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Association of Panoramic Radiograph and Lateral Cephalogram for Evaluation of Dento-Facial Characteristics- A Cross Sectional Study

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Abstract
Introduction: *In orthodontic practice to provide information such as axial inclination of teeth, maturation periods and surrounding tissues panoramic radiography is frequently used. This is usually the technique of choice because of its relatively low radiation exposure, patients' comfort and significant amount of diagnostic information which is obtained by viewing all the teeth and basal bone at once. Therefore, panoramic radiography is essential orthodontic screening tool.*
Aim: *To determine whether the use of panoramic radiograph can be extended for evaluating dento-facial characteristics.*
Materials and Method: *Panoramic radiographs (OPG) and lateral cephalograms were obtained from 30 patients who includes 10 skeletal class I, 10 skeletal Class II and 10 skeletal class III patients were obtained and compared.*
Results: *The measurement obtained from panoramic radiograph when compared with their lateral cephalometric alternatives showed mild statistically significant difference. But with the help of regression equations obtained from this study it is possible to determine following cephalometric parameters using their panoramic constants respectively i.e Go-Gn/S-N using OMAND, Go-Gn/S-N using OCOND and ANS-PNS/Go-Me using OCOND with predictability percentage of 34.5%, 39.6% and 39.6% respectively.*
Conclusion: *It can be concluded that although panoramic radiograph can be used for assessing certain dentofacial characteristics using regression equation, the predictiblity percentage has been found to be very low. But considering radiation exposure twice for panoramic radiograph and cephalogram, panaromic radiograph can be used to assess certain parameters like Go-Gn/S-N for class II and class I also ANS-PNS/Go-Me in class I. Either left or right side measurements on panoramic radiograph can be used for assessing certain parameters instead of taking into consideration both sides separately because they are not significantly different.*
Keywords: *Panoramic radiograph, Dento-facial characteristics.*

Introduction

In orthodontic practice to provide information such as axial inclination of teeth, maturation periods and surrounding tissues panoramic radiography is frequently used.[1,2] This is usually the technique of choice because of its relatively low radiation exposure, patients' comfort and significant amount of diagnostic information which is obtained by viewing all the teeth and basal bone at once.[3] Therefore, panoramic radiography is essential orthodontic screening tool.

The panoramic radiographs permits a determination of number of teeth present and their positions and evaluation of gross osseous changes in condyles which is quit helpful in asymmetry cases. So that clinician can compare the relationship of teeth with one another and to other structures.[4]

Levandoskiin 1991 used one of the first method to analyze panoramic radiographs. Since then very few studies have been done related to this subject. Furthermore, studies examining panoramic radiographs as a means of investigating skeletal patterns are lacking in the orthodontic literature.[5,6]

Detailed analysis of structural and special relationship of various dento-facial structures is an integral part of orthodontic diagnosis and treatment planning. Lateral cephalograms are used for the analysis of skeletal relationship. As OPG is also made routinely for Orthodontic diagnostic procedures, it would be clinically beneficial if certain insight can be obtained regarding the dento-facial characteristics. Although it cannot be solely used for detailed lateral cephalometric analysis.

The proposed research hypothesis is that panoramic radiograph will provide corresponding information about dento-facial characteristics obtained from lateral cephalogram.

Therefore the aim of the study is to determine whether the use of panoramic radiograph can be extended for evaluating dento-facial characteristics.

Materials and Method

Panoramic radiographs (OPG) and lateral cephalograms were obtained from 30 patients which includes 10 skeletal class I, 10 skeletal Class II and 10 skeletal class III patients were selected according to following criteria.

1. Patients in the age group of 18-25 years.
2. No skeletal asymmetry.
3. Full complement teeth up to 2nd molars.
4. Absence of any history of previous orthodontic treatment or surgical treatment.

The radiographs were made in standardized conditions with clinical Frankfort horizontal plane kept parallel to the floor, jaws in centric occlusion and lips relaxed using Digital Cephalostat machine Carestream CS 8000c.

