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Research Article

Panoramic Evaluation of Mesiodistal Angulation of Teeth in Various Malocclusions

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Abstract

Introduction: Objective of study was to evaluate the mesiodistal angulations of teeth in various malocclusions through use of panoramic radiograph in non treated orthodontic subjects.

Material and methods: The present study was conducted on panoramic radiographs and lateral head cephalograms of 56 females and 36 males of North Indian origin ranging in age from 12–20 yrs. The sample consisted of total of 68 children aged 12 to 20yrs of either sex. Of total, 24 subjects were Class I malocclusion (Group 1), 24 subjects with Class II malocclusion (Group 2) and 20 were Class III malocclusion (Group 3). 24 age and sex matched class I normal occlusion subjects served as "Control". Subjects were screened for Angle's molar relationship and Beta angle. Only those subjects who matched for dental and skeletal relationship were included in the study. The upper reference lines, lower reference lines and long axis of teeth were located on panoramic radiograph. The angulations were measured as mesial angle formed between the upper or lower reference line and long axis of upper or lower teeth with the help of protractor.

Results: Only few teeth in malocclusion subjects showed statistically significant difference in angulations as compared to control subjects.

Conclusion: Various malocclusions do not influence the value of angulations on panoramic radiograph.

Keywords: Panoramic; Mesiodistal Angulation; Teeth; Malocclusions

Introduction

A major objective of orthodontic treatment is the normalization of tooth positions in three planes of space, with the goal of approaching predefined cephalometric or occlusal standards. Dental positioning is an important factor since stability of the stomathognathic system can be maintained through neutralization of occlusal forces and the provision of normal function [1,2].

Thus, mesial force is intimately related to well-defined contact points dependent on correct axial inclination and the occlusal relationship of a tooth against two teeth. Therefore, the appropriate axial inclination should be included in the orthodontic treatment objectives, as accurate angulation is directly related to dental alignment. Further, Andrews [3] stated that proper mesiodistal root angulation (Tip) and facial lingual inclination (Torque) are required for ideally positioned teeth. This has special significance for orthodontically closed extraction sites, which are more prone to open if adjacent teeth are not parallel. If the roots are not parallel on either side of the extraction site the distribution of the occlusal loads depends upon the aforementioned teeth exerts a rotational force which could cause the posterior teeth to tilt and rotate mesially and the canines to rotate distally. Overbite of the anterior teeth can become exaggerated because the curve of Spee may increase in the mandibular arch and cause an opposing curve in the upper arch. This concludes that potential for periodontal injuries exist in cases where a correct parallelism is not obtained in conjunction with poor oral hygiene [4,5].

The principal advantages of this radiographic technique are the broad anatomic region imaged, the relatively low patient radiation dose, and the convenience, ease, and speed of the procedure [7].

Panoramic radiography, in addition to clinical evaluation, is often used before, during, and after orthodontic treatment to assess root parallelism and angulations.

Purpose of this study was to investigate the impact of different malocclusion on angulations of teeth.

Material and Methods

The present study was conducted on panoramic radiograph and lateral head cephalogram of North Indian origin subjects. The sample consisted of total of 68 children aged 12 to 20 yrs of either sex. Of total, 24 subjects were Class I malocclusion (Group 1), 24 subjects with Class II malocclusion (Group 2) and 20 were Class III malocclusion (Group 3). 24 age and sex matched class I normal occlusion subjects served as "Control". Subjects were first screened for Angle's molar relationship then Subjects were further evaluated for skeletal dysplasia as indicated by the value of Beta angle measured on lateral cephalogram. Only those subjects who matched for dental and skeletal relationship were included in the study.

56 females and 36 males of North Indian origin ranging in age from 12–20yrs were selected for study. All had untreated "normal" occlusions, with a full complement of teeth (possibly excepting third molars). In addition to above control group showed a maximum overbite of 3 mm and overjet of 2 mm. Slight rotations and minor midline deviations were also accepted.

Panoramic radiographs and lateral head cephalograms were taken on Rotagraph plus (Model MR05, Villa System Medical, Italy). Radiographs with marked distortion or blurring were discarded and retaken until adequate results were obtained. Each radiograph obtained thus subjected for tracing on .003" thick acetate paper sheets using 4H pencil on a view box using transilluminated light in a dark room. Any stray light dispersion were eliminated by covering the margins of the view box with a black paper leaving only that part which is required for radiograph visibility. All tracings were done by single operator.

