"EFFECTS OF RAPID MAXILLARY EXPANSION ON MAXILLARY THIRD MOLAR ANGULATION AFTER ORTHODONTIC THERAPY – A RETROSPECTIVE COHORT STUDY"

By

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LIST OF ABBREVIATIONS

RME	:	Rapid Maxillary Expansion
OPG	:	Orthopantomogram
°	:	Degree
FH plane	:	Frankfort Horizontal Plane

ABSTRACT

INTRODUCTION:

Teeth have been known to become impacted when they fail to erupt or develop in their exact functional location, third molar is the most common impacted tooth.

The third molar buds are angulated distally in the maxilla during of calcification. During its course of normal development it changes its direction from horizontal to mesioangular and then finally vertical. If the change from mesioangular to vertical direction does not take place it leads to crowding in the arch and the tooth remains impacted.

Another important reason for the tooth to remain impacted is the inadequate space present in the posterior region of the maxilla.

Rapid maxillary expansion is a treatment procedure commonly used for growing patients in an attempt to correct maxillary constriction. This procedure is known to increase the width of the maxilla because of the separation of the palatine bones through the opening of the midpalatal suture, and buccal inclination of the alveolar bone and molars. This activation force is not only capable of acting on the midpalatal suture, but also on the circum-maxillary sutures.

Rapid maxillary expansion not only helps in the correction of the malocclusion by increasing the arch perimeter but also provides enough space for the maxillary third molars to erupt.

There have been very few studies conducted to evaluate the effects of rapid maxillary expansion on the third molar angulation. Since the impaction of the third molars is also due to the space constraint in the maxillary arch, expansion overcomes this problem and therefore this study was conducted.

AIM:

To evaluate and compare the effects of rapid maxillary expansion treatment and non treated patients on third molar angulation.

MATERIALS AND METHODS:

The study was a retrospective cohort study conducted on 38 patients who had reported to the Department of Orthodontics and Dentofacial Orthopaedics, KLE Academy of Higher Education and Research, (KAHER) KLE V.K Institute of Dental Sciences, Belagavi. Pre-treatment and post-treatment orthopantomograms of patients who underwent rapid maxillary expansion followed by orthodontic therapy and those who refused orthodontic treatment were traced manually. The outer angle formed by the long axis of the molar teeth on the left and right side to the Frankfort Horizontal Plane were entered and scrutinized using SPSS (Statistical Package For Social Sciences Cooperation, Chicago USA) version 25. Further, descriptive and inferential analysis was done to reach a final conclusion.

RESULTS AND CONCLUSION:

The post-treatment mean value for third molar was 61º on the right side and 77º on the left side. The difference between pretreatment and post-treatment on the right as well as left side for third molar was found to be statistically significant. A similar result was observed with respect to comparison of third molar with and without intervention as well.

KEYWORDS: Rapid Maxillary expansion, Third molar angulation, Orthopantomograms , Radiographs

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INTRODUCTION

Third molar has many varying features ranging from the time of its development, calcification, its crown and root morphology, its course of eruption,final position and also presence or absence in the oral cavity. They are related to orthodontic treatment due the possibility of their eruption and/ or impaction due to genetic factors which manipulate planning of orthodontic treatment.[1]

Tooth impaction can be defined as a pathological condition due to which the tooth fails to erupt or develop in its normal functional position.[2] Third molars can also be impacted which means they are covered by soft tissue and/or jawbone or they only partially break through/erupt through the gingiva/ periodontium. It provides a breach for bacteria to enter around the tooth which can cause infection resulting in pain, swelling, stiffness amongst other complications[3] like periodontitis, cystic lesions, root resorption and it could even cause detrimental effects on the adjacent tooth.[2]

In today's contemporary population the third molar is one of the most commonly found impacted tooth. Eruption of the third molars varies on the basis of the genetic features , feeding pattern of the individual,functionality of the teeth and racial variability[4.] Prevalence of third molar ranges between 17-69%. Studies have reported no sex predilection in the impaction of third molars.[2,5]

The upper third molars can erupt in three planes of direction downwards, backwards and forwards. This movement if often delayed leads to their impaction.

The third molar tooth bud starts developing in a horizontal direction which later changes to a mesioangular direction and finally to vertical as the tooth continues to develop along with the growth of the jaws.

The mean age of eruption can be between 20-23 years but can also continue upto the age of 25 years in a few individuals. [6]

These teeth find it hard to occupy their place in the dental arch due to the inadequate space present for them , the variations in dentition and the eruption patterns also including the distance travelled by them and the direction varied from other teeth.[4]

It is established that third molar eruption not only leads to incisor crowding, but also buccal or lingual inclination of the second molars.[7]

A clinician who treats dental abnormalities due to abnormal tooth eruptions (due to genetic and acquired disorders) needs sufficient knowledge of basic eruption patterns and basic molecular mechanisms such as osteoblast-specific transcription factor, CBFA1 (RUNX2). Another reason for the impaction of maxillary third molar is the presence of bone juxtaposition at the maxillary tuberosity region and in the mandibular arch it can be due to the incomplete resorption of bone at the mandibular ramus region.[1]

When the impaction of third molars was co related to the skeletal facial types it was seen that the patients with a horizontal growth pattern had a lower incidence of impacted mandibular third molars when compared to the vertical growth pattern.[8]

In a study conducted by Niedzielska et al it was stated that the decrease in the arch length of the lower jaw led to crowding of the teeth and it was also associated to the insufficient space available for the third molars to erupt .[7]

In a normal stable occlusion the relationship between the arches should be such that the maxillary arch is wider than mandibular arch. Maxillary width deficiency therefore should be corrected in patients of any age by an orthodontist.[9]

To correct maxillary constriction in growing patients the different expansion procedures that can be carried out are slow , rapid or surgically assisted. The type of skeletal and dental pattern of the patient helps in determing the type of expansion that has to be carried out.

