, 0.927, and 0.954 for the gonial angle, 0.650, 0.605, and 0.320 for the palatal plane inclination, and 0.812, 0.810, and 0.758 for the maxillary incisor vertical index in skeletal Class I, II and III patients, respectively. The ICCs were all statistically significant ($P<0.05$) except for the palatal plane inclination in Class III patients ($P>0.05$). There was a significant difference in the gonial angle of Class II patients between the right and left sides ($P<0.05$). The upper incisor vertical index in the right and left sides showed significant differences in all three skeletal classes ($P<0.05$). The difference between the right and left sides in other angles and skeletal classes was not statistically significant ($P>0.05$).

Conclusion: Skeletal class does not affect the reliability of panoramic radiographs for angular measurements, except for the palatal plane inclination in Class III patients.

Keywords: Cephalometry; Malocclusion; Radiography; Panoramic

➢ **Cite this article as:** Panjnoush M, Ebrahimi S. Comparison of Panoramic Radiography and Lateral Cephalometry for Angular Measurements in Different Skeletal Classes. *Front Dent*. 2026:23:27. http://doi.org/10.18502/fid.v23i27.22559

INTRODUCTION

A detailed and individualized treatment plan is the cornerstone of orthodontic treatment. To this end, orthodontists need an accurate database and diagnosis which are fed by three main sources: 1) interview; 2) clinical examination, and 3) analysis of patient records including photographs, dental casts, and radiographs [1]. Among the various dental radiographic modalities, two are commonly used in orthodontic diagnosis: Lateral cephalometry and panoramic radiography. Panoramic radiographs provide a broad, comprehensive view of the dentition, jaws, and periodontal structures, and can help assess dental inclination and stage of development [2-5].

Lateral cephalograms aid in evaluation of skeletal structures, soft tissues, and dental relations as well as patients' growth pattern. Angular measurements are among the key parameters in lateral cephalometric analysis, capturing the patients' growth pattern, horizontal and vertical relationships between different components of the face, dental

angulation, and rotation of the jaws [6, 7].

To perform a meticulous angular analysis, orthodontists must identify anatomical landmarks on lateral cephalograms. Although lateral cephalograms have been used as a standard modality for angular and linear measurements for many years [1, 8], in some instances, specifically in patients with asymmetrical faces, superimposition of hard and soft tissues, especially in the gonial, orbital and porion regions, makes it difficult to identify anatomical landmarks on this type of radiograph [7]. On the other hand, identification of landmarks on panoramic radiographs is usually easier and more accurate due to fewer superimpositions between the right and left sides.

Although the use of panoramic radiography for angular measurements would not completely eliminate the need for lateral cephalometric analysis, panoramic radiography could be helpful in situations where the accuracy of such measurements is doubtful because of landmark superimpositions.

Although some investigations have compared panoramic and lateral cephalometric radiographs in the assessment of angular and skeletal measurements [7, 9-13], the results of such studies are conflicting. For instance, Mattila et al. [7] recommended panoramic radiographs, whereas Fischer-Brandies et al. [14] recommended lateral cephalograms for measuring the gonial angle.

To the best of the authors' knowledge, of the studies that compared measurements of the gonial angle on panoramic and lateral cephalometric radiographs, only one study compared this variable among different skeletal classes [15]. In addition, no study was found to compare panoramic radiography and lateral cephalometry in measuring the angles formed between the Frankfort plane and the palatal plane, and between the Frankfort plane and the upper incisor plane.

Therefore, the aim of the current study was to compare panoramic radiography and lateral cephalometry in some angular measurements (the gonial angle, the angle formed between the Frankfort plane and the palatal plane, and the angle formed between the Frankfort plane and the upper incisor plane) in different skeletal classes.

MATERIALS AND METHODS

In this retrospective study, panoramic and lateral cephalometric radiographs of 278 randomly selected patients from the dental faculty of Tehran University of Medical Sciences were analyzed. The protocol of the study was approved by the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.DENTISTRY.REC.1398.130). All radiographs were digital and were obtained at the above-mentioned center using the same radiographic unit. The time interval between taking the lateral cephalometric and panoramic radiographs did not exceed one month.