Dentoalveolar and skeletal structures drawn on panoramic radiographs were the External contour of mandible, Inferior outline of orbit, Mental foramen, Contour of all erupted teeth except 3rd molars, Upper reference line passing through the most inferior points of right and left orbit, Lower reference line passing through the centers of right and left mental foramen [8,9]. The long axes of the teeth were determined as follows:

- Single-rooted teeth-- image of the root canal in its longest extent.
- Upper bicuspids-- average image of the buccal and palatal root canals.
- Lower molars-- average image of the mesial and distal root canals.
- Upper molars-- image of the palatal root canal (Figure 1).

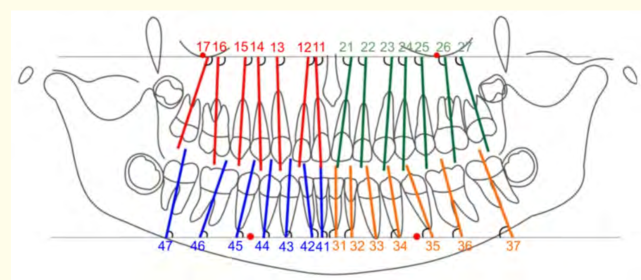

Figure 1: Panoramic radiograph tracing showing various landmarks, angular measurements of long axis of upper and lower teeth with respective reference line.

The angulation was measured as mesial angle formed between the upper or lower reference line and long axis of upper or lower teeth with the help of protractor. Teeth were represented in the tables using FDI notation. Mean value of control group was compared with malocclusion groups. Inter group comparison was also done between various malocclusion groups.

Results

On comparing the mean age of four groups, ANOVA revealed similar age among the groups (F=0.81, p=0.493) i.e. not differed statistically (Table 1). χ^2 test revealed similar sex proportions among the groups (χ^2=2.29, p=0.514). The comparisons concluded that the subjects of four groups were age and sex matched and comparable and these confounding variables thus may also not influence angulations.

Characteristics	Control (n=24) (%)	Group 1 (n=24) (%)	Group 2 (n=24) (%)	Group 3 (n=20) (%)	F value	p value
Age (yrs):						
Mean ± SD	15.42 ± 2.06	15.58 ± 1.95	14.9 ± 1.41	14.90 ± 1.94	0.81	0.493
Range	13 – 20	14 -20	14 - 19	12 - 19		
Sex:						
Females	12 (50.0)	16 (66.7)	14 (58.3)	14 (70.0)	2.29	0.514
Males	12 (50.0)	8 (33.3)	10 (41.7)	6 (30.0)		

Table 1: Mean and standard deviation of age and distribution of sex of four groups.

For each teeth, comparing the mean mesiodistal angulation between the four groups, ANOVA (Table 2) revealed significantly different mesiodistal angulation in 13 (F=2.84, p=0.042), 15 (F=3.98, p=0.010), 17 (F=5.45, p=0.002), 23 (F=4.88, p=0.003), 27 (F=4.70, p=0.004), T36 (F=4.01, p=0.010), 41 (F=3.74, p=0.014) and 42 (F=5.98, p=0.001), among the groups.

Teeth No	Control (n=24)	Group 1 (n=24)	Group 2 (n=24)	Group 3 (n=20)	F value	p value
11	88.75 ± 3.76	89.46 ± 5.37	89.83 ± 3.37	91.65 ± 6.08	1.47	0.230
12	92.33 ± 3.92	94.46 ± 6.29	94.33 ± 6.30	96.85 ± 8.31	1.87	0.140
13	87.92 ± 3.49	92.42 ± 6.18	90.58 ± 4.01	90.75 ± 7.40	2.84	0.042*
14	89.96 ± 5.75	89.46 ± 5.57	87.71 ± 8.50	89.70 ± 6.28	0.56	0.645
15	90.50 ± 4.67	90.75 ± 5.42	87.88 ± 8.88	94.55 ± 5.68	3.98	0.010*
16	93.58 ± 4.74	98.21 ± 4.91	95.50 ± 8.15	95.55 ± 6.82	2.19	0.095
17	99.92 ± 7.02	107.42 ± 5.52	108.00 ± 7.32	105.60 ± 10.76	5.45	0.002**

Table 2: Comparison of mean value of mesiodistal angulation of teeth of four different groups at Maxillary right quadrant using ANOVA.

