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"Extraction of First Premolars, Second Premolars Versus Non-Extraction on Mandibular Third Molar Angulation" - A Radiographic Study"

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Abstract
Background And Objectives*: The development of third molars and its influence on the dental arches has long been a concern to the dental profession. It would be useful to know the effect of orthodontic therapy on the final and crucial position of the developing third molar. The present study was undertaken to evaluate the effect of first premolar extraction, second premolar extraction and non-extraction on mandibular third molar angulation, to determine whether premolar extraction results in a more mesial movement of the buccal segment and causes favourable changes in the mandibular third molar angulation, which can enhance later eruption of the third molars and to evaluate the difference in mandibular third molar angulation change between first premolar (moderate anchorage) and second premolar extraction cases.*
Materials And Method*: Study design included a total sample size of 90 Pre-treatment and Post-treatment OPGs of patients treated with preadjusted edgewise appliance mechanotherapy at the Department of Orthodontics, Vydehi Institute of Dental sciences & Research Centre, Bangalore, Karnataka and various dental colleges in Bangalore, Karnataka. They were divided into 3 groups. Group I consisted of 30 pretreatment and post treatment OPGs of patients (9 males & 21 females) treated by non-extraction method, Group II consisted of 30 Pre-treatment and Post-treatment OPGs of patients (8 males & 22 females) treated with extraction of 1st premolars (under moderate anchorage requirement), Group III consisted of 30 Pre-treatment and Post-treatment OPGs of patients (11 males & 19 females) treated with extraction of 2nd premolars.*
Results
1. *The difference in pretreatment (T_1) and post treatment (T_2) angular measurements of 3rd molar and 2nd molar to HP showed that Group I had relatively lesser angular changes compared to Group II & Group III. Among the study groups, Group III observed highest mean angular changes as compared to the other groups.*
2. *This depicts that premolar extraction had a favorable influence on third molar angulation with more changes with second premolar extraction and least with non extraction.*

Conclusion: *Premolar extraction had a positive influence on third molar angulation. There was a definite improvement in the angulation of third molar in premolar extraction cases. Second premolar extraction cases had more improvement in angulation than first premolar extraction cases.There was least improvement in angulation in non extraction cases. The improvement in angulation will promote mesial migration and improving the possibility that the third molars will erupt in acceptable positions.*

Keywords: *Third molar, Nonextraction, 1st premolar extraction, 2nd premolar extraction, Horizontal reference plane.*

I. Introduction

The development of third molars and its influence on the dental arches has long been a concern to the dental profession[1]. Third molars may first appear on radiographs as early as 5 years of age and as late as 16 years of age. At first many lower third molars have a mesial inclination but they progressively become more upright up to the age of 25 and the teeth may erupt normally, usually between the ages of 18 and 24.[2] The developmental path of third molars in human beings is very irregular and the formation, calcification timing, position and course of eruption of these teeth show great variability. Frequently, third molars are impacted or congenitally missing.[1] The eruption space for the mandibular third molars are affected by the direction the teeth erupt during the functional phase of eruption. The more anteriorly the posterior teeth erupt, the more the retromolar space will increase.[3] The impact of third molar eruption on mandibular incisor crowding has been the subject of many studies. Causes for third molar impaction and predictions of third molar eruption have also been studied extensively. However, relatively few studies have investigated the effect of orthodontic treatment on third molar angulation[4].

The orthodontist should be aware of the relationship of the third molars to the remaining natural teeth in the dental arch. The main points to be decided are whether they will erupt, or become impacted, whether they will cause crowding of the mandibular anterior teeth, and whether the extraction of premolars will prevent crowding and influence their eruption. Developing third molars continually change their angular positions and undergo important pre-eruptive rotational movements. These rotational movements take place when the third molar bud comes into close proximity to the second molar. These rotational movements are extremely important since, if they fail to occur, impactions are inevitable. Therefore, it would be useful to know the effect of orthodontic therapy on the final and crucial position of the developing third molar.[5]

The aim of the present study is to determine whether extraction of premolars cause a favourable change in the third molar angulation. This study evaluates the changes in 3rd molar angulation relative to a reference plane and to the second molar long axis. These changes are compared in patients treated with 1st premolar extraction or 2nd premolar extraction and non-extraction to study the effect of mandibular premolar extraction on 3rd molar angulation. Thus, the null hypothesis of the study is that there is no statistically significant correlation between premolar extraction and third molar angulation.

II. Materials And Method

Source of data

Pre-treatment (T_1) and Post-treatment (T_2) OPGs of patients treated with preadjusted edgewise appliance mechanotherapy at the Department of Orthodontics, Vydehi Institute of Dental sciences & Research Centre, Bangalore, Karnataka and various dental colleges in Bangalore, Karnataka.

Materials

Pre-treatment (T_1) and Post-treatment (T_2) OPGs of patients treated by fixed orthodontic therapy with extraction of mandibular 1st premolars, 2nd premolars and non-extraction. A black lead pencil (3 H), ruler, right-angled triangle and protractor were used for the tracing.

Method of collection of data: (including sampling procedure if any).

A sample of 90 orthodontic patients who had undergone fixed orthodontic treatment (preadjusted edgewise appliance mechanotherapy) at the Department of Orthodontics, Vydehi Institute of Dental sciences & Research Centre, Bangalore, Karnataka and various dental colleges in Bangalore, Karnataka were selected. It was a retrospective radiographic study. The panoramic radiographs were taken using PM 2002 CC PROLINE (Planmeca Co., Helsinki, Finland) under standardized conditions.

Pre-treatment (T_1) and Post-treatment (T_2) OPGs of patients were collected. They were divided into 3 groups.

- Group I: 30 Pre-treatment (T_1) and Post-treatment (T_2) OPGs of patients treated by Non-Extraction method were selected.
- Group II: 30 Pre-treatment (T_1) and Post-treatment (T_2) OPGs of patients treated with extraction of Lower 1st premolars (under moderate anchorage requirement) were selected.
- Group III: 30 Pre-treatment (T_1) and Post-treatment (T_2) OPGs of patients treated with extraction of Lower 2nd premolars were selected.