The quality of the panoramic and lateral cephalometric radiographs were controlled using the criteria explained in the literature. For the panoramic radiographs, clear identification of the desired landmarks, lack of distortion, similar magnification between the right and left sides, and correct adjustment of the focal trough (by controlling the resolution and width of the teeth in incisor areas) were ensured. For the lateral cephalograms, clear identification of the desired landmarks, lack of superimposition between the right and left sides, which would interfere with the desired landmark identification, good resolution, and similar magnification between the right and left sides were ensured [1, 16].

The exclusion criteria were history of severe jaw or head trauma, severe congenital anomalies of the jaws or head, severe facial asymmetries, previous orthognathic surgery interfering with landmark identification (e.g. due to the presence of fixating mini-plates), and radiographs on which the identification of the desired landmarks was challenging due to superimpositions or distortions.

All angular measurement data from the panoramic and cephalometric radiographs were extracted by a trained operator using Planmeca Romexis® version 4.5 (Planmeca Oy, Helsinki, Finland) software.

First, the ANB angle was measured on lateral cephalograms, and patients were assigned to 3 subgroups accordingly. If the ANB angle

was between 0 and 4 degrees, the patient was classified as skeletal Class I. Values equal to or greater than 4 degrees were assigned to skeletal Class II and values equal to or less than 0 degrees were assigned to skeletal Class III group.

The following landmarks were identified and highlighted on the lateral cephalograms:

-*Menton* (the most inferior point on the mandibular symphysis),

-*T1* (the most posterior and inferior point on the posterior margin of the mandibular ramus),

-*T2* (the most inferior and posterior point on the inferior border of the mandibular body),

-*Articulare point* (intersection point between the posterior margin of the mandibular ramus and the inferior border of the cranial base),

-*Orbitale* (the most inferior point on the orbit),

-*Porion* (the most superior point of the external auditory canal),

-*Anterior nasal spine* (the most anterior point of the anterior nasal spine),

-*Posterior nasal spine* (intersection of the anterior margin of the pterygomaxillary fissure and inferior margin of the nasal cavity)

-*Incision superius incisalis* (incisal tip of the most anterior maxillary central incisor).

The following landmarks were identified and highlighted on the panoramic radiographs:

-*Menton* (the most inferior and most lateral point of the mandibular parasymphysis) on each side,

-*T1* (the most posterior and inferior point on the posterior border of the mandibular ramus) on each side,

-*T2* (the most inferior and posterior point on the inferior margin of the mandibular body) on each side,

-*The most prominent point on the posterior margin of the mandibular condyle on each side*,

-*Orbitale* (the most inferior point on the orbit) on each side,

-*Porion* (the most superior point on the external auditory canal) on each side,

-*Anterior nasal spine* (the intersection of the lower left and right edges of the nasal cavity)

-*Posterior nasal spine* (intersection of the anterior border of the pterygomaxillary fissure and the inferior border of the nasal cavity) on each side,

-*Incision superius incisalis* (the most incisal and medial point on the maxillary central tooth on each side).

The measured lines and planes on the panoramic and lateral cephalometric radiographs are shown in Fig 1. The gonial angle was the angle formed by the intersection of the mandibular and ramus planes.