Fig. 1 Digital Cephalostat machine Carestream CS 8000c

This study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, P.D.U. Dental College, Solapur, Maharashtra, India. Tracing was done on acetate matte tracing paper (0.003" thick; 8X10") using 0.3mm tip pencil. A single operator performed all the tracings in standardized manner to avoid errors due to inter operator variations. Angular measurements were made to 0.5^0.

The following landmarks were marked on the OPG (Fig. 1):

Landmark	Significance
Or	Orbitale: Lowest point on the inferior rim of the orbit.
Mae	Meatus AcusticusExternus: Location of external auditory meatus
Co	Condylion
ANS	Anterior Nasal Spine: Anterior tip of the sharp bony process at maxilla on the lower margin of the anterior nasal opening
Me	Menton: Lowest point on the mandibular symphysis
FMe	Foramen Mentale
MC	Mandibular canal
U6	Distobuccal cusp tip of upper first molar
L6	Distobuccal cusp tip of lower first molar
U1	Contact point of maxillary incisors
L1	Contact point of mandibular incisors

The bite plane used in the OPG altered the occlusion. Therefore, independent reference planes were set up in the maxilla and the mandible on panoramic images. FHP was constructed between meatus acusticusexternus (Mae) and orbital points, and a reference plane was drawn between the intersection point of the ascending and descending tangents on the mandibular canal (MC) and foramen mentale (FMe). Because the bite plane caused the mandible to shift forward, the maxillary and mandibular parameters were measured independently, so that the vertical and saggitalocclusal differences could not distort the measurements.

Following reference plane were considered on OPG:

Mae-Or: Frankfurt's Horizontal Plane

Co-MC: Condylar Plane

MC-FMe: Mandibular canal plane

MC-Me: Corpus line

Various angular measurements considered on OPG:

Angular Measurements	Significance
FH/ANS	Relationship of Frankfort Horizontal Plane to anterior nasal spine
OMAND (Co-MC/MC-Me)	Panoramic alternative of cephalometricgonial angle
FH/UOP (FH/U6-U1)	Angle between Frankfurt's horizontal plane and maxillary occlusal plane
FH/LOP (FH/L6-L1)	Angle between Frankfurt's horizontal plane and mandibular occlusal plane
UOCCL (U6-U1-U6)	Maxillary occlusal angle
LOCCL (L6-L1-L6)	Mandibular occlusal angle
OCOND (Co-MC/FMe-MC)	Panoramic radiograph alternative of condylar inclination angle
OMID (FH/U1)	Angle between Frankfurt's horizontal plane and Upper incisors.

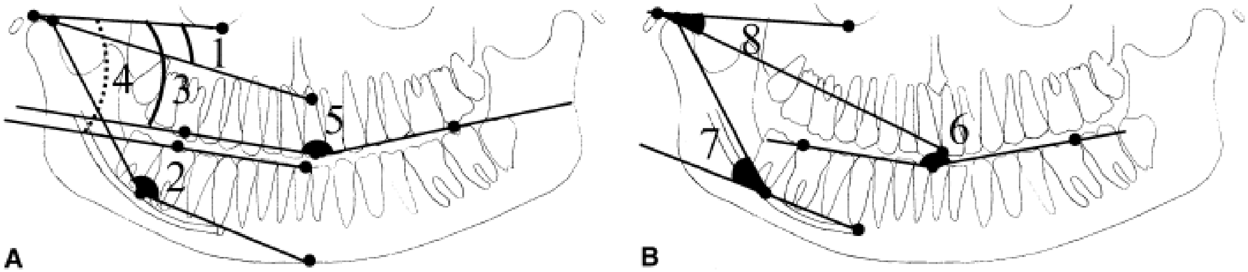

Fig 2. Landmarks and reference plane on panoramic radiograph

For Lateral Cephalogram following landmarks were selected[7](Fig 2):

Landmarks	Significance
S	Sella: Geometric center of pituitary fossa
N	Nasion:Most anterior aspect of frontonasal suture
Or	Orbitale: most inferior point on the inferior margin of the orbit
ANS	Anterior Nasal Spine
PNS	Posterior Nasal Point
A-Point	Subspinale- most posterior midline point on the concavity between the anterior nasal spine and prosthion
UI	Incisor edge of maxillary incisor
LI	Incisor edge of mandibular incisor
U6	Distobuccal cusp tip of upper first molar
L6	Distobuccal cusp tip of lower first molar
Gn	Most anteroinferior point on the symphysis of chin
Me	The most inferior midline point on the mandibular symphysis.