Each panoramic radiograph was traced using matte acetate paper and proper illumination. A standardized technique of tracing was used to trace the outlines of the mandible, nasal septum, hard palate and the mandibular second and third molar teeth.

Inclusion criteria:

- ✓ Bilateral mandibular third molars seen on a panoramic radiograph in mesioangular positions. Not more than two thirds of the root development of the third molars should have taken place in the pre-treatment radiograph.
- ✓ Dental Class I malocclusion with moderate anchorage requirement.
- ✓ Treatment of the extraction cases includes full closure of the extraction spaces.
- ✓ Age group of 11 to 16 years in all 3 groups to eliminate the effect of growth occurring in the retromolar area.
- ✓ The total treatment time in both the extraction and non extraction cases should have been between 18- 24 months.
- ✓ Good quality pre-treatment and post treatment pantomographs in which a clear view and well defined ANS, Nasal septum and Projection shadow of the palatine plane were clearly visible were included.

Exclusion Criteria:

- ✓ Standard edgewise cases requiring anchorage preparation.
- ✓ Patients with Class II malocclusion with second premolar extraction and mandibular molar protraction.
- ✓ Patients with Class I maxillomandibular protrusion cases with high anchorage preparation.

Methodology

The reference plane constructed in this study is a modification of the midline reference plane (MRP) as used by Elsey and Rock. The Nasal septum and ANS were traced and bisected. A perpendicular line was drawn to this midline bisector that extended through palatal shadow bilaterally. This constructed plane is termed the horizontal reference plane (HRP). The outlines of the mandibular second and third molars and their long axes were drawn on the tracing sheet. The long axis of the second molar was traced from mid-occlusal point through the midpoint between the mesial and distal root tips. The long axes of the mandibular third molar buds were drawn by the line bisecting a line connecting the mesial and distal outlines of the cervical areas (Fig 1). Pretreatment (T_1) tracings were done in black color and post treatment (T_2) tracings were done in red color. The OPGs and their tracings were color coded as black for non extraction cases (Fig 2,3,4 & 5), blue for first premolar extraction cases (Fig 6,7,8 & 9), green for second premolar extraction cases (Fig10,11,12 & 13) for better identification and assessment of the samples.

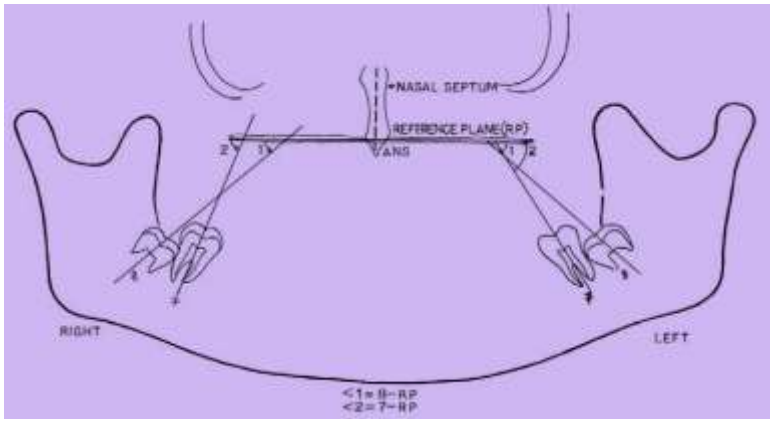

Figure 1: showing angulation measurements. 1) indicates mandibular third molar angulation to the horizontal reference plane (HRP) (3rd molar to HRP); 2) mandibular second molar angulation to HRP (2nd molar to HRP).

Landmarks And Measurements

ANS - Anterior nasal spine

Horizontal Reference Plane (Hrp): The ANS and the nasal septum were traced and bisected. A perpendicular line was drawn to the midline bisector that extends through the palatal shadow bilaterally. This constructed plane is termed the Horizontal Reference Plane (HRP).

8- Mandibular third molar.

7-Mandibular second molar.

Angles considered:

8 to HRP (Right and Left) - The outer angles formed by the mandibular third molar axes to the horizontal reference plane (HRP) on both the right and left sides.

7 to HRP (Right and Left) - The outer angles formed by second molar axes to the horizontal reference plane (HRP) on both the right and left sides

- An increase in the angle between the mandibular third molar to the horizontal reference plane (HRP), would indicate an improvement in the position of the mandibular third molar.

III. Method Of Statistical Analysis

The study data was analysed using SPSS v.22 IBM. Corp. The mean & SD was derived for the study parameters. Student paired t test was used to compare the mean difference between the right & left side angular measurements within the groups. The 3 study groups' data were analyzed using a One-way analysis of variance (ANOVA) for each group to find out whether any significant differences existed. Further wherever significant results were found through analysis of variance, Tukey's post hoc test was used to compare statistically significant difference between the study groups. The level of significance was set at $P< 0.05$.