Expansion causes increase in the transverse width which is due to the palatine bones being separated because of the opening of the midpalatal suture and buccal inclination of the alveolar bone and molars.[10]

The posterior teeth undergo a change in their axial inclination due to the opening of the midpalatal sutures which leads to the alveolar processes to bend in a lateral direction and the palatal shelves drop in a inferior direction along with the compression of the periodontal membrane.[11]

This procedure increases the arch perimeter and helps in correction of crowding in the maxillary arch.[12]

Rapid maxillary expansion treatment procedure compensates the space required for the eruption by increasing the arch perimeter and also increases the emphasis on non extraction treatment planning.[4]

There have been very few studies conducted to evaluate the effects of rapid maxillary expansion on the third molar angulation. Since the impaction of the third molars is also due to the space constraint in the maxillary arch, expansion overcomes this problem and therefore this study was conducted.

AIM AND OBJECTIVES

AIM:

To evaluate and compare the effects of rapid maxillary expansion treatment and non-treated patients on third molar angulation.

OBJECTIVES:

- To evaluate the changes in the maxillary third molar angulation following rapid maxillary expansion.
- To evaluate the changes in the maxillary third molar angulation in non-treated patients.
- To compare the changes in the maxillary third molar angulation following rapid maxillary expansion and non-treated patients.

REVIEW OF LITERATURE

Golovcencu et al (2019)[13] studied the maxillary third molar using orthopantomograms and found out that the eruption of the third molars was favorable in cases of molar or premolar extractions. The uncertainty of the third molar eruption could also lead to orthodontic relapse. They also stated that maxillary third molar impaction was determined by the insufficient space available due to the insufficient development of the maxillary tuberosity or the small size of maxilla.

D'Souza et al (2015)[14] stated that the current practices in the orthodontic field have shifted towards practice of dentofacial orthopedics. Therefore they conclude that rapid maxillary expansion increased the intercanine width and the amount of relapse seen from post expansion to post treatment was found to be statistically insignificant.

Akkaya et al (1998)[15] also advocated the application of expansion protocols so that the extraction of healthy teeth could be avoided. In the study it was seen that the inter-premolar width change was same as the inter-molar width.

Berlocher et al (1979)[16] in their study concluded that palatal expansion would lead to an improvement of the arch perimeter to tooth size discrepancy.

Adkins et al (1990)[12] concluded that transverse expansion of the alveolar and dental arches can be brought about by rapid maxillary expansion compensating for the arch perimeter deficiencies

Gohilot et al (2012)[5] evaluated changes in third molar angulation to a horizontal reference plane, in patients treated with or without premolar extractions. They found improvements in maxillary third molar angulation in the extraction group, thus

concluding that while non-extraction therapy did not seem to have any adverse effects, premolar extractions certainly had a positive influence on the developing maxillary third molar angulations on both sides. Third molars may be influenced by factors other than premolar extractions. They also found that during development of third molars they undergo change in their angular position and also undergo rotational movements when the third molar tooth bud comes in close proximity to the second molar.

Sokucu et al (2008)[6] conducted a study to determine whether rapid maxillary expansion affected the angulation of the upper third molars using lateral and frontal cephalograms and found a significant difference in the angular changes in the group undergoing maxillary expansion.

Kim at al (2003)[17] found favorable changes in the patients who underwent premolar extractions which lead to reduced impaction rate of the maxillary and mandibular third molar. This occurred due to the mesial movement of the teeth in the space created by extraction.

Artun et al (2005)[18] found that maxillary third molar angulation improves in patients treated with premolar extractions whereas no appreciable changes were observed in mandibular third molar angulation. They also found "more than 30˚ distal angulation as well as an amount of mesial angulation of the upper third molars post treatment and a better frequency of greater than 40 ˚ mesial angulation of the mandibular third molars post treatment in patients with impaction than in those with eruption", indicating that these angulations may be potential risk factors for third molar impaction.

Jain et al (2019)[19] stated that the Panoramic radiograph orthopantomogram (OPG) is the technique of choice for the evaluation of third molar impaction with regard to the angulation of the impacted tooth, the amount of bone covering the tooth and the level of impaction.

According to **Sokucu et al (2008)**[6] the uprighting of the third molar post the rapid maxillary expansion treatment is due to the increase in the arch perimeter which leads to the vertical eruption of the molars in the retention phase.