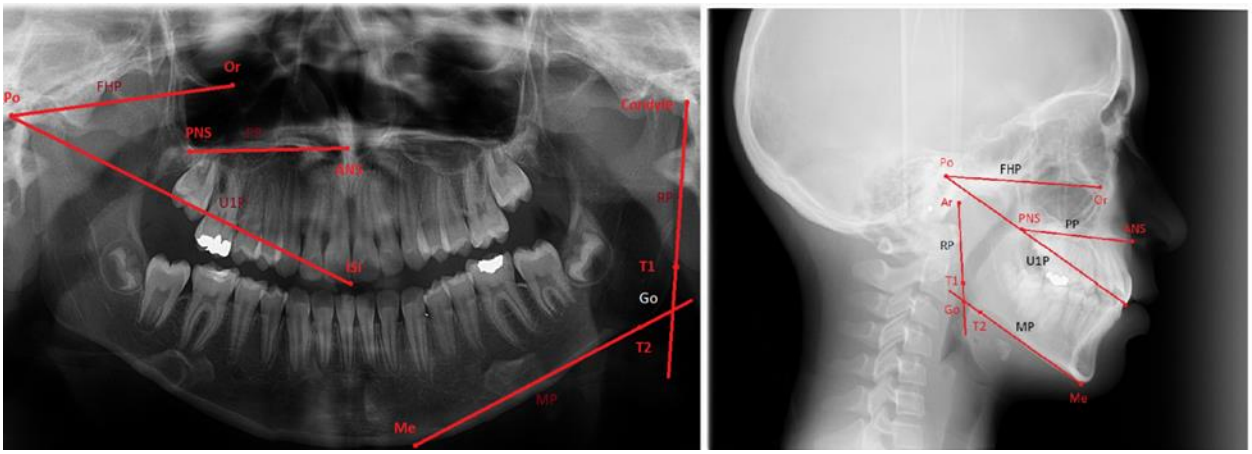

Fig 1. An example of the lines and planes used for angular measurements on panoramic (Left) and lateral cephalometric (Right) radiographs of a patient. ANS: Anterior nasal spine; Ar: Articulare; FHP: Frankfort horizontal plane; Go: Gonial angle; ISI: Incision superius incisalis; Me: Menton; MP: Mandibular plane; Or: Orbitale; PNS: Posterior nasal spine; Po: Porion; PP: Palatal plane; RP: Ramus plane; U1P: Upper incisor plane.

The angle formed between the Frankfort and palatal planes was measured on the panoramic and lateral cephalometric radiographs and was considered as the palatal plane inclination. The angle formed between the Frankfort plane and the upper incisor

plane was measured as the upper incisor vertical index (U1 vertical index) [17].

On the panoramic radiographs, the palatal plane inclination, U1 vertical index, and gonial angle were measured on each side, and the mean value of the right and left sides was compared with the measured values on lateral cephalograms.

To evaluate the reliability of the measurements, the recordings of 30 randomly selected patients were measured again after 2 weeks by the same examiner.

The intraclass correlation coefficient (ICC) estimates and their 95% confidence intervals (CIs) were calculated using SPSS version 25 (SPSS Inc., IL, USA), based on the mean values, consistency, and a 2-way mixed-effects model. This was done to compare analogous angles on panoramic radiographs and lateral cephalograms in different skeletal classes and to evaluate the intra-examiner reliability. The ICC values of angles in different skeletal classes were compared using their CIs according to the Wilson's method (Wilson's score intervals). Paired t-test was also used to compare the right- and left-side angles on panoramic radiographs. The ICC values for each angular measurement were interpreted according to Portney [18] using the following criteria: ICC values below 0.5 indicated poor reliability, values between 0.5 and 0.75 indicated moderate reliability, values between 0.75 and 0.9 indicated good reliability, and values above 0.90 indicated excellent reliability. Simple linear regression equations were calculated to predict cephalometric angular values from panoramic measurements. The power of the analysis was set at 0.8 and the significance threshold(α) at 0.05.

RESULTS

The mean age of patients was 14±6.11 years, and 64% of the patients were females. Ninety patients were skeletal Class I with a mean ANB angle of 2.39±0.97 degrees. One hundred patients were skeletal Class II with a mean ANB angle of 6.05±1.25 degrees, and 88 patients were skeletal Class III with a mean ANB angle of -2.06±2.32 degrees. Table 1 shows the mean values and ICCs of angular measurements made on lateral cephalograms and panoramic radiographs in different skeletal classes.

The ICC values for the gonial angle between the panoramic and lateral cephalometric radiographs were 0.941, 0.927, and 0.954 in skeletal Class I, II, and III patients, respectively and were all statistically significant (P=0.000, Table 1).

