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Impact of Extraction and Non-extraction Orthodontic Protocols on third molar Angulation in the Maxilla and Mandible

Dr.Eenal Bhambri[1], Dr. Narute Annaso Sarjerav[2], Dr.Ankit Bharadwaj[3], Dr.Abin Mathew Thomas[4], Dr.Arun Raj RG[5], Dr.Priyangka yambem[6]

[1]*BDS, MDS, Professor, Department of Orthodontics and Dentofacial Orthopaedics, Surendera Dental College and Research institute, Sri Ganganagar, Rajasthan*
[2]*BDS, MDS (Pursuing)Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Surendera Dental College and Research institute, Sri Ganganagar, Rajasthan*
[3]*BDS, MDS,Reader, Department of Orthodontics and Dentofacial Orthopaedics, Surendera Dental College and Research institute, Sri Ganganagar, Rajasthan*
[4]*BDS, MDS (Pursuing)Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Surendera Dental College and Research institute, Sri Ganganagar, Rajasthan*
[5]*BDS, MDS(Pursuing)Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Surendera Dental College and Research institute, Sri Ganganagar, Rajasthan*

[6]*BDS, MDS, Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Surendera Dental College and Research institute, Sri Ganganagar, Rajasthan*

Abstract:
Objectives: *To compare the angular changes in the developing maxillary and mandibular third molar in both first premolar and non- extraction cases and to determine whether premolar extraction results in a more mesial movement of the maxillary and mandibular buccal segment and causes favourable rational changes in maxillary and mandibular 3rd molar tilt, which can enhance later eruption of third molar.*
Material and method: *Study design includes a total sample size of 60 Pretreatment(T1) and Posttreatment (T2) OPGs of Patients treated with 1st premolar extraction and non-extraction. They were divided into 4 groups of 15 patients.*
Group I consisted of 15 pretreatment(T1) and post-treatment (T2) OPGs of patients treated with maxillary 1st premolar extraction.
Group II consisted of 15 pretreatment(T1) and post-treatment (T2) OPGs of patients treated with non- extraction in maxillary arch.
Group III consisted of 15 pretreatment(T1) and post-treatment (T2) OPGs of patients treated with mandibular 1st premolar extraction.
Group IV consisted of 15 pretreatment(T1) and post-treatment (T2) OPGs of patients treated with non- extraction in mandibular arch.
Results: *Premolar extraction had a favourable influence on third molar angulation and least changes with non-extraction cases. Statistical analysis showed that third molar angulation changes were less prominent in non-extraction and more in extraction cases ($p < 0.001$)*
The level of significance was set at 5% ($p<0.05$).
Conclusion: *Premolar extraction had a positive influence on the developing third molar angulations, and these improved angulations might favour third molar eruption. Non extraction cases did not have any adverse effects and third molar angulation were minimally improved or maintained.*
Keywords: *Third Molar, 1st premolar Extraction, Angulation, Horizontal reference plane*

I. Introduction:

The development of third molars and their influence on the dental arches has long been a concern to the dental profession[1]. Third molars hold unique position in the dentofacial complex because of their formation, development and evolution. Generally, they begin their formation at 8-9 years of age and emerge into the oral cavity around the age of 18-25 years[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[3]. The impaction rate is higher for the third molars than for any other teeth in modern populations. Reasons for impaction

are multifactorial but some common reasons are inadequacy of retromolar space, remodelling of ascending ramus. Also lack of compensatory periosteal apposition at the posterior outline of the maxillary tuberosities could prevent eruption of the maxillary third molar[4]. The impact of third molar eruption on mandibular incisor crowding has been the subject of many studies. It is important to know the status of third molars before formulating the orthodontic plan. Developing third molars continually change their angulation and undergo important pre-eruptive rotational movements[5,6]. These rotational movements take place when 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[5]. There is a strong possibility that appliance therapy that holds back the mandibular and maxillary third molars or actively tips them distally may have the effect of encouraging abnormal rotational movements of third molars and thereby increases the possibility of impaction[5]. On the other hand, extraction of premolars might cause favourable mesial movement and uprighting rotational changes in the developing third molars, thereby increasing the possibility of eruption. Extraction of premolars to allow mesial drifting of the buccal segment has been the subject of many investigations[5,7,8]. But with controversial results on third molar angulation[9]. The aim of the study is to determine whether extraction of premolars cause a favourable change in the third molar angulation and to compare it with non-extraction patients.

II. Materials and Method:

A Retrospective radiographic study on 60 orthodontic patients who had undergone orthodontic treatment in the Department of Orthodontics was done. Sample was divided into 4 groups.A power analysis was established by G*power, version 3.0.1 (Franz Faul universitat, Kiel, Germany). A sample size of 60 (15 per group) would yield 80% power to detect significant differences, assuming the effect size of 0.45 and significance level at 0.05.