* *P*=.05; ** *P*=.01; *** *P*=.001; *****P*=.0001

Further, Tukey's test in maxillary right quadrant (Table 3) revealed that the mean mesiodistal angulation of 13 was significantly (p<0.05) different and higher in Group 1 as compared to Control. Similarly, the mean mesiodistal angulation of 15 was also significantly (p<0.01) different and higher in Group 3 as compared to Group 2. Furthermore, the mean mesiodistal angulation of 17 was significantly (p<0.01) different and higher in both Group 1 and Group 2 as compared to Control.

Teeth No	Control (n=24)	Group 1 (n=24)	Group 2 (n=24)	Group 3 (n=20)	F value	p value
21	86.79 ± 3.92	86.71 ± 4.08	88.13 ± 4.49	84.75 ± 6.46	1.84	0.146
22	90.13 ± 4.79	92.46 ± 4.06	91.21 ± 6.55	87.70 ± 9.43	2.16	0.098
23	87.67 ± 3.97	89.42 ± 6.05	89.83 ± 5.62	84.55 ± 3.90	4.88	0.003**
24	87.29 ± 6.80	86.96 ± 5.72	86.71 ± 6.86	87.25 ± 4.12	0.05	0.986
25	90.04 ± 6.52	87.88 ± 4.96	88.96 ± 9.05	92.90 ± 6.50	2.08	0.109
26	91.54 ± 6.07	94.33 ± 5.22	93.63 ± 7.73	95.80 ± 5.83	1.76	0.161
27	97.04 ± 7.00	105.17 ± 8.14	104.67 ± 9.50	104.30 ± 9.95	4.70	0.004**

Table 3: Comparison of mean value of Mesiodistal angulation of teeth of four groups at Maxillary left quadrant using ANOVA

* *P*=.05; ** *P*=.01; *** *P*=.001; *****P*=.0001

In maxillary left quadrant Tukey's test (Table 4) revealed that the mean mesiodistal angulation of 23 lowered significantly (p<0.05 or p<0.01) in Group 3 as compared to both Group 1 and Group 2. In contrast, the mean mesiodistal angulation of 27 in all malocclusion groups (Group 1, Group 2 and Group 3) was found significantly (p<0.05 or p<0.01) different and higher as compared to Control group.

Teeth No	Control (n=24)	Group 1 (n=24)	Group 2 (n=24)	Group 3 (n=20)	F value	p value
31	88.04 ± 5.13	88.42 ± 6.18	87.58 ± 5.52	88.40 ± 4.50	0.12	0.947
32	89.63 ± 5.24	91.79 ± 6.32	93.17 ± 5.26	90.30 ± 5.26	1.91	0.134
33	84.54 ± 5.01	85.42 ± 6.25	88.67 ± 8.57	87.10 ± 6.54	1.76	0.160
34	83.17 ± 3.83	87.58 ± 6.72	84.75 ± 8.61	83.20 ± 6.34	2.29	0.083
35	76.42 ± 6.04	79.58 ± 11.41	74.63 ± 4.80	77.35 ± 6.67	1.72	0.168
36	74.63 ± 4.81	73.58 ± 5.47	70.54 ± 5.02	75.60 ± 5.65	4.01	**0.010***
37	68.25 ± 5.62	65.75 ± 6.46	67.58 ± 8.44	68.55 ± 7.19	0.74	0.529

Table 4: Comparison of Mesiodistal angulation of teeth of four groups at Mandibular left quadrant using ANOVA.

* *P*=.05; ** *P*=.01; *** *P*=.001; *****P*=.0001

In Mandibular arch, Tukey's test (Table 5) revealed that the mean mesiodistal angulation of 36 lowered significantly (p<0.05) in Group 2 as compared to Control.

In mandibular right quadrant, Tukey test (Table 6) revealed that the mean mesiodistal angulation of 41 and 42 was significantly (p<0.01) different and higher in Group 2 as compared to Control.

Teeth No	Control (n=24)	Group 1 (n=24)	Group 2 (n=24)	Group 3 (n=20)	F value	p value
41	89.75 ± 6.17	92.71 ± 7.35	95.88 ± 6.56	93.35 ± 4.98	3.74	**0.014***
42	91.08 ± 6.76	92.96 ± 8.30	99.50 ± 7.38	94.65 ± 6.11	5.98	**0.001****
43	85.83 ± 5.69	88.29 ± 6.92	90.54 ± 7.20	89.65 ± 6.29	2.31	0.082
44	83.33 ± 3.97	84.42 ± 5.50	83.96 ± 6.53	83.75 ± 5.60	0.16	0.922
45	75.83 ± 5.54	75.75 ± 6.80	75.50 ± 5.63	75.90 ± 6.21	0.02	0.996
46	72.04 ± 5.00	70.21 ± 5.23	68.46 ± 5.06	71.00 ± 6.27	1.88	0.138
47	67.04 ± 7.90	63.92 ± 6.70	65.00 ± 9.18	65.35 ± 6.23	0.69	0.561

Table 5: Comparison of mean of Mesiodistal angulation of teeth of four different groups at Mandibular right quadrant using ANOVA.