Table 1. Mean values of angular measurements made on cephalometric and panoramic radiographs in different skeletal classes and the related ICC values

Variable	Skeletal class	Lateral Cephalometric radiograph (Mean±SD)	Panoramic radiograph (Mean±SD)	ICC	ICC 95% Confidence Interval	
					Lower Bound	Upper Bound
Gonial Angle	I	125.76±7.26	123.5±6.49	0.941	0.910	0.961
	II	125.86±6.45	122.84±5.32	0.927	0.892	0.951
	III	127.25±5.68	124.8±5.31	0.954	0.930	0.970
Palatal Plane Inclination	I	3.22±2.9	4.14±2.72	0.650	0.468	0.769
	II	3.62±2.86	3.91±2.91	0.605	0.413	0.734
	III	3.01±2.72	4.2±2.89	0.320	-0.040	0.556
Upper Incisor Vertical Index	I	28.6±3.16	24.65±3.09	0.812	0.715	0.877
	II	28.11±2.94	24.63±2.92	0.810	0.718	0.872
	III	28.31±3.11	24.06±3.14	0.758	0.630	0.842

ICC: Intraclass correlation coefficient; SD: Standard deviation.

The ICC values for the palatal plane inclination between the panoramic and lateral cephalometric radiographs were statistically significant (P=0.000) in skeletal Class I and Class II patients, with values of 0.650 and 0.605, respectively; however, it was not statistically

significant (P>0.05) in skeletal Class III patients (mean=0.320 with 95% CI=-0.4-0.55; Table 1).
Finally, the ICC values for the upper incisor vertical index in skeletal Class I, II, and III patients were 0.812, 0.810, and 0.758, respectively, and all were statistically significant (P=0.000, Table 1).
A comparison of angular measurements made on panoramic radiographs between the right and left sides is presented in Table 2. In summary, there was a statistically significant difference in the gonial angle between the right and left sides in skeletal Class II patients with a mean difference of 0.96±3.6 degrees (P=0.009). The U1 vertical index showed statistically significant differences between the right and left sides in all three skeletal classes (P=0.000), with a mean difference of 1.21±2.4 degrees in skeletal Class I, 1.08±2.1 degrees in skeletal Class II, and 1.02±2.2 degrees in skeletal Class III. There was no statistically significant difference between the right and left sides for the other angles and skeletal classes (P>0.05).
Simple linear regression equations for predicting cephalometric angles by measuring them on panoramic radiographs are shown in Table 3. Table 3 also shows the mean absolute difference between the calculated cephalometric angles based on panoramic radiographs and the actual cephalometric angles of the patients.
Evaluation of the reliability of the angular measurements of 30 randomly selected patients after 2 weeks revealed statistically significant ICC values for all measurements (P=0.000).

DISCUSSION

The present study compared panoramic and lateral cephalometric radiographs for some angular measurements that are useful in the diagnosis and treatment planning of orthodontic patients.
Turp et al. [19] and Larheim and Svanaes [20] concluded that vertical and horizontal linear assessments on panoramic radiographs are unreliable and should be avoided. Similarly, Faryal et al. [21] compared panoramic and lateral cephalometric radiographs in terms of

Table 2. Mean values of angular measurements made on panoramic radiographs and their comparison between the right and left sides

Variable	Skeletal class	Right Side (Mean±SD)	Left Side (Mean±SD)	T-test (P value)	Paired Samples Correlation	Correlation P value
Gonial Angle	I	123.70±6.81	123.30±6.49	0.204	0.903	<0.001
	II	123.32±5.41	122.36±5.81	0.009	0.797	<0.001
	III	125.10±5.56	124.51±5.74	0.159	0.767	<0.001
Palatal Plane Inclination	I	3.99±2.98	4.29±2.86	0.193	0.728	<0.001
	II	3.76±3.10	4.05±3.20	0.226	0.715	<0.001
	III	4.38±3.35	4.01±2.98	0.183	0.676	<0.001
Upper Incisor Vertical Index	I	25.26±3.58	24.05±3.04	<0.001	0.747	<0.001
	II	25.17±3.36	24.09±2.82	<0.001	0.781	<0.001
	III	24.58±3.58	23.55±3.05	<0.001	0.792	<0.001

SD: Standard deviation.