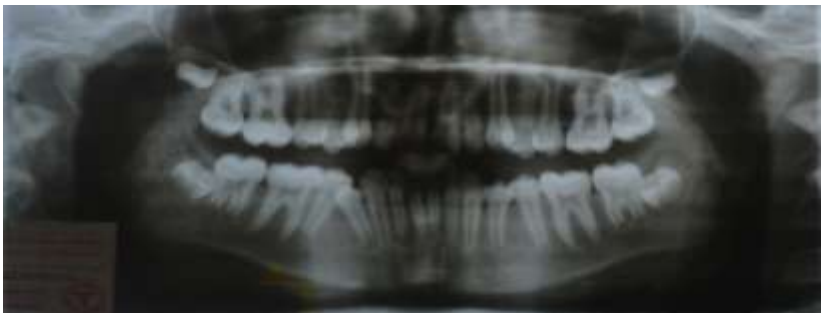

Figure 2: Group I (Non Extraction) Pretreatment (T_1) OPG

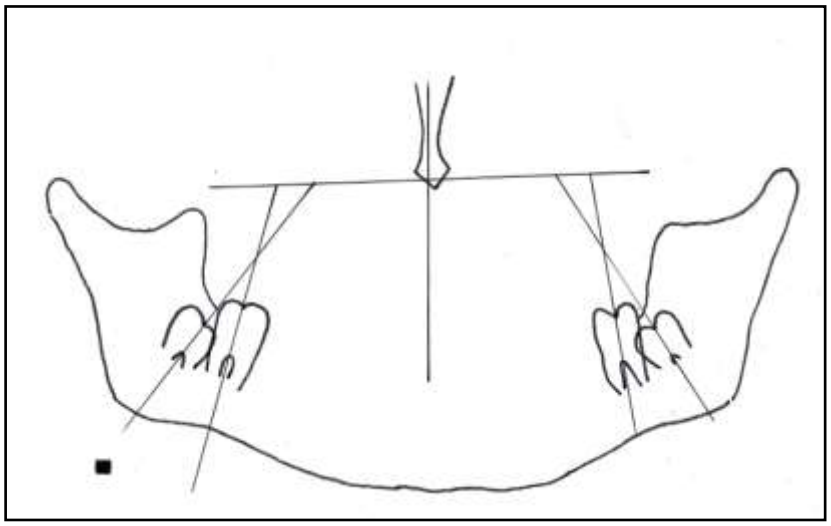

Figure 3: Group I (Non Extraction) Pretreatment (T_1) OPG Tracing

Figure 4: Group I (Non Extraction) Post treatment (T_2) OPG

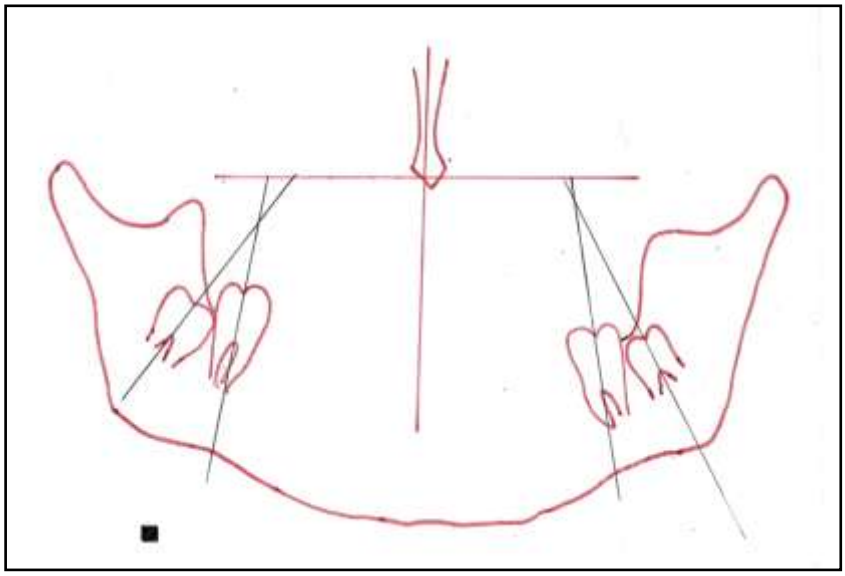

Figure 5: Group I (Non Extraction) Post treatment (T_2) OPG Tracing

Figure 6: Group II (1st Premolar Extraction) Pretreatment (T_1) OPG

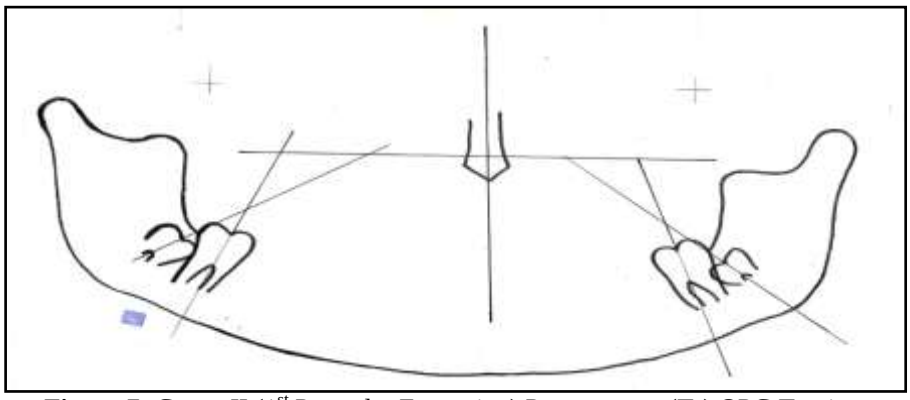

Figure 7: Group II (1st Premolar Extraction) Pretreatment (T_1) OPG Tracing

Figure 8: Group II (1st Premolar Extraction) Post treatment (T_2) OPG

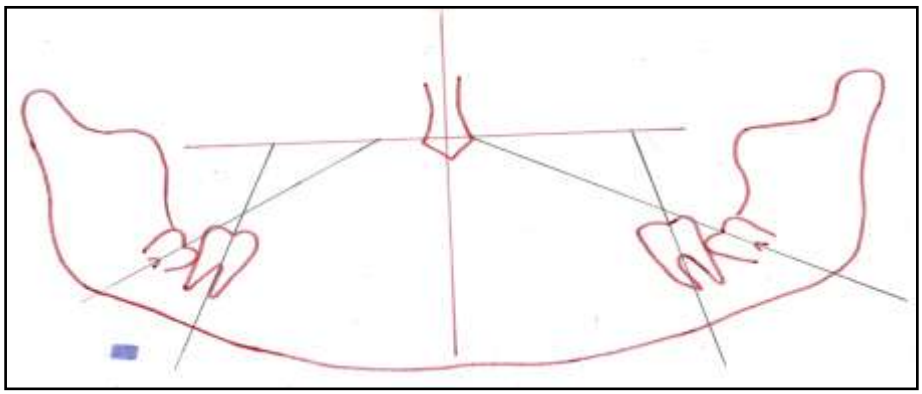

Figure 9: Group II (1st Premolar Extraction) Post treatment (T_2) OPG Tracing

Figure 10: Group III (2nd Premolar Extraction) Pretreatment (T_1) OPG

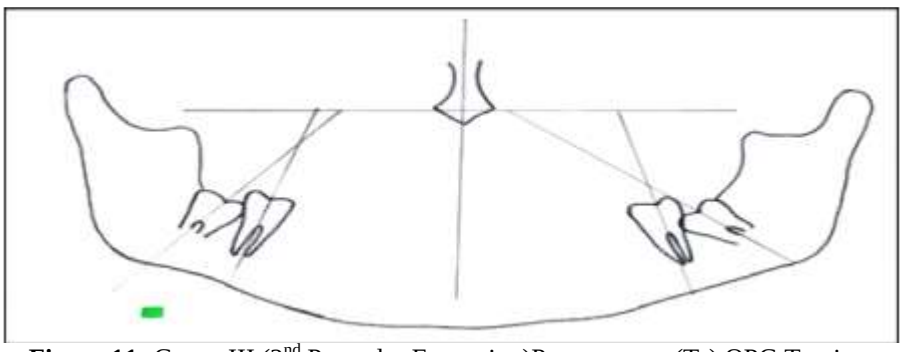

Figure 11: Group III (2nd Premolar Extraction)Pretreatment (T_1) OPG Tracing

Figure 12: Group III (2^{nd} Premolar Extraction) Post Treatment (T_2) OPG

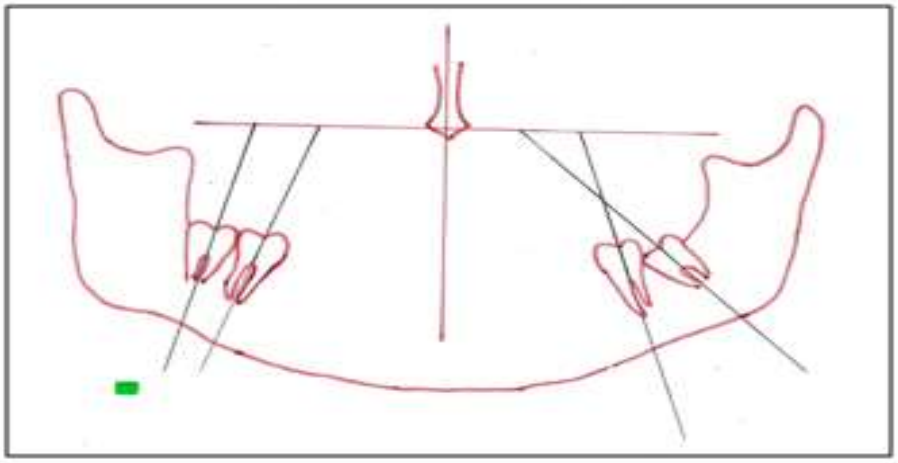

Figure 13: Group III (2^{nd} Premolar Extraction) Post Treatment (T_2) Tracing

IV. Results

Statistical Analysis: The study data were analysed using SPSS v.22 IBM. Corp. The mean & standard deviation were derived for the study parameters. Student paired't' test was used to compare the mean difference between the right & left side angular measurements within the groups. The 3 study groups' data were analyzed using a One-way analysis of variance (ANOVA) for each group to find out whether any significant differences existed. Further wherever significant results were found through analysis of variance, Tukey's post hoc test was used for pair wise comparison of study groups to find statistical significant difference between them. The level of significance was set at $P< 0.05$.

The age-wise distribution of the sample studied is represented in Table I & Graph I. Most of the samples in the study groups belonged to the age-groups of 11-16 years, and the mean average distribution of the age in Group I, Group II, and Group III were 14.0 ± 1.4, 13.8 ± 1.3, and 13.8 ± 1.3 respectively. Comparison of age between the Group I, Group II and Group III showed no statistically significant differences. The gender-wise distribution of the samples in the study groups is studied in Table II & Graph II. 32.1% of