ORIGINAL RESEARCH

Role of Orthopantomogram as an Ancillary to Lateral Cephalogram in Diagnosis of Vertical Malocclusions: A Comparative Study

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Abstract

Aim: Vertical malocclusion is an important and commonly seen anomaly of the craniofacial complex. The aim of the present study was to evaluate and compare the efficiency of the orthopantomogram (OPG) over the lateral cephalogram.

Materials and methods: A total of 60 radiographs were collected from patients. Independent reference planes were set up in the maxilla and the mandible. The inclusion criteria of the study involved subjects in the age group of 20–25 years, class I skeletal and dental relationship with an overjet, and overbite in the range of 2–4 mm with an orthognathic profile. Exclusion criteria involved crowding, asymmetry, or spacing along with no history of prior orthodontic or surgical treatment. Mean values were evaluated using the *z* test. The statistical analysis was performed by using the Statistical Package for the Social Sciences.

Results: Significant values were obtained for effective length of ramus, effective length of corpus, effective height of corpus, interocclusal distance, panoramic alternative of gonial angle (PGOA), panoramic alternative condylar inclination (PCOI), panoramic alternative of mandibular plane angle (PMPA), and maxillary occlusal angle.

Conclusion: On completion of our study, we can conclude that the OPG can be used in the assessment of vertical malocclusion quantitatively.

Clinical significance: Less radiation exposure and easy availability of OPGs will be useful clinically.

Keywords: Deep bite, Lateral cephalogram, Open bite, Orthopantomogram.

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Introduction

In the field of orthodontics, malocclusion can be found in different planes like anteroposterior, sagittal, and vertical. Since the time of Edward angle,[1] orthodontists are mainly interested in anteroposterior malocclusion. But if we look back into the history, we will find very little work on more disfiguring vertical malocclusion. Vertical malpositions of teeth are the most common malocclusions encountered and more difficult to treat as compared to anteroposterior malocclusion.[2] Anterior open bite and deep bite are the two most common vertical malocclusions encountered. Before we arrive at a treatment plan, a good diagnosis of the malocclusion is required. The most commonly used diagnostic aids used in orthodontics are the lateral cephalograms and orthopantomograms (OPGs).[3] Lateral cephalograms are used for quantitative description of dental and skeletal parameters whereas OPGs are qualitative in nature.[4] So far digital cephalometric radiography has gained popularity in orthodontic practices for diagnosis of vertical malocclusion. Levandoski in 1991 gave the first method to analyze panoramic radiographs and since then, there are a few studies done on this subject.[5]

Orthopantomogram used routinely has the maximum cost–benefit ratio due to low radiation exposure.[6] There have been studies to diagnose mandibular asymmetries[7,8] and condylar inclination[9] by OPG. However, there is no study in the literature mentioning the use of OPGs for the diagnosis of vertical malrelationships. Thus, the present study was designed to evaluate the vertical malrelationships between the jaws.

Materials and Methods

This study was approved by the research ethics committee of Kalinga Institute of Medical Sciences. Panoramic radiographs of 60 subjects—20 open bite (Fig. 1), 20 deep bite (Fig. 2), and 20 control group—were included for the study and consent was taken from all the patients. All digital panoramic radiographs were made by a standardized technique[10] and used for analysis. Tracing was done on an acetate paper using a 0.5 mm lead pencil. The same operator performed all the tracing in a standardized manner to avoid errors due to interoperator variation. Measurements were made on both left and right sides of panoramic radiographs. The bite plate used while making a panoramic radiograph altered the occlusion. Therefore, independent reference planes were set up in the maxilla and the mandible. The inclusion criteria of the study involved subjects in the age group of 20–25 years, class I skeletal and dental relationship with an overjet, and overbite in the range of 2–4 mm with an orthognathic profile. Exclusion criteria involved crowding, asymmetry, or spacing along with no history of prior orthodontic or surgical treatment.

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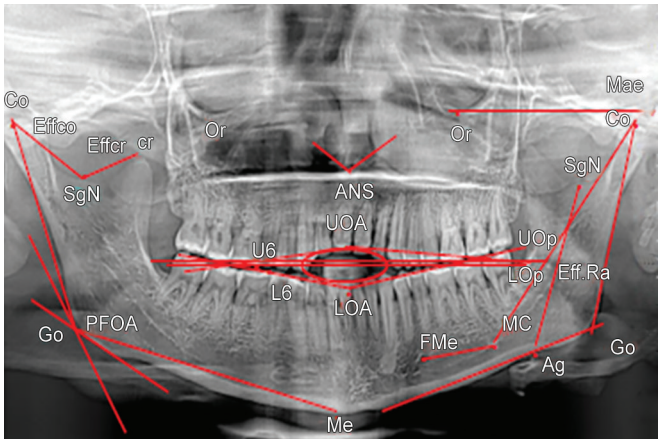