Table 3. Simple linear regression equations for prediction of cephalometric angles based on the measured values on panoramic images. Absolute difference is the difference between the calculated and actual cephalometric angles of the patients

Angle	Linear Regression Equation	R^2	P value	Absolute difference (Mean ± SD)
Gonial	C=(P×1.01)+1.47	0.797	<0.001	2.33±1.77
Palatal Plane Inclination	C=(P×0.37)+1.81	0.136	<0.001	2.01±1.70
Upper Incisor Vertical Index	C=(P×0.66)+12.22	0.430	<0.001	1.73±1.53

C: Calculated cephalometric angle; R^2: R-Squared; P: Measured panoramic value; SD: Standard deviation.

horizontal and vertical linear measurements and showed that panoramic radiographs were unreliable for horizontal linear measurements (e.g., mandibular body or total mandibular length), unlike vertical measurements (e.g., ramus height). Therefore, only angular measurements could be performed in the current study to compare the two imaging modalities [17, 22, 23].

One limitation of panoramic radiographic analysis is the invalidity of angular measurements between the mandible and other components of the face [17]. This limitation arises from the process of taking panoramic radiographs, as patients must advance their lower jaw to place their teeth in the bite block. Therefore, any angular analysis between the mandible and the maxilla or between the mandible and the cranial base would be inaccurate; thus, it was avoided in the present study.

Three angles were evaluated: gonial, palatal plane inclination, and upper incisor vertical index. The gonial angle and palatal plane inclination provide a general perspective of patient's vertical skeletal class. Comparison of the right and left gonial angles on panoramic radiographs could be helpful in detecting true facial asymmetries, which is a limitation in lateral cephalograms because the right and left gonial angles cannot be distinguished. The upper incisor vertical index, introduced by Akcam et al. [17] on panoramic radiographs helps to evaluate the vertical eruption and extrusion of maxillary incisors.

The results of the present study showed that panoramic radiography is a reliable source of angular measurements in orthodontic analysis in different skeletal classes; the only exception was the palatal plane inclination in skeletal Class III patients, which showed a non-significant and relatively low ICC.

The ICCs for the gonial angle were excellent in all skeletal classes according to the criteria by Portney [18], whereas the palatal plane inclination had poor to moderate ICCs in skeletal Class I and II patients and poor ICC in skeletal Class III patients. This could be due to the positioning of the patients in the panoramic machine, especially in patients with large mandibles, resulting in more image distortion, especially in the palatal region. The U1 vertical index showed moderate to good ICCs in different skeletal classes.

Patients with Class I, II, and III skeletal patterns had the highest ICCs for U1 vertical index followed by the palatal plane inclination. For the gonial angle, patients classified as Class III exhibited the highest ICCs followed by Class I, and Class II.

Although the majority of published studies [7, 15, 24-30], as well as the present investigation, support the hypothesis that there would be no statistically significant difference in the gonial angle measurements between panoramic radiography and lateral cephalometry, and that panoramic radiographs are reliable sources for gonial angle measurements, there are some other studies that drew different conclusions. Fisher-Brandies et al. [14] demonstrated that the gonial angles measured on panoramic radiographs were approximately 2.2 to 3.6 degrees smaller than those measured on lateral cephalograms, leading them to conclude that a significant disparity exists between these radiographic modalities. Mattila et al. [7] conducted a comparison between the gonial angles measured on panoramic radiographs and lateral cephalograms and the gonial angles of dry skulls, and concluded that panoramic radiographs had greater precision in measuring the gonial angle.

According to the present study, the mean gonial angle measured on panoramic radiographs was smaller than that measured on lateral cephalograms, but high ICCs and linear regression equations with a good accuracy (R=0.8) make panoramic radiographs a reliable source for gonial angle measurements. Shahabi et al. [24] asserted that the divergent outcomes observed in comparing panoramic and lateral cephalometric radiographs in gonial angle measurement may be attributable to the variations in age and malocclusion of patients across different studies. The current study demonstrated excellent ICC values for the gonial angle in all skeletal classes.

Mattila et al. [7] and Dahan and Jesdinsky [31]

contributed the variation in the gonial angle measurements to different methods of mandibular plane tracing. Radhakrishnan et al. [25] used the line tangent to the lower border of the mandible while other investigators, used the line passing through the menton or gnathion points, similar to the present study.