Weyrich C et al (2010)[20] formulated that rapid maxillary expansion was the only method that could be used to expand the midpalatal suture in patients with transverse constriction of dental arch along with unilateral or bilateral crossbite. This treatment could be performed on patients within the pubertal growth spurt which was considered the ideal time for the expansion as the suture ossifies after puberty and the expansion procedure is difficult post this phase.

Garrett et al (2008)[21] stated that skeletal expansion of the maxilla occurs in a triangular pattern with the wider base in the anterior region making up for 55% of the total expansion occurring at first premolar region, 45% at the second premolar region and 38% at the first molar region.

Tendulkar et al (2021)[22] in their study found significantly more skeletal changes in terms of increase in mandibular length and consequently a significant improvement in the space available for lower third molar eruption as well as in the third molar angulation following treatment with fixed twin block.

MATERIALS AND METHODS

STUDY DESIGN:

Retrospective Cohort study

SOURCE OF DATA:

The study will be done on pre-treatment and post treatment orthopantomograms of patients who were treated in the Department of Orthodontics and Dentofacial Orthopaedics, KLE Academy of Higher Education and Research , KLE VK Institute of Dental Sciences, Belagavi.

MATERIAL REQUIRED:

- Pre and post treatment orthopantomograms
- Acetate matte sheets
- Lead pencil (0.35 mm)
- Scale
- Set squares
- Protractor
- View box

INCLUSION CRITERIA:

- Patients in the age group of 14-19 years
- Patients who have undergone rapid maxillary expansion treatment followed by fixed mechanotherapy
- Patients with radiographically confirmed upper third molars

- Both male and female patients

EXCLUSION CRITERIA:

- History of orthognathic surgical treatment
- History of extracted or missing permanent teeth as seen in the orthopantomogram
- Congenitally missing maxillary third molars as seen in the orthopantomogram
- Presence of any developmental anomalies, dentofacial deformities or severe facial asymmetries

SAMPLE SIZE ESTIMATION:

Sample size for the study was calculated as 19 subjects in each group (Rapid maxillary expansion using hyrax and non-orthodontically treated patients) with a total of 38 subjects, based on the formula

$$N = \frac{2\,(S)^2 (Z_{1-\alpha/2} + Z_{1-\beta})^2}{d^2}$$

Where standard deviation

$S_1 = 5.53$ $S_2 = 4.46$

d=detectable mean difference= 5.54

$Z_{1-\alpha} = 1.96$ at 5% α error

$Z_{1-\beta} = 1.282$ at 90% power

So the estimated sample size is **19** per group, which makes the sample size **38** in total.

DETAILS OF THE PROCEDURES TO BE CONDUCTED DURING THE RESEARCH

Patients will be divided into two equal groups

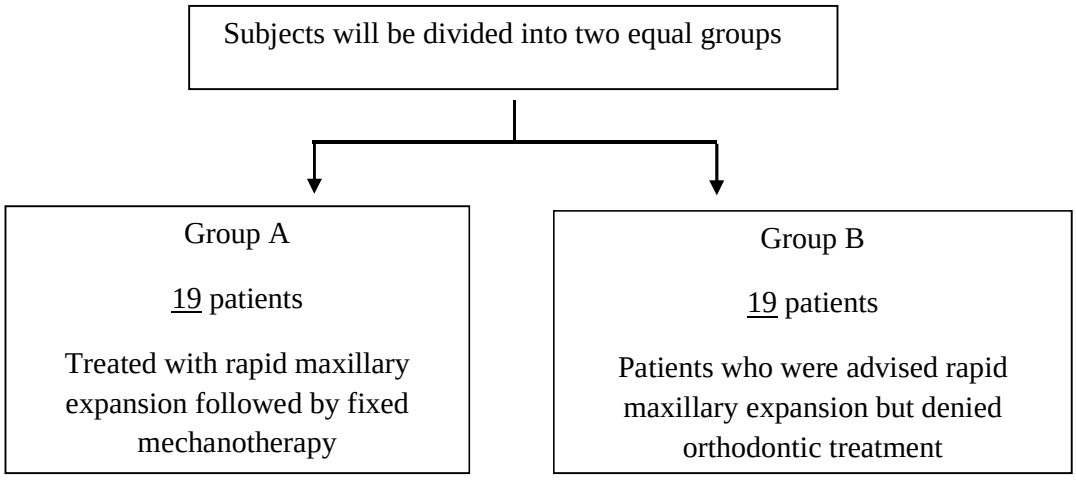
- Group A: 19 patients treated with rapid maxillary expansion followed by fixed mechanotherapy.
- Group B: 19 Patients who were advised rapid maxillary expansion but denied orthodontic treatment.

Pretreatment and post treatment orthopantomograms will be traced on lead acetate paper and reference plane constructed in this study is Frankfort Horizontal Plane (FH Plane).

The outlines of the maxillary first, second and third molars and their long axes are drawn on the tracing sheet. The long axis of the first and second molar is traced from the midocclusal point through the midpoint of the root bifurcation and the midpoint between the mesial and distal root tips. The long axis of the third molar are also traced.

The outer angles formed by the three molar axes to the Frankfort Horizontal Plane on both the right and left sides are marked and measured using a protractor. An increase in the angle of the third molar to the Frankfort Horizontal Plane, would indicate an improvement in the position of the third molar after the rapid maxillary expansion.