Fig. 1: An open bite orthopantomogram with all landmarks, angular parameters, linear parameters, and the elliptical orifice

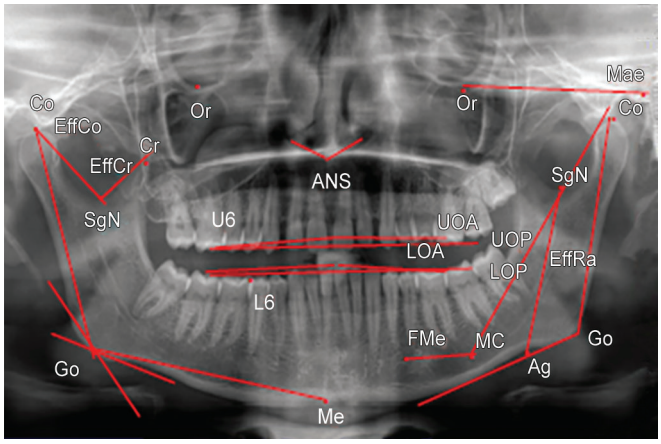


Fig. 2: A deep bite orthopantomogram with all landmarks and angular and linear parameters

The following panoramic landmarks were identified:

Landmarks

- Orbitale (or): the lowest point on the inferior rim of the orbit
- Mae—meatus acusticusextemus: location of the external auditory meatus
- ANS—anterior nasal spine: the anterior tip of the sharp bony process of the maxilla
- Me—Menton: the lowest point on the symphysis shadow of the mandible
- Condylion (Co): the most superior point on head of the mandibular condyle
- Coronoid point (Cor): the most superior point on the coronoid process
- Sigmoid notch point (Snp): the deepest point on the sigmoid notch
- Gonion (Go): the most posteroinferior point at the angle of mandible
- F Me: foramen mentale
- MC: mandibular canal: perpendicular to the lower border of the mandibular canal
- U6: the mesiobuccal cusp on the upper first molar
- L6: the mesiobuccal cusp on the lower molar mandible

The following reference planes were then drawn:

- Mae-Or: Frankfort's horizontal plane
- Co-MC: condylar plane
- MC-Fme: mandibular canal plane
- MC-Me: corpus line
- Upper occlusal plane: the line drawn from the mesiobuccal cusp of the right first molar to the left first molar
- Lower occlusal plane: the line drawn from the mesiobuccal cusp of the right lower first molar to the left lower first molar

Following measurement were made:

Linear

- Effective length of the condyle: measured from the condyle to the sigmoid notch
- Effective length of the coronoid: measured from the coronoid to the sigmoid notch
- Angle between the condyle and the coronoid process: formed at intersection of two longitudinal lines drawn from the condyle and the coronoid along their long axis
- Effective length of the ramus: measured from Snp to point Ag
- Effective length of the corpus: measured from point Ag to point M
- Effective height of the corpus: distance between the distal root apex of the mandibular first molar and the inferior mandibular border
- Interocclusal distance: distance between upper occlusal planes

Angular

- PGOA (Co.Go/Go-Me): panoramic alternative of cephalometric gonial angle
- PMPA: panoramic alternative of mandibular plane angle
- UOA (U6-U1-U6): maxillary occlusal angle
- LOA (L6-L1-L6): mandibular occlusal angle
- PCOI (Co-MC/Fme-MC): a panoramic radiograph alternative of condylar inclination
- Oral orifices

Results

All statistical analysis was performed with the Statistical software version 20 (SPSS Inc., Chicago, IL, USA). Student's *t* tests were used to evaluate group's comparability. The results were considered significant ($p < 0.05$).

Significant values (Table 1) were obtained for effective length of the ramus, effective length of the corpus, effective height of the corpus, interocclusal distance, PGOA, PCOI, PMPA, and maxillary occlusal angle.

All the values that we got from OPG were compared with that of lateral cephalometric[11,12] values (Table 2) for proper reliability of the study. Following measurements were made—length of the ramus, length of the corpus, effective height of the corpus, cephalometric gonial angle, cephalometric mandibular plane angle, cephalometric condylar inclination, and occlusal plane angle.