By comparing two gonial angles, no difference was found between the right and left sides of panoramic radiographs in skeletal Class I and III patients, while a statistically significant difference was found in Class II patients. Akcam et al. [17] discovered a high correlation between the right and left gonial angles on panoramic radiographs of skeletal Class II patients. However, in the current study, despite a relatively high correlation between the right and left gonial angles of Class II patients, there was a statistically significant difference between the two sides. The mean difference was less than 1 degree (larger on the right side) and could be clinically insignificant. The right and left upper incisor vertical indices were also significantly different statistically with the right side exhibiting a higher mean value, although the mean difference was less than 1.5 degrees in all skeletal classes. The palatal plane inclination showed a non-significant difference between the two sides of panoramic radiographs.

Clinicians can estimate lateral cephalometric gonial angles with high precision using linear regression equations (R^2=0.8). Predicting upper incisor inclination (R^2=0.43) and palatal plane inclination (R^2=0.14) using regression equations showed moderate and weak accuracy. Although the absolute difference between the predicted and actual angles was clinically imperceptible, these equations should be used with caution. Further studies are required to further elucidate this topic.

CONCLUSION

Reliability of panoramic images for measuring the gonial angle, palatal plane inclination and upper incisor vertical index was found to be excellent, poor to moderate and moderate to good, respectively. The skeletal class does not affect the reliability of panoramic images for angular measurements. The exception was palatal plane inclination in skeletal Class III patients.

CONFLICT OF INTEREST STATEMENT

None declared.

GENERATIVE AI IN SCIENTIFIC WRITING

The authors declare that no artificial intelligence was used in the preparation of the present article.

REFERENCES

1. Fields HW Jr, Larson BE, Sarver DM, Proffit WR. Contemporary Orthodontics. 7th ed. St. Louis (MO): Elsevier; 2025. Chapter 6, Orthodontic Diagnosis; p. 139.
2. Piedra I. The Levandoski Panoramic Analysis in the diagnosis of facial and dental asymmetries. J Clin Pediatr Dent. 1995 Fall;20(1):15-21.
3. Graber TM. Panoramic radiography in orthodontic diagnosis. Am J Orthod. 1967 Nov;53(11):799-821.
4. Bruks A, Enberg K, Nordqvist I, Hansson AS, Jansson L, Svenson B. Radiographic examinations as an aid to orthodontic diagnosis and treatment planning. Swed Dent J. 1999;23(2-3):77-85.
5. Friedland B. Clinical radiological issues in orthodontic practice. Semin Orthod. 1998 Jun;4(2):64-78.
6. Cobourne MT, DiBiase AT. Handbook of Orthodontics. 3rd ed. Edinburgh: Elsevier; 2024. Chapter 7, The Orthodontic Patient: Examination and Diagnosis; p. 193–224.
7. Mattila K, Altonen M, Haavikko K. Determination of the gonial angle from the orthopantomogram. Angle Orthod. 1977 Apr;47(2):107-10.
8. Tenti FV. Cephalometric analysis as a tool for treatment planning and evaluation. Eur J Orthod. 1981;3(4):241-5.
9. Araki M, Kiyosaki T, Sato M, Kohinata K, Matsumoto K, Honda K. Comparative analysis of the gonial angle on lateral cephalometric radiographs and panoramic radiographs. J Oral Sci. 2015;57(4):373-8.
10. Zangouei-Booshehri M, Aghili HA, Abasi M, Ezoddini-Ardakani F. Agreement between panoramic and lateral cephalometric radiographs for measuring the gonial angle. Iran J Radiol. 2012 Nov;9(4):178-82.
11. Ongkosuwito EM, Dieleman MM, Kuijpers-Jagtman AM, Mulder PG, van Neck JW. Linear mandibular measurements: comparison between orthopantomograms and lateral cephalograms. Cleft

