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

Authors

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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 dento-facial characteristics using regression equation, the predictibility 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.
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.

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.

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.

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°.

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 Acusticus Externus: 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 |
| FMMe     | 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 acusticus externus (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 sagittal occlusal 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 cephalometric gonial angle |
| FH/UOP (FH/U6-U1)     | Angle between Frankfort’s horizontal plane and maxillary occlusal plane |
| FH/LOP (FH/L6-L1)     | Angle between Frankfort’s horizontal plane and mandibular occlusal plane |
| UOCLL (U6-U1-U6)      | Maxillary occlusal angle |
| LOCLL (L6-L1-L6)      | Mandibular occlusal angle |
| OCOND (Co-MC/FMe-MC)  | Panoramic radiograph alternative of condylar inclination angle |
| OMID (FH/U1)          | Angle between Frankfort’s horizontal plane and Upper incisors. |

![Fig 2. Landmarks and reference plane on panoramic radiograph](image-url)

For Lateral Cephalogram following landmarks were selected (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 |
| U1        | Incisor edge of maxillary incisor |
| L1        | 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:
- L6-L1: Lower occlusal plane
- U6-U1: Upper occlusal plane
- S-N: Anterior cranial base
- Mae-Or: Frankfurt’s horizontal plane
- ANS-PNS: Palatal plane
- S-N: Anterior cranial base
- Go-Gn: Mandibular plane
- Go-Me: Mandibular plane
- Co-Go: Ramal plane.
Following angular measurements were measured:

| Measure    | Description                                      |
|------------|--------------------------------------------------|
| 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               | 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-Mc)  | 145     | 3.5 | 144.2   | 2.9 | 144.2   | 5.5 |
| Right                | 144.6   | 4.5 | 143.2   | 4.3 | 145     | 5.3 |
| Left                 | 3.6     | 2.5 | 5.55    | 3.1 | 3.7     | 1.2 |
| FH/UOP (FH/U6-U1)    | 4.5     | 3.7 | 5.5     | 3.8 | 3.8     | 0.8 |
| 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 |
| LOCCCL (L6-L1-L6)    | 170.3   | 6.9 | 167.6   | 9.0 | 173.4   | 6.2 |
| OCOND (Co-MC/Fme-Mc) | 40.6    | 4.7 | 40.5    | 5.9 | 39.3    | 7.2 |
| Right                | 42.3    | 4.9 | 40.6    | 2.9 | 40.5    | 7.7 |
| Left                 | 21.3    | 2.7 | 22.8    | 1.9 | 21.3    | 2.9 |
| OMID (FH/UI)         | 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 panoramic gonial angle (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 vs Gonial 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|
| UOCL vs FH/U6-U1  | 0.232     | 0.52   | 0.012      | 0.97  | -0.011      | 0.97   |
| UOCL 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 (r=0.920, p<0.0001), FH/UOP and FH/LOP correlation between LOCCL and UOCL (r=0.815, p=0.004).

(r=0.777, p=0.008), FH/UOP and FH/LOP for class – III, there was significant positive (r=0.971, p<0.0001), FH/UOP and FH/LOP correlation between LOCCL and UOCL (r=0.687, p=0.03). (Table V).

Table V: Correlation between LOCCL and UOCL of OPG measurements

|                  | Class – I |        | Class – II |        | Class – III |        |
|------------------|-----------|--------|------------|--------|-------------|--------|
|                  | r-value   | p-value| r-value    | p-value| r-value     | p-value|
| LOCCL vs UOCL    | 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                        | R² | p-value |
|-----------------------------------|--------------------|---------------------------------|----|--------|
| RE1 G0-Gn/S-N (Class-II)          | OMAND              | Go-Gn/S-N = -107 + 0.933 OMAND  | 34.5% | 0.09 |
| RE2 G0-Gn/S-N (Class-I)           | OCOND              | Go-Gn/S-N = 49.7 - 0.578 OCOND  | 39.6% | 0.001 |
| RE2 ANS-PNS/Go-Me (Class-I)       | OCOND              | ANS-PNS/Go-Me = 50.8 - 0.659 OCOND | 39.6% | 0.003 |
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 measurements13 and horizontal linear measurements10 on the condyle and the ramus are 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 (OCOND-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.

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.\textsuperscript{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.\textsuperscript{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\textsuperscript{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 predictibility percentage has been found to be very low. But considering radiation exposure twice for panoramic radiograph and cephalogram, panoramic 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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