* *P*=.05; ** *P*=.01; *** *P*=.001; *****P*=.0001

Comparisons	11	12	13	14	15	16	17
Control vs. Group 1	0.954	0.648	0.025*	0.994	0.999	0.060	0.006**
Control vs. Group 2	0.856	0.690	0.325	0.646	0.490	0.717	0.003**
Control vs. Group 3	0.184	0.091	0.314	0.999	0.164	0.731	0.080
Group 1 vs. Group 2	0.993	1.000	0.644	0.799	0.409	0.447	0.994
Group 1 vs. Group 3	0.420	0.594	0.739	0.999	0.211	0.505	0.865
Group 2 vs. Group 3	0.582	0.553	1.000	0.756	0.005**	1.000	0.736

Table 6: Comparison (p value) of mean mesiodistal angulation between the groups by Tukey's post hoc test at Maxillary right quadrant.

* *P*=.05; ** *P*=.01; *** *P*=.001; *****P*=.0001

Comparisons	21	22	23	24	25	26	27
Control vs. Group 1	1.000	0.587	0.624	0.998	0.701	0.421	0.009**
Control vs. Group 2	0.767	0.936	0.445	0.987	0.949	0.663	0.016*
Control vs. Group 3	0.493	0.594	0.178	1.000	0.527	0.123	0.034*
Group 1 vs. Group 2	0.732	0.905	0.992	0.999	0.949	0.980	0.997
Group 1 vs. Group 3	0.529	0.073	0.010*	0.999	0.086	0.868	0.988
Group 2 vs. Group 3	0.097	0.273	0.004**	0.991	0.245	0.666	0.999

Table 7: Comparison (p value) of mean mesiodistal angulation teeth between the groups by Tukey's post hoc test at Maxillary left quadrant.

* *P*=.05; ** *P*=.01; *** *P*=.001; ****_P_=.0001

Comparisons	31	32	33	34	35	36	37
Control vs. Group 1	0.995	0.533	0.969	0.103	0.487	0.901	0.604
Control vs. Group 2	0.991	0.129	0.153	0.840	0.851	0.040*	0.988
Control vs. Group 3	0.996	0.978	0.593	1.000	0.978	0.927	0.999
Group 1 vs. Group 2	0.951	0.826	0.343	0.451	0.123	0.190	0.801
Group 1 vs. Group 3	1.000	0.811	0.842	0.134	0.773	0.582	0.551
Group 2 vs. Group 3	0.959	0.327	0.868	0.866	0.647	0.010*	0.968

Table 8: Comparison (p value) of mean mesiodistal angulation teeth between the groups by Tukey's test at Mandibular left quadrant.

* *P*=.05; ** *P*=.01; *** *P*=.001; ****_P_=.0001

Comparisons	41	42	43	44	45	46	47
Control vs. Group 1	0.380	0.806	0.567	0.902	1.000	0.640	0.493
Control vs. Group 2	0.007**	0.001**	0.069	0.979	0.998	0.104	0.792
Control vs. Group 3	0.251	0.367	0.227	0.994	1.000	0.919	0.885
Group 1 vs. Group 2	0.319	0.012*	0.636	0.992	0.999	0.673	0.961
Group 1 vs. Group 3	0.987	0.866	0.903	0.978	1.000	0.962	0.926
Group 2 vs. Group 3	0.560	0.127	0.970	0.999	0.996	0.405	0.999

Table 9: Comparison (p value) of mean mesiodistal angulation teeth between the groups by Tukey's test at Mandibular right quadrant.

* *P*=.05; ** *P*=.01; *** *P*=.001; ****_P_=.0001

Discussion

All the panoramic radiographs were obtained in the same Rotagraph plus (Villa System Medical, Italy) and all the subjects positioned in the panoramic unit fitted the universal focal trough and did not compromise the fidelity of the angular measurements values extracted from the radiograph. All the radiographs were taken by single technician. All the tracings and measurement was done by single operator.

The mean angulations values for groups 1, 2 and 3 were compared individually with the normal mean values of the control group using ANOVA test and Tukey's test.