samples from Group I, 28.6% of samples from Group II, and 39.3% of samples from Group III were males; and 33.9% of samples from Group I, 35.5% of samples from Group II, and 30.6% of samples from Group III were females. Comparison of gender between the Group I, Group II and Group III showed no statistically significant differences.Comparison of the mean angular changes in 3rd molar & 2nd molar to HP measurements of Group I between right & left sides using student paired't' test (Table III, Table IV, Table V and Graph III, Graph IV) showed there were no statistically significant difference between the right and left side. There were statistically significant differences between right and left side T_1 measurements of 3rd molar to HP which is not significant for our study. Comparison of the mean angular changes in 3^{rd} molar & 2^{nd} molar to HP measurements of Group II between right & left sides using student paired't' test (Table VI, Table VII, Table VIII) showed no statistical significance between the right and left side measurements.

Comparison of the mean angular changes in 3^{rd} molar & 2^{nd} molar to HP measurements of Group III between right & left sides using student paired't' test (Table IX, Table X, Table XI) showed no statistical significance between the right and left side measurements.Comparison of mean angular changes between 3 study groups for the parameters under 3^{rd} molar to HP measurements using one-way ANOVA test (Table XII, Table XIII) revealed that the mean angular changes (in degrees) ± standard deviation for right side was 3.3 ±

1.4 for Group I, 8.4 ± 1.7 for Group II and 11.2 ± 1.9 for Group III. The mean angular changes (in degrees) ± standard deviation for left side was 3.7 ± 1.7 for Group I, 7.6 ± 1.9 for Group II and 11.2 ±1 .5 for Group III. These differences with respect to mean angular changes between the 3 study groups were statistically significant at $p < 0.001$. Multiple comparison using Tukey's post hoc analysis for pair wise comparison of study groups revealed that the difference between Group I & Group II; Group I & Group III; Group II & Group III were statistically significant at $p < 0.001$. Hence we could infer that Group I had relatively lesser angular changes compared to Group II & Group III as well as Group III observed highest mean angular changes as compared to the other groups.