Group I: 15 pretreatment (T1) and post-treatment (T2) OPGs of patients treated with 1st maxillary premolar extraction.

Group II: 15 pretreatment (T1) and post-treatment (T2) OPGs of patients treated with non-extraction in maxillary arch.

Group III: 15 pretreatment (T1) and post-treatment (T2) OPGs of patients treated with 1st mandibular premolar extraction.

Group IV: 15 pretreatment (T1) and post-treatment (T2) OPGs of patients treated with non- extraction in mandibular arch.

2.1 Inclusion criteria:

- Bilaterally unerupted mandibular molars seen on OPGs in mesioangular positions. Not more than two thirds of the root development of the third molars had taken place.
- Moderate Anchorage requirements.
- The total time in both extraction and non-extraction cases was between 18-24 months.
- Good quality pretreatment and post treatment OPGs in which a clear view and well defined ANS, Nasal septum and projection shadow of the palatine plane were clearly visible.

2.2 Exclusion criteria:

- Standard edgewise cases requiring anchorage preparation and absolute and maximum anchorage cases.
- Patients with second premolar extraction.
- History of previous orthodontic treatment.
- Poor quality radiographs.
- Patients with erupted third molars at start of the treatment.

The nasal septum and ANS were traced and bisected. A perpendicular line was drawn to this midline bisector that extend through Palatal shadow bilaterally. This constructed plane is termed the horizontal reference plane (HRP). The outline of the mandibular and maxillary third molar and their long axes were drawn on the tracing sheet. The long axis of maxillary and mandibular third molar buds were drawn by the line bisecting a line connecting the mesial and distal outlines of the cervical areas.

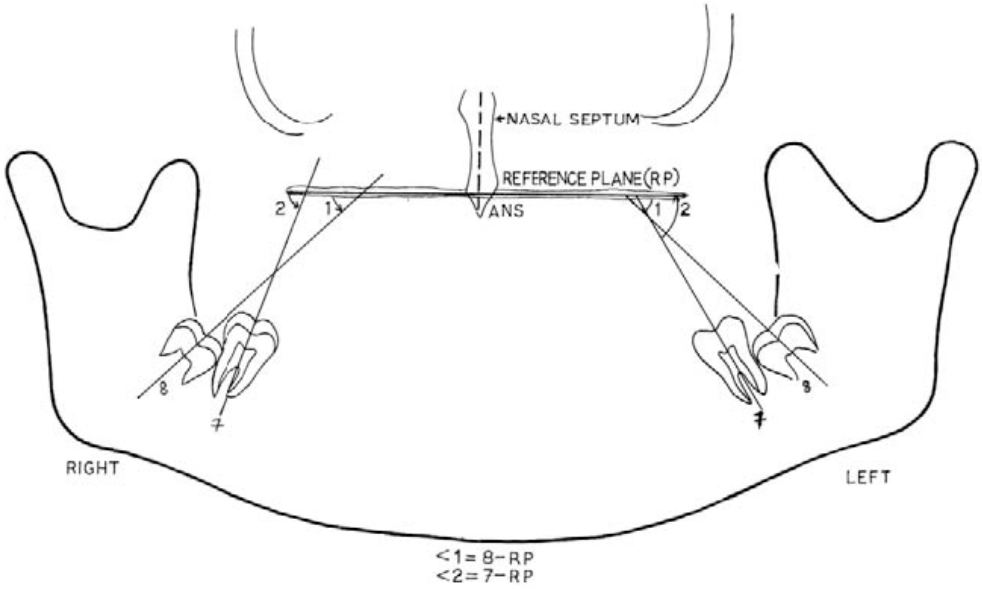

Fig. 1 : Diagram of Angulation Measurements.

Showing angulation measurements. 1) indicates mandibular third molar angulation to the horizontal reference plane (third molar to HRP); 2) mandibular second molar angulation to HRP (second molar to HRP)
Angles considered : 8 to HRP (Right and Left) – The outer angle formed by the maxillary third molar axes and mandibular third molar axes to the horizontal reference plane(HRP) both right and left side.An increase in angle between the mandibular third molar to the Horizontal reference plane (HRP), would indicate an improvement in the position of the mandibular third molar.An increase in angle between the maxillary third molar to the Horizontal reference plane (HRP), would indicate an improvement in the position of the maxillary third molar and are the measurements were done on right and left sides separately.

2.3 Statistical analysis:
SPSS (Statistical Package For Social Sciences) version 21. (IBM SPASS statistics [IBM corporation: NY, USA]) was used to perform the statistical analysis.
An independent sample t-test was used to compare quantitative parameters between groups, while a paired t-test was applied to compare parameters within groups at different time intervals (Pre vs Post), with the level of significance set at 5%.