Following Planes were considered on Lateral cephalogram:

S-N: Anterior cranial base

Mae-Or: Frankfort's horizontal plane

ANS-PNS: Palatal plane

L6-L1: Lower occlusal plane

U6-U1: Upper occlusal plane

Go-Gn: Mandibular plane

Go-Me: Mandibular plane

Co-Go: Ramal plane.

Following angular measurements were measured:

SNA	Relation of anterior portion of maxilla to cranial base
SNB	Relation of anterior portion of mandible to cranial base
ANB	Relation of maxilla to mandible
S-N/N-ANS	Relation of cranial base to anterior nasal spine
Co-Go/Go-Me	Gonial angle
ANS-PNS/Go-Me	Relation of palatal plane to mandibular plane
FH-U1	Relation of Frankfort's horizontal plane to upper incisor
FH/ANS-PNS	Relation of Frankfort's horizontal plane to palatal plane
Go-Gn/S-N	Relation of mandibular plane to cranial base
FH/U6-U1	Angle between Frankfort's horizontal plane and upper occlusal plane
FH/L6-L1	Angle between Frankfort's horizontal plane and lower occlusal plane

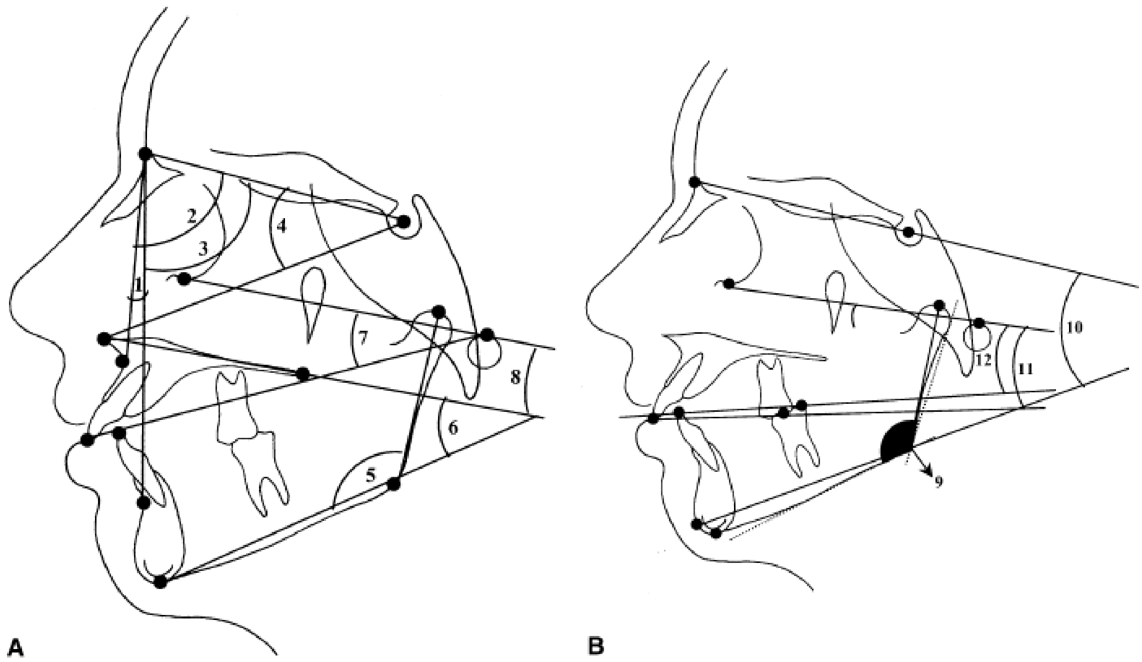

Fig .2 A Cephalometric reference planes and B. angular measurements

Statistical analysis

The data were tabulated and analyzed by statistical software SPSS v 16.0. The descriptive statistics such as mean, mean differences, standard deviations and standard errors were calculated for all variables. The paired t test was used to compare the variables within the groups. One-way analysis of variance (ANOVA; F statistics) was used for comparing the measurements for Class-I, Class-II and Class-III in both groups. Correlations between variables were done by using Pearson's correlation coefficient. Significance was determined at the 0.05 and 0.01 levels of significance. Regression equation were set for the significant correlations.