Comparison of mean angular changes between 3 study groups for the parameters under 2nd molar to HP measurements using one-way ANOVA test (Table XIV, Table XV) showed that the mean angular changes (in degrees) ± standard deviation for right side were 2.3±1.1 for Group I, 6.5±1.0 for Group II and 6.7±1.3 for Group III. The mean angular changes (in degrees) ± standard deviation for left side were 2.2±1.4 for Group I, 6.2±1.7 for Group II and 6.3±1.5 for Group III. These differences with respect to mean angular changes between the 3 study groups were statistically significant at $p < 0.001$. Multiple comparison using Tukey's post hoc analysis for pair wise comparison of study groups revealed that the difference between Group I & Group II; Group I & Group III; Group II & Group III were statistically significant at $p < 0.001$. Hence we could infer that Group I had relatively lesser angular changes compared to Group II & Group III as well as Group III observed highest mean angular changes as compared to the other groups.

Table I: Age-wise distribution of subjects among

Groups	Mean	SD	Range	
			Min	Max
Group I	14.0	1.4	11	16
Group II	13.8	1.3	11	16
Group III	13.8	1.3	11	16

study groups.

Table II: Gender-wise distribution of subjects among study groups.

Groups	Males		Females	
	n	%	n	%
Group I	9	32.1%	21	33.9%
Group II	8	28.6%	22	35.5%
Group III	11	39.3%	19	30.6%

Table – III: Comparison of mean angular changes in Group I between right & left sides for 3rd molar & 2nd molar to HRP measurements using Student paired't' test.

Measure	Parameters	N	Mean	SD	S.E.M	Mean Diff	t	P-Value
3rd molar to HRP	T_1 (R)	30	45.6	3.6	0.7	1.9	2.184	0.04*
	T_1 (L)	30	43.7	2.9	0.5			
	T_2 (R)	30	48.9	3.8	0.7	1.4	1.680	0.10
	T_2 (L)	30	47.4	3.0	0.5			
	Diff (R)	30	3.3	1.4	0.3	-0.4	-1.257	0.22
	Diff (L)	30	3.7	1.7	0.3			
2nd molar to HRP	T_1 (R)	30	68.3	4.8	0.9	0.9	0.706	0.49
	T_1 (L)	30	67.5	4.4	0.8			
	T_2 (R)	30	70.6	4.6	0.8	0.9	0.742	0.46
	T_2 (L)	30	69.7	5.9	1.1			
	Diff (R)	30	2.3	1.1	0.2	0.1	0.178	0.86
	Diff (L)	30	2.2	2.2	0.4			

*** - Statistically Significant**

Table – IV: Comparison of mean angular changes in Group I between right & left sides for 3rd molar to HRP measurements.

Sides	T_1	T_2	Difference
Right	45.6	48.9	3.3
Left	43.7	47.4	3.7

Table – V: Comparison of mean angular changes in Group I between right & left sides for 2nd molar to HRP measurements.

Sides	T_1	T_2	Difference
Right	68.3	70.6	2.3
Left	67.5	69.7	2.2

Table –VI: Comparison of mean angular changes in Group II between right &left sides for 3rd molar & 2nd molar to HRP measurements using Student paired't' test.

Measure	Parameters	N	Mean	SD	S.E.M	Mean Diff	t	P-Value
3rd molar to HRP	T_1 (R)	30	46.2	6.4	1.2	-0.8	-0.624	0.54
	T_1 (L)	30	47.0	5.6	1.0			
	T_2 (R)	30	54.6	6.2	1.1	0.0	0.000	1.00
	T_2 (L)	30	54.6	4.9	0.9			
	Diff (R)	30	8.4	1.7	0.3	0.8	1.588	0.12
	Diff (L)	30	7.6	1.9	0.3			
2nd molar to HRP	T_1 (R)	30	71.8	3.4	0.6	-1.4	-1.931	0.06
	T_1 (L)	30	73.2	3.3	0.6			
	T_2 (R)	30	78.3	3.4	0.6	-1.2	-1.594	0.12
	T_2 (L)	30	79.4	3.2	0.6			
	Diff (R)	30	6.5	1.0	0.2	0.3	0.583	0.56
	Diff (L)	30	6.2	1.7	0.3			

Table – VII: Comparison of mean angular changes in Group II between right & left sides for 3rd molar to HRP measurements.

Sides	T_1	T_2	Difference
Right	46.2	54.6	8.4
Left	47.0	54.6	7.6

Table – VIII: Comparison of mean angular changes in Group II between right & left sides for 2nd molar to HRP measurements.

Sides	T_1	T_2	Difference
Right	71.8	78.3	6.5
Left	73.2	79.4	6.2

Table – IX: Comparison of mean angular changes in Group III between right & left sides for 3rd molar & 2nd molar to HRP measurements using student paired't' test.

Measure	Parameters	N	Mean	SD	S.E.M	Mean Diff	t	P-Value
3rd molar to HRP	T_1 (R)	30	49.2	4.5	0.8	0.0	-0.027	0.98
	T_1 (L)	30	49.2	4.2	0.8			
	T_2 (R)	30	60.4	4.2	0.8	0.0	-0.029	0.98
	T_2 (L)	30	60.4	4.2	0.8			
	Diff (R)	30	11.2	1.9	0.3	0.0	-0.858	0.40
	Diff (L)	30	11.2	2.5	0.5			
2nd molar to HRP	T_1 (R)	30	65.3	3.2	0.6	0.1	0.078	0.94
	T_1 (L)	30	65.3	2.9	0.5			
	T_2 (R)	30	72.0	3.0	0.6	0.5	0.613	0.54
	T_2 (L)	30	71.6	2.8	0.5			
	Diff (R)	30	6.7	1.3	0.2	0.4	1.046	0.30
	Diff (L)	30	6.3	1.5	0.3			

Table – X : Comparison of mean angular changes in Group III between right & left sides for 3rd molar to HRP measurements.