METHODOLOGY:



Pre and Post treatment standardized orthopantomograms taken in natural head position, with teeth in centric occlusion and lips in relaxed position will be collected

⬇

Acetate sheet will be placed on top of the radiograph and the landmarks including the molars present in the maxilla and the mandible will be traced

⬇

The reference plane is taken to be the Frankfort Horizontal Plane , it is the line joining the lower contour of orbit and external auditory meatus

⬇

The outer angles formed from the long axes of the molars to the Frankfort Horizontal Plane will be measured

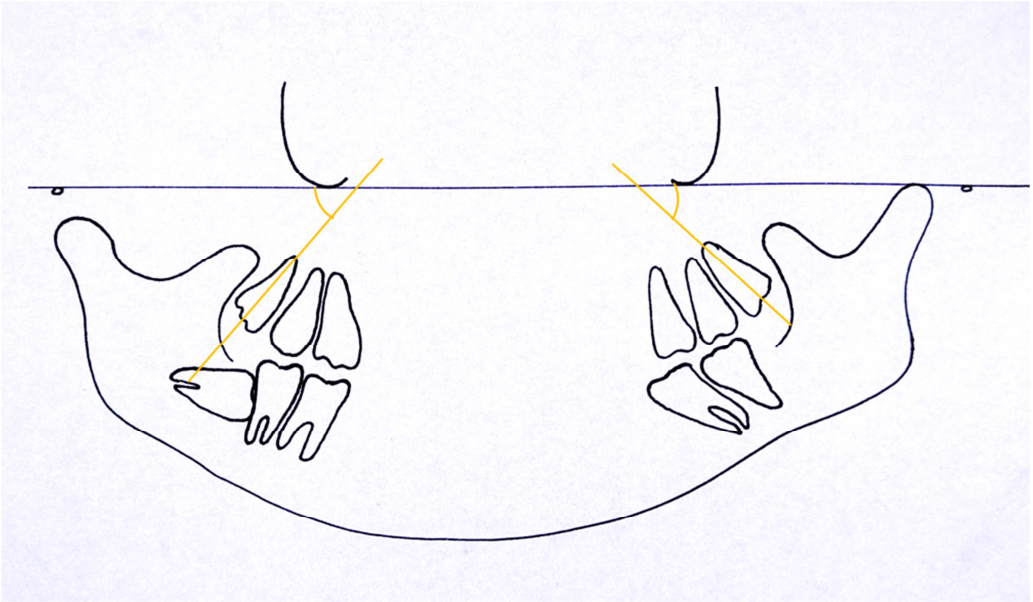


Figure 1 : OPG tracing showing the long axis of the right and left third molar and the outer angles formed by the long axis of the third molar and the Frankfort Horizontal Plane on both right and left sides.

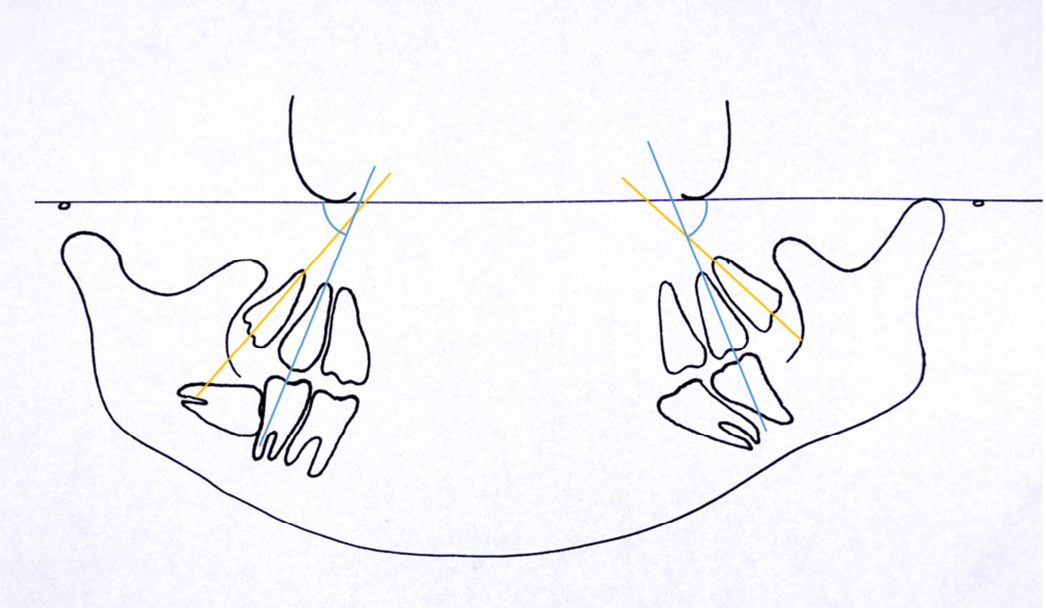


Figure 2 : OPG tracing showing the long axis of the right and left second molar and the outer angles formed by the long axis of the second molar and the Frankfort Horizontal Plane on both the right and left sides.