III. Results:

Comparison of pre and post values of third molar angulation in maxillary extraction cases showed a statistically significant difference ($p<0.01$), while the comparison of pre and post values of third molar angulation in maxillary non-extraction cases (Table 1) showed no significant difference ($p>0.01$). Comparison of the pre-post changes in third molar angulation between maxillary extraction and maxillary non extraction cases showed statistically significant difference ($p<0.01$) (Table 2). The comparison of pre and post values of third molar angulation in mandibular extraction cases showed a statistically significant difference ($p<0.01$), while the comparison of pre and post values of third molar angulation in mandibular non-extraction cases (Table 3) showed no significant difference ($p>0.01$). Comparison of the pre-post changes between mandibular extraction and non-extraction cases represented in table 4 showed statistically significant difference($p<0.01$).

TABLE 1: COMPARISON OF THE PRE AND POST VALUES OF MAXILLARY EXTRACTION GROUP & PRE AND POST VALUES OF MAXILLARY NON-EXTRACTION GROUP USING PAIRED T TEST

Maxillary Extraction

Side	Time interval	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Right	Pre	15	33.0	83.0	65.27	13.04	-7.8	0.007*
	Post	15	36.0	87.0	73.07	12.01		
Left	Pre	15	50.0	93.0	67.67	12.54	-13.26	0.001*
	Post	15	70.0	96.0	80.93	8.92		

Maxillary Non-Extraction

Side	Time interval	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Right	Pre	15	49.0	75.0	62.47	9.64	-0.73	0.21
	Post	15	50.0	76.0	63.20	9.53		
Left	Pre	15	53.0	72.0	61.87	5.51	-0.40	0.11
	Post	15	54.0	73.0	62.27	5.43		

TABLE 2: COMPARISON OF THE PRE-POST CHANGES BETWEEN MAXILLARY EXTRACTION AND MAXILLARY NON-EXTRACTION

Side	Groups	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Right	Maxillary Extraction	15	-31.0	0.0	-7.80	9.57	-7.06	0.008*
	Maxillary Non-Extraction	15	-2.0	0.0	-0.73	0.70		
Left	Maxillary Extraction	15	-32.0	0.0	-13.27	10.83	-12.86	0.001*
	Maxillary Non-Extraction	15	-2.0	2.0	-0.40	0.91		

*significant

TABLE 3: COMPARISON OF THE PRE AND POST VALUES OF MANDIBULAR EXTRACTION GROUP & PRE AND POST VALUES OF MANDIBULAR NON-EXTRACTION GROUP USING PAIRED T TEST

Mandibular Extraction

Side	Time interval	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Right	Pre	15	26.0	88.0	52.27	15.64	-4.93	0.048*
	Post	15	36.0	89.0	57.20	14.27		
Left	Pre	15	33.0	78.0	50.07	15.55	-5.60	0.002*
	Post	15	35.0	82.0	55.67	14.85		

Mandibular Non-Extraction

Side	Time interval	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Right	Pre	15	30.0	81.0	50.53	14.49	-1.73	0.123
	Post	15	30.0	82.0	52.27	15.05		
Left	Pre	15	24.0	85.0	48.73	16.02	-1.53	0.144
	Post	15	26.0	84.0	50.27	14.66		

TABLE 4: COMPARISON OF THE PRE-POST CHANGES BETWEEN MANDIBULAR EXTRACTION AND MANDIBULAR NON-EXTRACTION

Side	Groups	N	Minimum	Maximum	Mean	S.D	Mean diff	p value
Right	Mandibular Extraction	15	-26.0	12.0	-4.93	8.83	-4.02	0.039*
	Mandibular Non-Extraction	15	-9.0	0.0	-1.73	3.63		
Left	Mandibular Extraction	15	-18.0	0.0	-5.60	5.78	-4.06	0.031*
	Mandibular Non-Extraction	15	-11.0	1.0	-1.53	3.83		

*significant

IV. Discussion:

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[10]. Modern population has higher frequency of impaction of third molars than primitive ones, because people usually eat soft and sophisticated diets that require minimal chewing forces. The end result is minimal interproximal attrition and mesial shift of posterior teeth, leading to inadequate retromolar space [11].

Cephalometric growth studies suggest 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. 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[12].

The purpose of this study was to evaluate the effect of first premolar extraction, and non-extraction on maxillary and mandibular third molar angulations using OPG. Measurements of third molar angulations on lateral cephalograms, as seen in previous studies, may be biased because of differences in angulation between the superimposed images. Similar problems are present in any cephalometric study of changes in posterior tooth positions and can only be overcomed if measurements are made on 60-degree head films of the left and right sides, as shown by Richardson[13]. However, studies have shown that panoramic radiographs are a reliable indicator in evaluating third molar positions, and so they were used in the present study[10,14]. Previous studies have used the occlusal plane and mandibular plane as the horizontal plane of reference to measure treatment changes.