- Cephalometric condylar inclination angle—angle between the Frankfort horizontal plane and tangent to the anterior border of the condyle (<1 in Fig. 3)

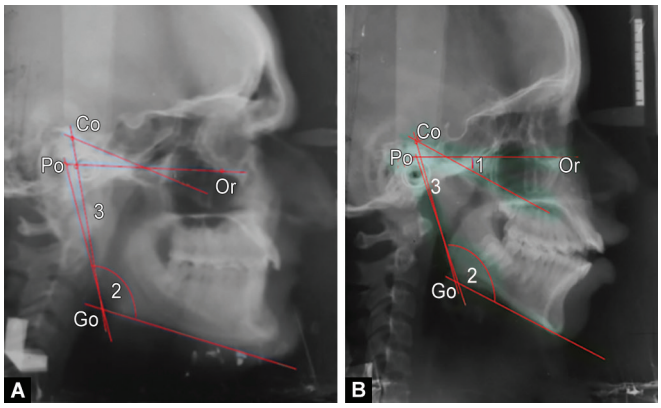
Table 1: Mean and standard deviations calculated from parameters measured from orthopantomograms

	Open bite		*Deep bite*		*Control group*		*Total*		
Measurments	*Mean*	*Std. deviation*	*Mean*	*Std. deviation*	*Mean*	*Std. deviation*	*Mean*	*Std. deviation*	*Sig.*
Eff. length of condyle	2.50	0.46	3.04	0.36	3.00	0.71	2.82	0.55	0.105
Eff. length of coronoid	0.98	0.28	1.69	0.56	1.02	0.35	1.22	0.51	**0.007**
Eff. length of ramus	8.00	0.76	7.44	0.77	4.97	0.27	6.95	1.45	**0.000**
Eff. length of corpus	9.13	0.83	8.00	0.87	7.33	0.41	8.24	1.04	**0.001**
Eff. height of corpus	2.95	0.56	2.17	0.33	2.17	0.26	2.47	0.55	**0.002**
Int. occlusal distance	0.94	0.62	5.07	0.53	0.70	0.23	2.25	2.10	**0.000**
PGOA	127.38	3.38	111.21	5.40	120.58	0.92	120.05	7.86	**0.000**
PCOI	138.00	3.55	126.29	8.08	120.00	0.63	128.95	9.13	**0.000**
PMPA	30.88	1.89	21.57	3.21	24.33	0.82	25.90	4.66	**0.000**
Max. occl. angle	−163.75	5.18	156.43	11.44	177.67	3.93	40.52	164.58	**0.000**
Mand. occl. angle	157.13	3.98	159.57	5.94	155.00	5.48	157.33	5.20	0.298
Ang. between Con and Cor	44.50	0.76	48.29	3.25	54.00	7.21	48.48	5.64	**0.002**

Bold values indicate that orthopantomogram values match the values got from lateral cephalograms of open bite and deep bite patients.

Table 2: Comparative evaluation of significant values of orthopantomogram with that of norms of lateral cephalogram

Cephalometric parameters	*Normal values*	*OPG—open bite*	*OPG—deep bite*
Condylar inclination (°)	39	45	30
Gonial angle (°)	128.7	145	115
Mandibular plane angle (°)	25	32	20
Effective length of ramus (mm)	47	40	50
Corpus length (mm)	77	83	70
Corpus height	Variable	Variable	Variable
Occlusal plane angle (°)	14	20	14



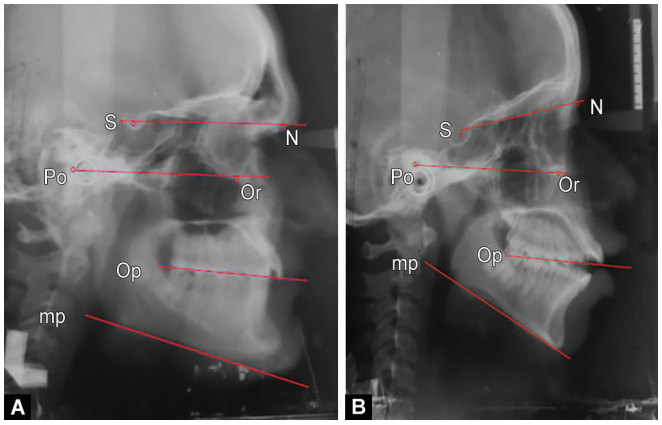
Figs 3A and B: (A) Cephalometric condylar inclination angle, cephalometric gonial angle, and effective length of the ramus in (A) Deep bite; (B) Open bite