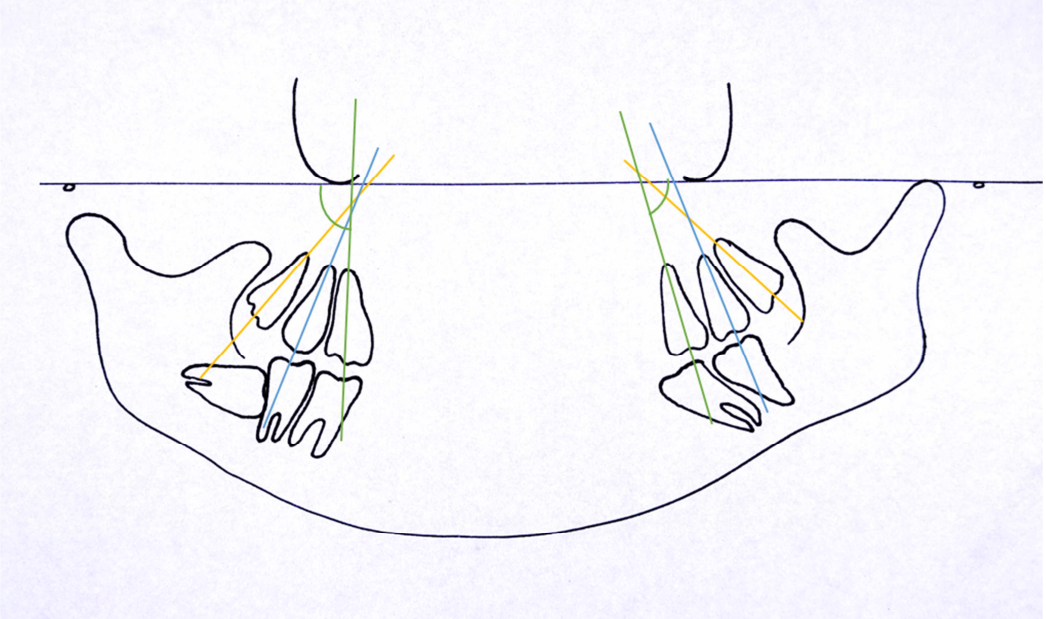


Figure 3 : OPG tracing showing the long axis of the right and left first molar and the outer angles formed by the long axis of the first molar and the Frankfort Horizontal Plane on both the right and left sides.

The following table will be made to mention the measurement of the angles for both Group A and Group B subjects :-

Variable	Right		Left	
	Pre	Post	Pre	Post
FH Plane to 3rd molar (Figure 1)				
FH Plane to 2nd molar (Figure 2)				
FH Plane to 1st molar (Figure 3)				

STATISTICAL TEST:

1. Independent t- test
2. Dependent t-test

RESULTS

1) DESCRIPTIVE STATISTICS

Table 1 - Descriptive statistics of the angle of different teeth pre and post-intervention on the Right side

Tooth number		N	Minimum	Maximum	Mean	Std. Deviation
Third molar (^{o})	Pre	19	32.00	95.00	52.63	16.73
	Post	19	47.00	95.00	61.95	13.39
Second molar(^{o})	Pre	19	46.00	92.00	68.39	14.08
	Post	19	42.00	81.00	67.11	11.69
First molar (^{o})	Pre	19	66.00	96.00	81.00	7.86
	Post	19	70.00	89.00	79.37	6.06

Table 1 denotes the descriptive statistics of the three molar teeth on the right side of the upper jaw and the pre and post intervention values are presented in the form of mean and standard deviation. The pre-treatment values of third molar, second molar and first molar were 52.63 ± 16.73, 68.39 ± 14.08 and 81.00 ± 7.86 respectively. The post-treatment values of the same were 61.95 ± 13.39, 67.11 ± 11.69 and 79.37 ± 6.06.

Table 2 – Descriptive statistics of the angle of different teeth pre and post-intervention on the Left side

Tooth number		N	Minimum	Maximum	Mean	Std. Deviation
Third molar (^{o})	**Pre**	19	60.00	93.00	79.26	10.31
	Post	19	66.00	89.00	77.68	7.39
Second molar (^{o})	**Pre**	19	56.00	81.00	67.47	7.18
	Post	19	54.00	77.00	66.52	7.27
First molar (^{o})	**Pre**	19	45.00	69.00	50.26	19.51
	Post	19	42.00	80.00	60.11	13.62

The descriptive statistics of the first, second and third molar on the left side on the upper jaw has been depicted in **Table 2**. The pre and post treatment mean and standard deviation of third molar were 79.26 ± 10.31 and 77.68 ± 7.39 respectively. Similarly, the pre and post treatment mean and standard deviation of second molar were 67.47 ± 7.81 and 66.52 ± 7.27. For the first molar, pre and post-treatment values for mean and standard deviation values 50.26 ± 19.51 and 60.11 ± 13.62 respectively.

Table 3 - Descriptive statistics of the angle of different teeth that were untreated on the Right side

Tooth number	N	Minimum	Maximum	Mean	Std. Deviation
Third molar (^{o})	19	31.00	89.00	59.47	17.59
Second molar (^{o})	19	56.00	86.00	72.53	7.55
First molar (^{o})	19	66.00	102.00	83.58	9.24

Table 3 provides certain descriptive values like the minimum, maximum, mean and standard deviation of the three molar teeth that were untreated on the right upper side of the jaw in terms of their angles. The mean and standard deviation for the third molar was 59.47 ± 17.59, while the value for second molar was 72.53 ± 7.55 and for first molar it was 83.58 ± 9.24.