Sides	T_1	T_2	Difference
Right	49.2	60.4	11.2
Left	49.2	60.4	11.2

Table – XI: Comparison of mean angular changes in Group III between right & left sides for 2nd molar to HRP measurements.

Sides	T_1	T_2	Difference
Right	65.3	72.0	6.7
Left	65.3	71.6	6.3

Table - XII: Pair wise comparison of mean angular changes between 3 study groups for the

parameters under 3rd molar to HRP measurements using Tukey's post hoc analysis

Parameters	Groups	N	Mean	SD	Std. Error	Min	Max	F	P-Value	Sig. Diff	P-Value
T_1 (R)	Group I	30	68.3	4.8	0.9	58	76	21.187	<0.001*	G1 VS G2	0.002*
	Group II	30	71.8	3.4	0.6	67	79			G1 Vs G3	0.009*
	Group III	30	65.3	3.2	0.6	61	71			G2 Vs G3	<0.001*
T_1 (L)	Group I	30	67.5	4.4	0.8	57	74	38.809	<0.001*	G1 VS G2	<0.001*
	Group II	30	73.2	3.3	0.6	67	80			G2 Vs G3	<0.001*
	Group III	30	65.3	2.9	0.5	61	72				
T_2 (R)	Group I	30	70.6	4.6	0.8	60	77	35.312	<0.001*	G1 VS G2	<0.001*
	Group II	30	78.3	3.4	0.6	72	85			G2 Vs G3	<0.001*
	Group III	30	72.0	3.0	0.6	67	78				
T_2 (L)	Group I	30	69.7	5.9	1.1	50	79	45.939	<0.001*	G1 VS G2	<0.001*
	Group II	30	79.4	3.2	0.6	73	86			G2 Vs G3	<0.001*
	Group III	30	71.6	2.8	0.5	67	77				
Diff (R)	Group I	30	2.3	1.1	0.2	1	5	131.411	<0.001*	G1 VS G2	<0.001*
	Group II	30	6.5	1.1	0.2	5	8			G1 Vs G3	<0.001*
	Group III	30	6.7	1.3	0.2	5	10				
Diff (L)	Group I	30	2.2	2.2	0.4	7	6	48.541	<0.001*	G1 VS G2	<0.001*
	Group II	30	6.2	1.7	0.3	4	11			G1 Vs G3	<0.001*
	Group III	30	6.3	1.5	0.3	3	9				

*** - Statistically Significant**

Note: G1 - Group I; G2 - Group II; G3 - Group III

Table –XIII: Comparison of mean angular changes between 3 study groups for the parameters under 3rd molar to HRP measurements.

Groups	T_1 (R)	T_1 (L)	T_2 (R)	T_2 (L)	Diff (R)	Diff (L)
Group I	45.6	43.7	48.9	47.4	3.3	3.7
Group II	46.2	47.0	54.6	54.6	8.4	7.6
Group III	49.2	49.2	60.4	60.4	11.2	11.2

Table - XIV: Pair wise comparison of mean angular changes between 3 study groups for the parameters under 2nd molar to HRP measurements using Tukey's post hoc analysis.

Parameters	Groups	N	Mean	SD	Std. Error	Min	Max	F	P-Value	Sig. Diff	P-Value
T_1 (R)	Group I	30	68.3	4.8	0.9	58	76	21.187	<0.001*	G1 VS G2	0.002*
	Group II	30	71.8	3.4	0.6	67	79			G1 Vs G3	0.009*
	Group III	30	65.3	3.2	0.6	61	71			G2 Vs G3	<0.001*
T_1 (L)	Group I	30	67.5	4.4	0.8	57	74	38.809	<0.001*	G1 VS G2	<0.001*
	Group II	30	73.2	3.3	0.6	67	80			G2 Vs G3	<0.001*
	Group III	30	65.3	2.9	0.5	61	72				
T_2 (R)	Group I	30	70.6	4.6	0.8	60	77	35.312	<0.001*	G1 VS G2	<0.001*
	Group II	30	78.3	3.4	0.6	72	85			G2 Vs G3	<0.001*
	Group III	30	72.0	3.0	0.6	67	78				
T_2 (L)	Group I	30	69.7	5.9	1.1	50	79	45.939	<0.001*	G1 VS G2	<0.001*
	Group II	30	79.4	3.2	0.6	73	86			G2 Vs G3	<0.001*
	Group III	30	71.6	2.8	0.5	67	77				
Diff (R)	Group I	30	2.3	1.1	0.2	1	5	131.662	<0.001*	G1 VS G2	<0.001*
	Group II	30	6.5	1.0	0.2	5	8			G1 Vs G3	<0.001*
	Group III	30	6.7	1.3	0.2	5	10				
Diff (L)	Group I	30	2.2	1.4	0.3	1	6	56.662	<0.001*	G1 VS G2	<0.001*
	Group II	30	6.2	1.7	0.3	4	11			G1 Vs G3	<0.001*

	Group III	30	6.3	1.5	0.3	3	9				

*Statistically Significant

Note: G1 - Group I; G2 - Group II; G3 - Group III

Table – XV:Comparison of mean angular changes between 3 study groups for the parameters under 2nd molar to HRP measurements.

Groups	**T_1 (R)**	**T_1 (L)**	**T_2 (R)**	**T_2 (L)**	**Diff (R)**	**Diff (L)**
Group I	68.3	67.5	70.6	69.7	2.3	2.2
Group II	71.8	73.2	78.3	79.4	6.5	6.2
Group III	65.3	65.3	72.0	71.6	6.7	6.3

V. Discussion

Mandibular third molars are the most frequently appearing impacted teeth. The prevalence of mandibular third molar impaction is variable in different populations, ranging from 9.5% to 39%. This difference may be due to sampling variations, racial characteristics, and/or the clinicians' own definition of impaction.[28] Modern population have higher frequency of impaction of third molars than primitive ones, because they usually eat soft and sophisticated diets that require minimal chewing forces. The end result will be minimal interproximal attrition and mesial shift of posterior teeth, therefore; the retromolar space will not be adequate to occupy the third molar.[25]