- Cephalometric gonial angle—angle between tangent drawn to the lower border of the mandible and the ramus (<2 in Fig. 3)
- Effective length of the ramus—line drawn from Co to Go (3 in Fig. 3)
- Cephalometric mandibular plane angle—angle between tangent drawn to the lower border of the mandible Frankfort horizontal plane (Fig. 4)
- Cephalometric occlusal plane angle—angle between the occlusal plane and the SN plane (Fig. 4)
- Effective height of the corpus—line drawn from the distal root of mandibular first molar to the lower border of the mandible (Fig. 5)
- Effective length of the corpus—line drawn from Go to Gn (Fig. 5)

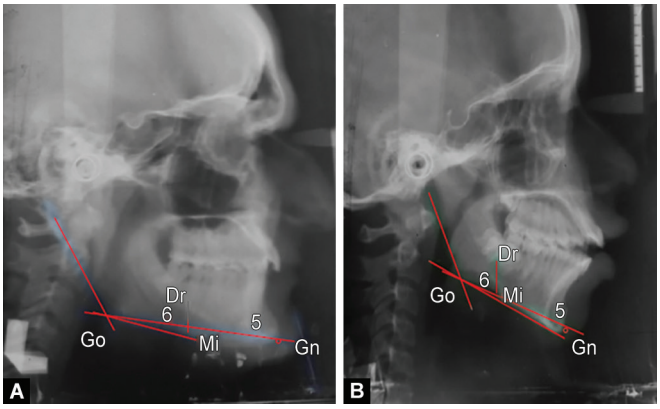
Discussion

Multiple skeletal and dental components were deemed to contribute in the development of both deep bite and open bite malocclusions. When the contributions of the components to open and deep bite malocclusions were compared, the skeletal components had a more evident influence in the etiology of open bite. On the other hand, the dental discrepancies were more sharing in the development of deep bite. The mandibular skeletal parameters were shown to play a more important role in the development of open bite malocclusion compared to deep overbite. Accordingly, the orthopedic control of the mandibular growth and rotation can have a more profound impact in the treatment of open bite malocclusion. Diagnosis of vertical malocclusion is not a complex process as that of skeletal asymmetry. It can also be done clinically and by lateral cephalograms.[13] Then why the use of OPG for diagnosis of vertical malocclusion? There are studies that say that the open mouth position allows more accurate tracing of the condyle because in habitual occlusion it gets obscured by the temporal bone.[14] The panoramic radiograph is relatively accessible as compared to lateral cephalograms. Now, high-quality panoramic machines are being manufactured that have greater versatility than the conventional machines. On completion of this study, it was found that PGOA,[15,16] PCOI, and PMPA are increased in case of open bite and decreased in case of deep bite as compared to the control group. Open bite patients have a steep mandibular plane,[17] so the gonial angle is increased in cases of open bite and decreased in deep bite.

Hapak,[18] Subtelny and Skuda,[19] and Nahoum[20] also noted a steep mandibular plane and a large gonial angle in open bite. The ramus is forwardly inclined in deep bite and conversely more posteroinferiorly inclined in open bite; this gives a higher PCOI angle in open bite and lower in deep bite. A more downwardly inclined mandibular plane is expected in open bite and a more horizontal mandibular plane in deep bite; this results in a higher PMPA in open bite. Swimehart[21] reported a short ramus in open bite, which was corroborated in our study as the effective ramal length was found to be decreased in open bite.



Figs 4A and B: (A) Cephalometric mandibular plane angle and occlusal plane angle in (A) Deep bite; (B) Open bite



Figs 5A and B: (A) Effective height and effective length of the corpus in (A) Deep bite; (B) Open bite

Thereby, based on the current findings, we can draw some guidelines elucidating the sharing components in vertical malocclusion as a whole and also clarifying some components that could differentiate between open and deep bite malocclusions. Anteroinferior tilt of the maxillary alveolar plane is associated with deep bite, and posterosuperior inclination is associated with open bite. The dentoalveolar compensation for this is made by the curve of Spee, which results in anterior occlusal closure. This is why here we noticed increased maxillary occlusal angle in deep bite and decreased in open bite.

Anterior are always extruded in deep bite and intruded in open bite. This results in decreased interocclusal distance in open bite. A consistent finding of our study is the oral orifice that is always elliptical in open bite. Aberrant muscle growth and function and digit sucking are the etiological factors for open bite. Neff and Kydd[22] based on strain-gauge studies concluded that the reason for open bite is the abnormal force pattern associated with swallowing and muscles of mastication. This may be the reason for the elliptical oral orifice.

Conclusion

On completion of our study, we can conclude that the OPG can be used in the assessment of vertical malocclusion quantitatively. On comparing the values of OPG and the lateral cephalogram, it was found that OPG can be crucial for diagnosis of vertical malocclusion. However, OPGs are not reliable enough to give acceptably accurate information like lateral cephalograms and further evaluation is necessary.[23]

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