Table 4 – Descriptive statistics of the angle of different teeth that were untreated on the Left side

Tooth number	N	Minimum	Maximum	Mean	Std. Deviation
Third molar (^{o})	19	62.00	97.00	84.47	8.53
Second molar (^{o})	19	42.00	90.00	73.89	11.61
First molar (^{o})	19	33.00	79.00	54.89	12.38

The descriptive statistics of the angle of the teeth that were untreated on the left side of the upper jaw was denoted using minimum, maximum, mean and standard deviation and represented in **Table 4**. For the third molar, the mean and standard deviation was 84.47 ± 8.53 and for second molar and first molar, the value was 73.89 ± 11.61 and 54.89 ± 12.38 respectively.

2) PRE AND POST COMPARISON USING PAIRED T-TEST

Table 5 – Pre and post-intervention comparison of angle amongst different teeth on the Right side

Right side		Mean difference	Paired t-test		
			t value	df	p value
Pair 1	**Third molar: Pre vs Post-intervention**	-9.31	-5.768	18	0.000*
Pair 2	**Second molar: Pre vs Post-intervention**	1.26316	0.393	18	0.699
Pair 3	**First molar: Pre vs Post-intervention**	1.63158	0.778	18	0.446

*p value <0.05 statistically significant

The comparison of the angles of the three molar teeth on the right side of the upper jaw between pre-intervention and post-intervention was done using Paired t-test and the result has been depicted in **Table 5**. A statistically significant difference was noted for the third molar only (p=0.000) with a mean difference of -9.31. A statistically significant difference was not found with respect to the second and first molar, although the mean difference was 1.26316 and 1.63158 respectively.

Table 6 – Pre and post-intervention comparison of angle amongst different teeth on the Left side

Left side		Mean difference	Paired t-test		
			t value	df	p value
Pair 1	**Third molar: Pre vs Post-intervention**	1.57895	0.802	18	0.043*
Pair 2	**Second molar: Pre vs Post-intervention**	-0.05263	-0.028	18	0.978
Pair 3	**First molar: Pre vs Post-intervention**	-2.35294	-0.807	18	0.431

*p value <0.05 statistically significant

Table 6 provides the data for comparison of pre and post intervention angles among the three molar teeth on the left side of the upper jaw using Paired t-test. The mean difference of 1.57895 was found to be statistically significant with respect to the third molar (p=0.043). However, a dissimilarity was seen with respect to the second and first molar and their differences were not found to be statistically significant.

3) COMPARISON BETWEEN INTERVENTION AND NO INTERVENTION USING UNPAIRED T-TEST

Table 7 – Comparison of angle between intervention and NO intervention amongst different teeth on the Right side

Right side		Mean difference	Unpaired t-test		
			t value	df	p value
Pair 1	**Third molar: Intervention vs NO intervention**	2.47368	0.488	18	0.050*
Pair 2	**Second molar: Intervention vs NO intervention**	-5.42105	-1.698	18	0.278
Pair 3	**First molar: Intervention vs NO intervention**	-4.21053	-1.660	18	0.160

*p value <0.05 statistically significant

Comparison of the angles of the molar teeth between the intervention and No intervention group on the left side was conducted using an unpaired t-test and was denoted in **Table 7.** The result with respect to the third molar teeth only was found to be statistically significant (p=0.05). The mean difference for the first and second molar was not found to be statistically significant.

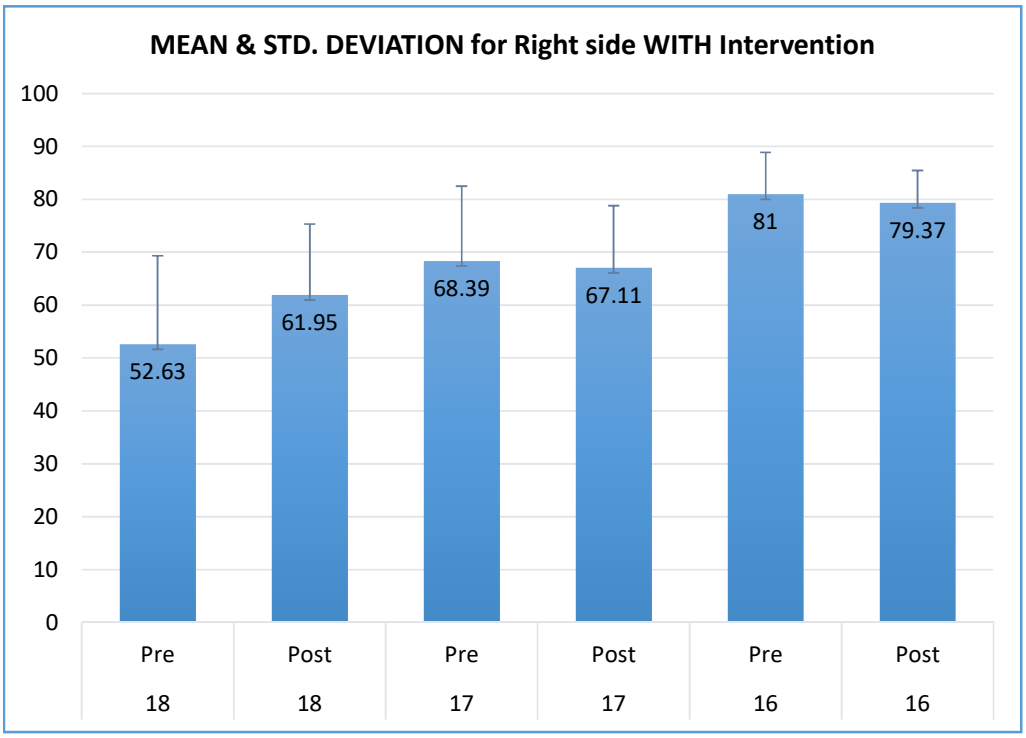
Table 8 – Comparison of angle between intervention and NO intervention amongst different teeth on the Left side