Results

Panoramic radiographs (OPG) and lateral cephalograms were obtained from 30 patients which includes 10 skeletal class I, 10 skeletal Class II and 10 skeletal class III patients. Evaluation was done for comparing craniofacial characteristics and for investigation about possibility of enhancing the clinical versatility of panoramic radiographs.

Table I: Descriptive statistics of Cephalometric Measurements

Cephalometric Measurements	Class – I		Class – II		Class – III	
	Mean	SD	Mean	SD	Mean	SD
SNA	81.2	3.9	85.2	2.9	78.6	6.9
SNB	79.4	3.3	79.3	2.6	81.4	5.7
ANB	2.35	1.0	5.9	1.3	-2.8	1.9
S-N/N-ANS	87.6	4.9	91.7	3.0	85.5	6.3
Co-Go/Go-Me	117.2	6.2	121	7.1	124.3	5.7
ANS-PNS/Go-Me	24.1	4.4	25	2.6	23.3	3.4
FH/U1	128.3	7.2	118.9	5.8	120.4	6.7
FH/ANS-PNS	4.15	1.9	2.6	1.3	2.5	1.6
Gonial Angle	117.8	6.2	120.8	9.6	122	7.1
Go-Gn/S-N	26.2	4.0	27.8	4.2	28	3.2
FH/U6-U1	8.8	4.1	11.8	2.6	9.7	3.1
FH/L6-L1	7.3	3.9	7.1	3.7	5.1	2.8

Table II: Descriptive statistics of measurement on OPG

OPG	Class – I		Class – II		Class – III	
	Mean	SD	Mean	SD	Mean	SD
FH/ANS						
Right	11.8	3.4	12.4	1.5	12.3	2.5
Left	13.3	4.0	12.4	2.17	11.7	1.6
OMAND (Co-MC/MC-Me)						
Right	145	3.5	144.2	2.9	144.2	5.5
Left	144.6	4.5	143.2	4.3	145	5.3
FH/UOP (FH/U6-U1)						
Right	3.6	2.5	5.55	3.1	3.7	1.2
Left	4.5	3.7	5.5	3.8	3.8	0.8
FH/LOP (FH/L6-L1)						
Right	4.3	2.4	5.6	3.8	3.3	0.8
Left	5.0	4.0	5.3	3.4	3.2	0.9
UOCCL	171.2	3.3	166.7	8.8	172.7	6.2
LOCCL (L6-L1-L6)	170.3	6.9	167.6	9.0	173.4	6.2
OCOND (Co-MC/Fme-MC)						
Right	40.6	4.7	40.5	5.9	39.3	7.2
Left	42.3	4.9	40.6	2.9	40.5	7.7
OMID (FH/UI)						
Right	21.3	2.7	22.8	1.9	21.3	2.9
Left	22.8	3.6	22.9	2.5	21.5	2.8

To summarize the results of correlation test for skeletal parameters between Cephalometric measurement and OPG: There was significant positive correlation between panoramic gonial angle (OMAND) and Go-Gn/S-N for class-II (r=0.647, p=0.04).There was significant negative correlation between pa [noramic condylar inclination (OCOND) and Go-Gn/S-N for class-I (r= - 0.681, p=0.03).There was significant negative correlation between panoramic condylar inclination (OCOND) and ANS-PNS/Go-Me for class-I (r= - 0.720, p=0.02). The correlation between panoramic gonial angle (OMAND) was weak but noteworthy (r=0.621, p=0.056). (Table III).