Cephalometric growth studies suggested two important mechanisms for development of the retromolar space in the mandible: resorption at the anterior border of the ascending ramus and anterior migration of the posterior teeth during the functional phase of tooth eruption. Both might depend more on the amount and direction of condylar growth than on the presence of the third molars. The amount of periosteal apposition on the maxillary tuberosities could be more compensatory, reflecting the size and number of the maxillary posterior teeth. Accordingly, mesial movement of the molars during closure of the extraction site could have a larger effect on third molar impaction in the mandible than in the maxilla.[10] The presence, position and angulation of mandibular third molars remain an important clinical finding to orthodontists during the setup of patient's treatment plan. This is due to its influence during ongoing orthodontic treatment as well as on the subsequent stability of treatment results.[25]

If third molar eruption can be predicted at an early age during the course of orthodontic treatment, later occurrences of difficult impactions can be avoided. The subjects of our study ranged in age from 11 to 16 years, with a mean age of about 13 years; during this time, the third molar bud is developing and is undergoing important rotational pre-eruptive movements. Therefore, patients in this age group were selected to determine whether the treatment technique (extraction or non extraction) had any favorable effect on the rotational, uprighting, and pre-eruptive movements taking place at that time.

The purpose of our study was to evaluate the effect of first premolar extraction, second premolar extraction and non-extraction on mandibular third molar angulation, to determine whether premolar extraction results in a more mesial movement of the buccal segment and causes favourable changes in the mandibular third molar angulation, which can enhance later eruption of the third molars and to evaluate the difference in mandibular third molar angulation change between first premolar (moderate anchorage) and second premolar extraction cases. The patients were grouped as Group I, Group II and Group III. Group I comprised of 30 Pre-treatment and Post-treatment OPGs of patients treated by Non-Extraction method. Group II comprised of 30 Pre-treatment and Post-treatment OPGs of patients treated with extraction of Lower 1st premolars (under moderate anchorage requirement). Group III comprised of 30 Pre-treatment and Post-treatment OPGs of patients treated with extraction of Lower 2nd premolars.

Pretreatment (T_1) and post treatment (T_2) OPGs of patients were evaluated using a standardized technique of tracing the images of the molar teeth, mandible, nasal septum, ANS on matte acetate paper. The Nasal septum and ANS were bisected. A perpendicular line was drawn to this midline bisector that extended through palatal shadow bilaterally. This constructed plane was termed the horizontal reference plane (HRP). The outlines of the mandibular second and third molars and their long axes were drawn on the tracing sheet. The long axis of the second molar was traced from mid-occlusal point through the midpoint between the mesial and distal root tips. The long axes of the mandibular third molar buds were drawn by the line bisecting a line connecting the mesial and distal outlines of the cervical areas. The angles measured were the outer angles formed by the mandibular third molar axes to the horizontal reference plane (HRP) on the right and left sides, the outer angles formed by second molar axes to the horizontal reference plane (HRP) on both the right and left sides. An increase in the angle between the mandibular third molar to the horizontal reference plane (HRP), would indicate an improvement in the position of the mandibular third molar.

Pretreatment (T_1) and post treatment (T_2) angular measurements of right and left side within the groups compared using Student paired t test showed that there were no statistically significant differences between the right and left side except in the T_1 measurements of 3rd molar to HP, where there was statistically significant difference between right and left side T_1 measurements. This finding was not significant for our study. Pretreatment (T_1) and post treatment (T_2) angular measurements of 3rd molar to HP using a One-way analysis of variance (ANOVA) for each group followed by pair wise comparison using Tukey's post hoc analysis showed that the mean angular changes (in degrees) ± standard deviation for right side was 3.3 ± 1.4 for Group I, 8.4 ± 1.7 for Group II and 11.2 ± 1.9 for Group III. The mean angular changes (in degrees) ± standard deviation for left side was 3.7 ± 1.7 for Group I, 7.6 ± 1.9 for Group II and 11.2 ±1 .5 for Group III. These differences with respect to mean angular changes between the 3 study groups were statistically significant at $p < 0.001$. Multiple comparison using Tukey's post hoc analysis for pair wise comparison of study groups revealed that the difference between Group I & Group II; Group I & Group III; Group II & Group III were statistically significant at $p < 0.001$. Hence we could infer that Group I had relatively lesser angular changes compared to Group II & Group III as well as Group III observed highest mean angular changes as compared to the other groups. This depicts that premolar extraction had a favorable influence on third molar angulation.

Pretreatment (T_1) and post treatment (T_2) angular measurements of 2nd molar to HP using a One-way analysis of variance (ANOVA) for each group followed by pair wise comparison using Tukey's post hoc analysis showed that the mean angular changes (in degrees) ± standard deviation for right side were 2.3±1.1 for Group I, 6.5±1.0 for Group II and 6.7±1.3 for Group III. The mean angular changes (in degrees) ± standard deviation for left side were 2.2±1.4 for Group I, 6.2±1.7 for Group II and 6.3±1.5 for Group III. These differences with respect to mean angular changes between the 3 study groups were statistically significant at $p < 0.001$. Multiple comparison using Tukey's post hoc analysis for pair wise comparison of study groups revealed that the difference between Group I & Group II; Group I & Group III; Group II & Group III were statistically significant at $p < 0.001$. We could infer that Group I had relatively lesser angular changes compared to Group II & Group III as well as Group III observed highest mean angular changes as compared to the other groups. Thus our study also showed that there was improvement in 2nd molar angulation as well with most in second premolar extraction cases and least in non extraction cases.

Among the groups, an analysis of sexual dimorphism showed no statistically significant difference between genders in any of the parameters considered in the study. The sample consisted of age group of 11 to 16 years in all 3 groups to eliminate the effect of growth occurring in the retromolar area.