Left side		Mean difference	Unpaired t-test		
			t value	df	p value
Pair 1	**Third molar: Intervention vs NO intervention**	2.78947	0.890	18	0.002*
Pair 2	**Second molar: Intervention vs NO intervention**	-6.36842	-2.026	18	0.083
Pair 3	**First molar: Intervention vs NO intervention**	-4.36842	-6.608	18	0.314

*p value <0.05 statistically significant

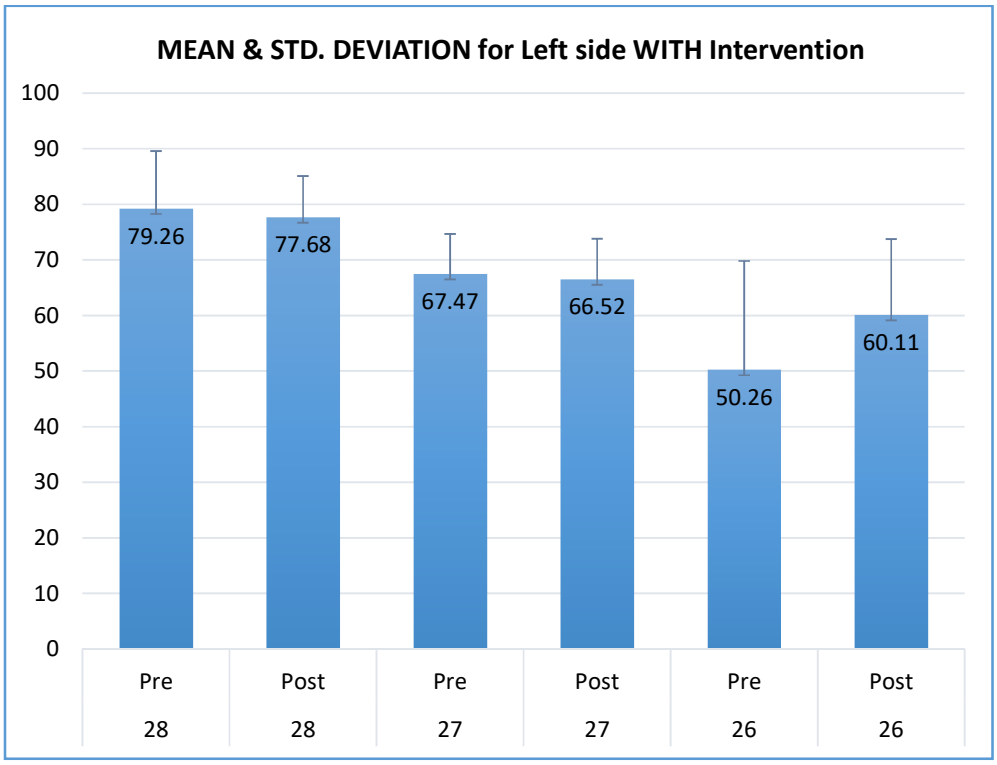
Table 8 provides the results of the comparison between intervention and NO intervention amongst the three molar teeth on the left side of the jaw, which was conducted using unpaired t-test. The mean difference for the third molar tooth was found to be statistically significant (p=0.002). However, a statistically significant difference was not found for the first and second molar teeth.