Table III: Correlation of skeletal parameters between Cephalometric and OPG measurements

	Class – I		Class – II		Class – III	
	r-value	p-value	r-value	p-value	r-value	p-value
OMAND vs Co-Go/Go-Me	0.457	0.18	0.621	0.056	0.110	0.76
OMAND vs Go-Gn/S-N	0.451	0.19	0.647	0.04 #	-0.176	0.63
OMAND vs ANS-PNS/Go-Me	0.375	0.28	0.36	0.31	-0.228	0.53
OCOND vs Co-Go/Go-Me	-0.491	0.15	0.383	0.27	0.083	0.82
OCOND vs Go-Gn/S-N	-0.681	0.03 #	0.340	0.34	0.192	0.59
OCOND vs ANS-PNS/Go-Me	-0.720	0.02 #	0.543	0.10	0.217	0.55
FH/ANS vs Co-Go/Go-Me	-0.392	0.26	0.290	0.42	-0.536	0.11
FH/ANS vs Go-Gn/S-N	0.075	0.84	0.206	0.57	-0.255	0.48
FH/ANS vs ANS-PNS/Go-Me	-0.393	0.26	-0.112	0.76	-0.145	0.69
FH/ANS vsGonial Angle	-0.455	0.18	-0.002	0.99	-0.294	0.41

- indicates statistically significant correlation.

There was no significant correlation between all parameters for all classes ($p>0.05$). (Table IV).

Table IV: Correlation of Dental parameters between Cephalometric and OPG measurements.

	Class – I		Class – II		Class – III	
	r-value	p-value	r-value	p-value	r-value	p-value
UOCCL vs FH/U6-U1	0.232	0.52	0.012	0.97	-0.011	0.97
UOCCL vs FH/U1	-0.223	0.54	-0.247	0.49	-0.071	0.84
FH/UOP vs FH/U6-U1	0.462	0.179	-0.019	0.96	0.003	0.99
FH/LOP vs FH/L6-L1	0.461	0.18	-0.061	0.87	0.178	0.62
LOCCL vs FH/L6-L1	0.082	0.82	-0.176	0.63	0.442	0.20
OMID vs FH/U1	-0.240	0.50	0.487	0.15	-0.268	0.46

For class – I, there was significant positive correlation between LOCCL and UOCCL ($r=0.777$, $p=0.008$), FH/UOP and FH/LOP ($r=0.868$, $p=0.001$).

For class – II, there was significant positive correlation between LOCCL and UOCCL ($r=0.920$, $p<0.0001$), FH/UOP and FH/LOP ($r=0.815$, $p=0.004$).

For class – III, there was significant positive correlation between LOCCL and UOCCL ($r=0.971$, $p<0.0001$), FH/UOP and FH/LOP ($r=0.687$, $p=0.03$). (Table V).

Table V: Correlation between LOCCL and UOCCL of OPG measurements

	Class – I		Class – II		Class – III	
	r-value	p-value	r-value	p-value	r-value	p-value
LOCCL vs UOCCL	0.777	0.008 #	0.920	<0.0001 #	0.971	<0.0001 #
FH/UOP vs FH/LOP	0.868	0.001 #	0.815	0.004 #	0.687	0.03 #

Table VI: Regression equation (RE)

Predicted cephalometric parameter	Panoramic constant	Equation	R^2		p-value
RE1 G0-Gn/S-N (Class-II)	OMAND	Go-Gn/S-N = - 107 + 0.933 OMAND	34.5%	Constant Predictor Regression	0.09 0.04 0.04
RE2 G0-Gn/S-N (Class-I)	OCOND	Go-Gn/S-N = 49.7 - 0.578 OCOND	39.6%	Constant Predictor Regression	0.001 0.03 0.03
RE2 ANS-PNS/Go-Me (Class-I)	OCOND	ANS-PNS/Go-Me = 50.8 - 0.659 OCOND	39.6%	Constant Predictor Regression	0.001 0.03 0.03

Discussion

The aim of the study is to determine whether the use of panoramic radiograph can be extended for evaluating dento-facial characteristics. There are number of articles published on magnification and image distortion in panoramic radiographs, [8-12]there are only few studies about use of panoramic radiograph in evaluating dento-facial specifications. For avoiding image distortion and magnification of the images, we were careful about standard exposure and proper patient posture. Maxillary and mandibular measurements were made independent because the bite plane separates the maxillary and mandibular teeth during panoramic radiographic exposure.[1]For elimination of superimposition of corresponding teeth, bite plates are necessary but they also move mandible forward and eliminate the overjet. Therefore, independent measurements of the maxillary and mandibular parameters were considered.