Third Molar impaction is a clinical problem, if third molar eruption can be predicted at an early age during the course of orthodontic treatment, then later occurrences of difficult impactions can be avoided. The subjects of this study ranged in age from 13 to 16 years, during this time, the third molar bud is developing and is undergoing important rotational pre-eruptive movements[5,15]. Therefore, patients in this age group were selected to determine whether the treatment technique (extraction or non-extraction) had any favourable effect on the rotational, uprighting, and pre-eruptive movements taking place at that time[16].

The study results showed that comparison of pre- and post-values of third molar angulation in maxillary extraction group demonstrated an improvement in third molar angulation on both the right(7 degree) and left sides (9 degree) whereas comparison of pre and post values of third molar angulation in maxillary non-extraction group showed no improvement in third molar angulation. The results are in favour of Behbehani F, Artun J, ThalibL (2006)[8] who found a significant improvement in third molar angulation following extraction treatment on both the right (6.3 degrees) and left (8.2 degrees) sides and Similar uprighting or improvements in third molar angulations with extraction of premolars was also reported by Mustafa Yigit and Saysel et al[1].

The study results showed that in non-extraction cases, the angulation of the third molar increased, although the increase was minimal (1.9 degree) on right side and (2.3) on left side and was satistically insignificant. The results are in favour of Jain S (2009)[16] and Gohilot A who also reported minimum increase in third molar angulation on the right side(1.7 degrees) and on the left side(1.3 degrees). Hence, the third molar angulations were more or less maintained in all cases and showed very minimal improvement when treatment was done with the non-extraction technique**.**

The study results also indicated an improvement in the angulation of third molars when comparing pre- and post values in the mandibular extraction group on right side (4 degree) & on left side (6 degree). The results are in agreement with Tae-Woo Kim et al and Saysel et al who determined that orthodontic treatment involving premolar extractions improves mandibular third molar angulation. However, Staggers and Staggers et al[9] found contradictory results in mandibular third molar angulation after first premolar extraction. They concluded that premolar extraction therapy reduced the frequency of third molar impaction.

The study results indicated minimal or no changes in the angulation of the mandibular third molars in non-extraction cases on right side(1.9 degree) and on left side(2.3 degree). The results are in accordance with Gohilot A et al. (2012)[17] who showed that in non-extraction group, mandibular third molar angulation increased minimally 0.3 ±8 on right side and 1.2 ± 9 on left side which were not statistically significant. The probable reason for minimal changes taking place in the absence of extractions could be attributed to the growth taking place in the retromolar area. However, Yigit et al (2005)[18] showed a worsening of mandibular third molar angulations with non-extraction treatment. The probable reason for the same could be that non-extraction therapy, by holding back or distally tipping the mandibular first and second molars, increased the chances of third molar impaction.

The study results showed that in the extraction group, the angulation of the maxillary third molars increased by 3 degrees on the right side and 4.5 degrees on the left side, while the angulation of the mandibular third molars increased by 6.5 degrees on the right side and 7.2 degrees on the left side, with these changes being statistically significant. The results are supported by Bayram M et al[11] and Moffitt who concluded that the 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.

So, the current study results support findings that a large third-molar eruption space and increased eruption space due to mesial molar movement after premolar extraction can reduce the risk of third-molar impactions.

Clinical implications

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. Hence, this aspect of dental practice needs to be more widely appreciated in the planning of treatment for children. Although it is not possible to predict the success rate of eruption of third molars, it is clear that the improved positions would facilitate surgery for many of those teeth that did ultimately require removal. So it is recommended that third molar angulations be included in the treatment planning of borderline extraction cases.

Conclusions:

- Premolar extractions had a positive influence on the developing third molar angulations, and these improved angulations might favour third molar eruptions later in life.
- Non-extraction therapy did not have any adverse effects, however third molar angulations were minimally improved or maintained.

Limitations:

Large sample is required and follow up are required as to evaluate third molar eruptions.

Data Availability Statement

The whole data that support the findings of this study are available from the corresponding author upon request.

Patient Consent

Written informed consent was obtained from all patients included in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Dr. Narute Annaso Sarjerav collected and scored the data. Dr. Eenal Bhambri, Dr. Ankit Bharadwaj, Dr. Abin Mathew Thomas, Dr. Arun Raj RG analyzed the data. Dr. Eenal Bhambri, Dr. Narute Annaso Sarjerav, Dr. Priyangka Yambem led the writing. All authors contributed to writing the manuscript.

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