Tae-Woo Kim et al[3] conducted a study to determine the association of premolar extraction treatment with mesial movement of the molars concomitant with an increase in the eruption space for the third molars and tested the hypothesis that such treatment reduces the frequency of third molar impaction. Lateral cephalograms, panoramic or periapical radiographs, and study models made before (T1) and after (T2) treatment and a minimum of 10 years post retention (T3) of 157 patients were selected from the post retention sample at the Department of Orthodontics of the University of Washington, Seattle. Treatment for 105 patients included the extraction of 4 premolars; the other 53 were treated non extraction. These patients represented all the extraction and non extraction patients in the sample who had at least 1 third molar at T1 or T2 and who showed evidence of full eruption or closure of the root apex at T2 or T3. Third molar impaction was defined as incomplete eruption at T2 or T3 because of inclined position relative to the second molar or the ascending ramus, or lack of space, with radiographic evidence of apical closure. Third molar eruption was defined as the presence of the third molars in full occlusion at T2 or T3. Upper molar movement (U-MM) and lower molar movement (L-MM) were measured to the nearest 0.5 mm along the averaged occlusal plane on the superimposed images of the T1 and T2 cephalograms with a digital caliper. Maxillary superimposition was performed according to Doppel et al, and mandibular superimposition according to Bjork. The upper (U-ES) and lower (L-ES) eruption spaces were measured on the T2 cephalograms. U-ES was defined as the distance from the pterygoid vertical to the distal surface of the maxillary first molar crown along the occlusal plane. L-ES was defined as the distance from Ricketts' Xi point or from the anterior border of the ramus (R) to the distal surface of the mandibular second molar crown along the occlusal plane. Statistical analyses were performed using Student *t* tests. They concluded that premolar extraction therapy reduced the frequency of third molar impaction because of increased eruption space concomitant with mesial movement of the molars during space closure.

Though the material and methodology used in the above study and our study were different, both the studies found that there was improvement in third molar angulation with extraction of premolars. The above study concluded that there was reduced frequency of impaction in premolar extraction therapy; but it did not take in to consideration which premolar (first or second) had more impact on third molar impaction. Our study could determine that there was improvement in third molar angulation with premolar extraction therapy with more changes in second premolar extraction cases followed by first premolar extraction cases and least in non extraction cases. Both the studies were not able determine if there was complete eruption of third molar with premolar extraction therapy. Hence the above study is supporting our study.

Mustafa Yigit Saysel et al[1] determined the relationship between the inclinations of second and third molars during a 2 to 2.5-year period in patients treated orthodontically both with and without premolar extractions. Records of 37 first premolar extraction patients and 33 nonextraction patients were examined. The pretreatment and post treatment panoramic radiographs were analyzed. Radiographs were evaluated using a standardized technique of tracing the images of the molar teeth on matte acetate paper. The occlusal line was constructed through the cusp tips of the first molar and the second premolar. All second premolars were fully erupted at the beginning of the treatment period. The anterior angles formed by the long axis of the third molar and the occlusal plane plus the angle between the long axes of the second and third molar were measured. For each measurement, pretreatment values were subtracted from post treatment values to obtain the change that occurred during treatment. The changes in third molar angulations relative to occlusal plane and relative to the second molar from pretreatment to posttreatment for each group were compared with Mann–Whitney U-test and Wilcoxon test ($P < .05$). Statistical analysis revealed that mandibular third molars showed an improvement in angulation relative to the occlusal plane in the first premolar extraction group. Thus, they concluded that orthodontic treatment involving premolar extractions improves mandibular third molar angulations.

When comparing the above study with our study; the results of our study also showed that there was improvement in third molar angulation in premolar extraction therapy. The above study used the occlusal plane and mandibular plane as the horizontal plane of reference to measure treatment changes. However, the changes in the occlusal plane, with treatment and remodeling of the lower border of the mandible during growth, may cause misinterpretation of third molar angle calculations. Our study used palatal plane as reference plane. The third molar angulation relative to the palatal plane at each time period may be misinterpreted in the event of remodeling changes of the palatal process over time. Even if such changes had taken place, they were likely to be small during the relatively short treatment period (around 2 years) of the subjects in our study. Hence the palatal plane is more reliable. Though the parameters used in above study and present study were different, the results of both studies showed that the extraction of premolars had a positive influence on third molar angulation. Hence the above study supports our study. But the above study never compared which premolar (first or second) had more influence on mandibular third molar angulation.

Our study showed that premolar extractions in preadolescent orthodontic patients have a positive influence on third molar angulations by promoting mesial migration and improving the possibility that the third molars will erupt in acceptable positions. This was more in case of second premolar extraction than first premolar extraction and least in non extraction. Although it is not possible to predict from the results how many third molars would erupt fully later on, it is clear that the improved positions would facilitate surgery for many of those teeth that did ultimately require removal. Thus we could predict that the null hypothesis is not significant for our study.

Further studies are recommended of a longer duration to verify the complete eruption of third molars rather than only a prediction of future eruption or a favorable change in angulation. Probably a 3-Dimensional study using a CBCT would provide a better understanding of the various parameters and give a more accurate result.

VI. Conclusion

The results of the present study demonstrated the effects of extraction of premolars (first or second) on third molar angulation.

The following conclusions are drawn from the study:

- Premolar extraction had a positive influence on third molar angulation.
- There was a definite improvement in the angulation of third molar in premolar extraction cases.
- Second premolar extraction cases had more improvement in angulation than first premolar extraction cases.
- There was least improvement in angulation in non extraction cases.
- The improvement in angulation will promote mesial migration and improving the possibility that the third molars will erupt in acceptable positions.
- Even though there was improvement in angulation, it is not possible to predict how many third molars would erupt fully later on.
- The improved positions would facilitate surgery for many of those teeth that did ultimately require removal.
- There was no statistically significant sexual dimorphism between the three groups.

Further studies are recommended of a longer duration to verify the complete eruption of third molars rather than only a prediction of future eruption or a favorable change in angulation. Probably a 3-Dimensional study using a CBCT would provide a better understanding of the various parameters and give a more accurate result.Hence the null hypothesis of the study that there is no statistically significant correlation between premolar extraction and third molar angulation is rejected because there was a definite improvement in third molar angulation in cases treated with premolar extraction.

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