Panoramic radiograph is easy and convenient method of radiographing maxillao-mandibular region for both practitioner and patient, and produces a lower radiation dose equivalent to that received from four bite wing exposures measured at bone marrow level.[10] Use of rare earth film screens (Kodak Lanex screens) in combination with a Kodak T-Mat G film, the radiation dose is reduced by an additional 47 percent.

American Board of Orthodontics (ABO) has recommended the use of panoramic radiograph to determine the angulations in finished orthodontic cases. While the ABO recognizes that the panoramic radiograph is not the perfect record for evaluating root angulations, it is still considered the best practical means for making this assessment. The ABO instructions for determining root parallelism using the panoramic radiograph are that the deviation of each tooth is to be assessed with respect to its deviation from adjacent teeth, and its orientation perpendicular to a constructed occlusal plane perpendicular to an arbitrary midsagittal line [11].

Previously many studies have been conducted to confirm the accuracy of panoramic radiograph. More or less all studies were done on the typdodont models and differed only in the manner of positioning typhodont model on machine or reference planes used in measurement of angulations. So results of these typhodont studies cannot be applied to the general population. To our knowledge there are no studies in present literature which measured angulations in various malocclusions. The aim of this study was to measure the angulations of various malocclusions and to determine that if any differences exist between them.

Dental panoramic radiography has been considered to be inadequate for accurate measurement of structures and has been shown to be inaccurate in recording root angulations and root parallelism in posterior segments. This has been attributed to incorrect head positioning and errors associated with patient movement during exposure. Unreliable panoramic radiograph could be explained by considering the position of jaws in relation to rotation centers and path of x-ray beam. They showed that inaccuracy was mainly due to backward rotation of head and that lateral cants around the saggital axis (y-axis) of up to 10 degrees had a negligible effect [12,13]. As the occlusal plane is tipped -4 to + 20 degrees in relation to a parallel line with the floor, the maxillary tooth root converge away from occlusal plane and mandiular tooth root diverge away from occlusal plane [14].

Maximum value of angulations was found in molar region while the smallest angulations were found in lower incisor region in all the groups. Maxillary teeth showed distal angulations where as the mandibular teeth showed mesial angulations irrespective of their groups under study. Now it is obvious that irrespective of group angulations had a constant pattern on panoramic radiograph i.e. highest value were seen in molar region and lowest value were observed in lower anterior region.

When the groups 1, 2 and 3 were compared individually with the normal mean values of the control group, we found that in maxillary arch statistically significant differences were found in teeth 13, 17 and 27 in Group 1, 17 and 27 in group 2 and 27 in Group 2 as compared to control. Similarly statistically significant differences were observed in teeth 36, 41 and 42 in Group 2 as compared to control in mandibular arch.

When comparison was made between malocclusion groups statistically significant differences were observed in tooth 15 in Group 3 as compared to Group 2 and tooth 23 in Group 3 as compared to Group 1 and Group 2 in maxillary arch. In mandibular arch statistically significant differences was observed in tooth 36 in Group 2 as compared to Group 3 and tooth 42 in Group 2 as compared to Group 1.

The comparison of angulations in different malocclusion revealed that very few differences can be observed in angulations in different malocclusion on panoramic radiograph. So whatever may be the malocclusion it has got same angulation on panoramic radiograph.

Current study also support the use of panoramic radiograph as it could be fairly interpreted from the results of current study that whatever may be saggital malocclusion it will be represented in similar manner on panoramic radiograph.

Conclusion

The valuable information that can be obtained from panoramic radiograph is ignored on assumption that panoramic radiographs are always distorted and therefore, of no value. It is essential that for panoramic radiograph to be of maximum value to practitioner and patient one should have the thorough knowledge of distortion that can occur in panoramic radiograph and methods to minimize these, especially issues related to patient positioning. Findings of Current study can be summarized as follows:

1. A significant increase in angulations in maxillary arch was observed in right canine of class I malocclusion, right 2nd molars of class I and II malocclusions and left 2nd molar of class I, II and III malocclusions as compared to control. Whereas significant increase was also observed in angulations of mandibular right central and lateral incisor of class II malocclusion as compared to control. Furthermore, significant increase in angulation of right 2nd premolar was observed in class III malocclusion as compared to Class II malocclusion.
2. A significant decrease in angulations was found in maxillary left canine of class III malocclusion as compared to class I and class II malocclusions. Similarly a decrease of angulation was observed in mandibular left 1st molar of class II malocclusion as compared to control.

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