Palate Craniofac J. 2009 Mar;46(2):147-53.
12. Nohadani N, Ruf S. Assessment of vertical facial and dentoalveolar changes using panoramic radiography. Eur J Orthod. 2008 Jun;30(3):262-8.
13. Alhaija ES. Panoramic radiographs: determination of mandibular steepness. J Clin Pediatr Dent. 2005 Winter;29(2):165-6.
14. Fischer-Brandies H, Fischer-Brandies E, Dielert E. Der Unterkieferwinkel auf dem Orthopantomogramm [The mandibular angle in the orthopantomogram]. Radiologe. 1984 Dec;24(12):547-9.
15. Okşayan R, Aktan AM, Sökücü O, Haştar E, Ciftci ME. Does the panoramic radiography have the power to identify the gonial angle in orthodontics? ScientificWorldJournal. 2012;2012:219708.
16. Mallya S, Lam EWN. White and Pharoah's Oral Radiology: Principles and Interpretation. 8th ed. St. Louis (MO): Elsevier; 2019. Chapter 8, Cephalometric and Skull Imaging, p. 119–131; Chapter 9, Panoramic Imaging, p. 132–150.
17. Akcam MO, Altiok T, Ozdiler E. Panoramic radiographs: a tool for investigating skeletal pattern. Am J Orthod Dentofacial Orthop. 2003 Feb;123(2):175-81.
18. Portney LG, Watkins MP. Foundations of Clinical Research: Applications to Practice. Norwalk (CT): Appleton & Lange; 1993. p. 505–528.
19. Türp JC, Vach W, Harbich K, Alt KW, Strub JR. Determining mandibular condyle and ramus height with the help of an Orthopantomogram--a valid method? J Oral Rehabil. 1996 Jun;23(6):395-400.
20. Larheim TA, Svanaes DB. Reproducibility of rotational panoramic radiography: mandibular linear dimensions and angles. Am J Orthod Dentofacial Orthop. 1986 Jul;90(1):45-51.
21. Faryal A, Shaikh A. Reliability of orthopantomogram in comparison to lateral cephalogram for linear mandibular measurements. J Ayub Med Coll Abbottabad. 2022 Oct-Dec;34(Suppl 1)(4):S957-63.
22. de Mora EP, Caleya-Zambrano AM, Martin-Vacas A, Ginés-Pérez A, de Nova-Garcia J, Gallardo-López NE. Panorametric study in a paediatric population in Madrid. J Clin Pediatr Dent. 2023 Sep;47(5):103-15.
23. Wyatt DL, Farman AG, Orbell GM, Silveira AM, Scarfe WC. Accuracy of dimensional and angular measurements from panoramic and lateral oblique radiographs. Dentomaxillofac Radiol. 1995 Nov;24(4):225-31.
24. Shahabi M, Ramazanzadeh BA, Mokhber N. Comparison between the external gonial angle in panoramic radiographs and lateral cephalograms of adult patients with Class I malocclusion. J Oral Sci. 2009 Sep;51(3):425-9.
25. Radhakrishnan PD, Sapna Varma NK, Ajith VV. Dilemma of gonial angle measurement: Panoramic radiograph or lateral cephalogram. Imaging Sci Dent. 2017 Jun;47(2):93-7.
26. Kumar SS, Thailavathy V, Srinivasan D, Loganathan D, Yamini J. Comparison of orthopantomogram and lateral cephalogram for mandibular measurements. J Pharm Bioallied Sci. 2017 Nov;9(Suppl 1):S92-5.
27. Bhullar MK, Uppal AS, Kochhar GK, Chachra S, Kochhar AS. Comparison of gonial angle determination from cephalograms and orthopantomogram. Indian J Dent. 2014 Jul;5(3):123-6.
28. Srii R, Koju S, Mahanta SK, Marla V, Niroula D, Upadhyaya C, et al. Digital radiographic study of gonial angle in forensic odontology in a tertiary care centre: A descriptive cross-sectional study. JNMA J Nepal Med Assoc. 2021 Apr;59(236):350-5.
29. Kaya D. Is there any difference between gonial angle values measured on digital lateral cephalograms and orthopantomograms? Turk J Orthod. 2020 May;33(2):72-6.
30. Goyal D, Kumar P, Jain S. Digital evaluation and correlation of facial growth patterns assessed on lateral CEPH and orthopantomogram through ONECEPH mobile application. J Orthod Sci. 2023 Apr;12:29.
31. Dahan J, Jesdinsky HJ. Evaluation of the orthopantomogram for cephalometric studies in orthodontics. Stoma. 1968 Aug;21(3):200-6.