Vertical linear measurements[13] and horizontal linear measurements[10] on the condyle and the ramusare not reliable for patients. So, only angular measurements were made on the panoramic radiographs. In descriptive analysis, on comparison of panoramic radiograph measurements between classes on right and left side, it was observed that, there was no significant difference between classes for all variables (p>0.05) (Table No. VI). Between (OCONDR-OCONDL) and (OMANDR-OMANDL) on right and left side there was no significant difference. So, point Co can be used on either cephalometric or panoramic measurements for the same gonial angle.

Table VI: Comparison of OPG Measurements in different classes

OPG	Class – I		Class – II		Class – III		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD		
FH/ANS								
Right	11.8	3.4	12.4	1.5	12.3	2.5	0.15	0.8
Left	13.3	4.0	12.4	2.17	11.7	1.6	0.82	0.4
OMAND (Co-MC/MC-Me)								
Right	145	3.5	144.2	2.9	144.2	5.5	0.12	0.9
Left	144.6	4.5	143.2	4.3	145	5.3	0.4	0.7
FH/UOP (FH/U6-U1)								
Right	3.6	2.5	5.55	3.1	3.7	1.2	2.09	0.1
Left	4.5	3.7	5.5	3.8	3.8	0.8	0.7	0.5
FH/LOP (FH/L6-L1)								
Right	4.3	2.4	5.6	3.8	3.3	0.8	2.9	0.07
Left	5.0	4.0	5.3	3.4	3.2	0.9	1.4	0.3
UOCCL	171.2	3.3	166.7	8.8	172.7	6.2	2.3	0.1
LOCCL (L6-L1-L6)	170.3	6.9	167.6	9.0	173.4	6.2	1.5	0.2
OCOND (Co-MC/Fme-MC)								
Right	40.6	4.7	40.5	5.9	39.3	7.2	0.1	0.9
Left	42.3	4.9	40.6	2.9	40.5	7.7	0.3	0.7
OMID (FH/UI)								
Right	21.3	2.7	22.8	1.9	21.3	2.9	1.2	0.3
Left	22.8	3.6	22.9	2.5	21.5	2.8	0.7	0.5

There was significant positive correlation between OMAND and Go-Gn/S-N for class II (r=0.647,p=0.04). Their regression equation was considerable, this suggests the possibility of predicting the cephalometric parameter from panoramic condylar measurements because the level of prediction is 34.5%. Also, OCOND and Go-Gn/S-N for class I shows significant negative correlation (r=0.681,p=0.03) with possibility of predicting the cephalometric parameter from panoramic condylar measurement of 39.6%. However, as the condylar parameters are questionable in predicting cephalometric measurements, it is likely that using OCOND to evaluate vertical dimensions of the face is not reliable. Even though, the OCOND parameter indicates condylar inclination, because the reference plane of this parameter is mandibular canal (MC) whose position depends upon the vertical growth pattern of mandible.[14]

In our study there was significant negative correlation between OCOND and ANS-PNS/Go-Me for class I (r=0.720,p=0.02) similar to the study of Akcam et al.[1] Indicating that as ANS-PNS/Go-Me increase there is corresponding decrease in the OCOND. This is in accordance with the finding Ulrika et al[14]. This indicates that ANS-PNS/Go-Me can be predicted with reasonable degree of accuracy using OCOND from the panoramic radiograph. The prediction value found to be 39.6%.

Still clinically, it can be suggested that panoramic radiography is not reliable enough to give accurate additional information compared to the lateral cephalogram due to image magnification errors.

Conclusion

Although panoramic radiograph can be used for assessing certain dentofacial characteristics using regression equation, the predictiblity percentage has been found to be very low. But considering radiation exposure twice for panoramic radiograph and cephalogram, panaromic radiograph can be used to assess certain parameters like Go-Gn/S-N for class II and class I also ANS-PNS/Go-Me in class I. Either left or right side measurements on panoramic radiograph can be used for assessing certain parameters instead of taking into consideration both sides separately because they are not significantly different.

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