GRAPHS



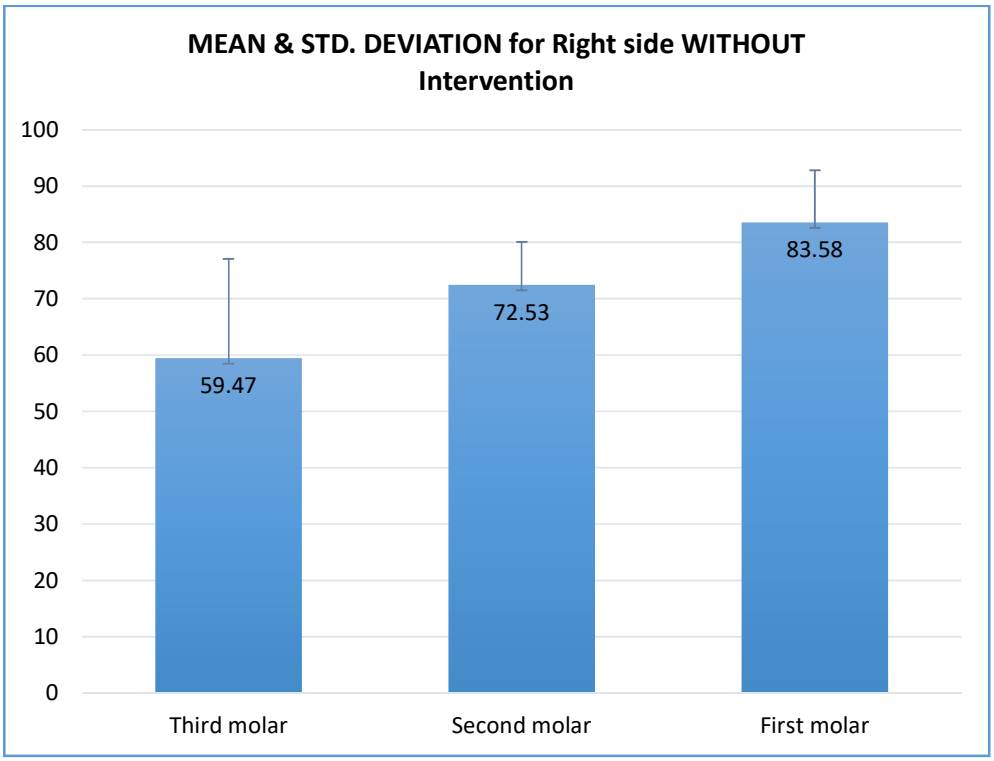
Graph 1: Descriptive statistics of the angle of different teeth pre and post-intervention on the Right side

Graph 1 denotes the descriptive statistics of the angles of all the teeth at pre-intervention and post-intervention stage on the right side of the jaw. For the 1st, 2nd and 3rd Molar, the pre-intervention mean values are 52.63, 68.39 and 81 degrees respectively. The post-intervention values are 61.95, 67.11 and 79.37 degrees for the three teeth.



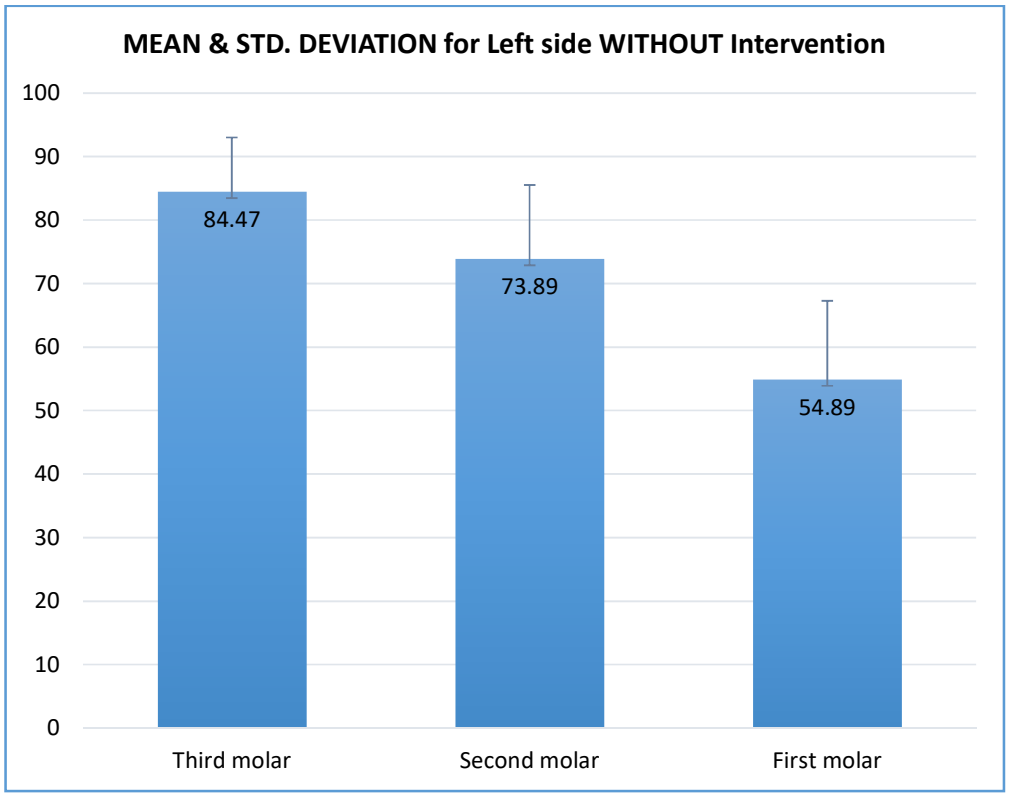
Graph 2: Descriptive statistics of the angle of different teeth pre and post-intervention on the Left side

Graph 2 depicts the descriptive statistics of the angles of different teeth at the pre and post intervention stage on the left side of the upper jaw. The pre-intervention value for the third molar was 79.26 degrees while the post-intervention value was 77.68 degrees. Similarly, for the second molar, the pre-intervention value was 67.47 degrees and the post-intervention value was 66.52 degrees. For the 1st molar, the pre-intervention value was 50.26 degrees and the post-intervention value was 60.11 degrees.



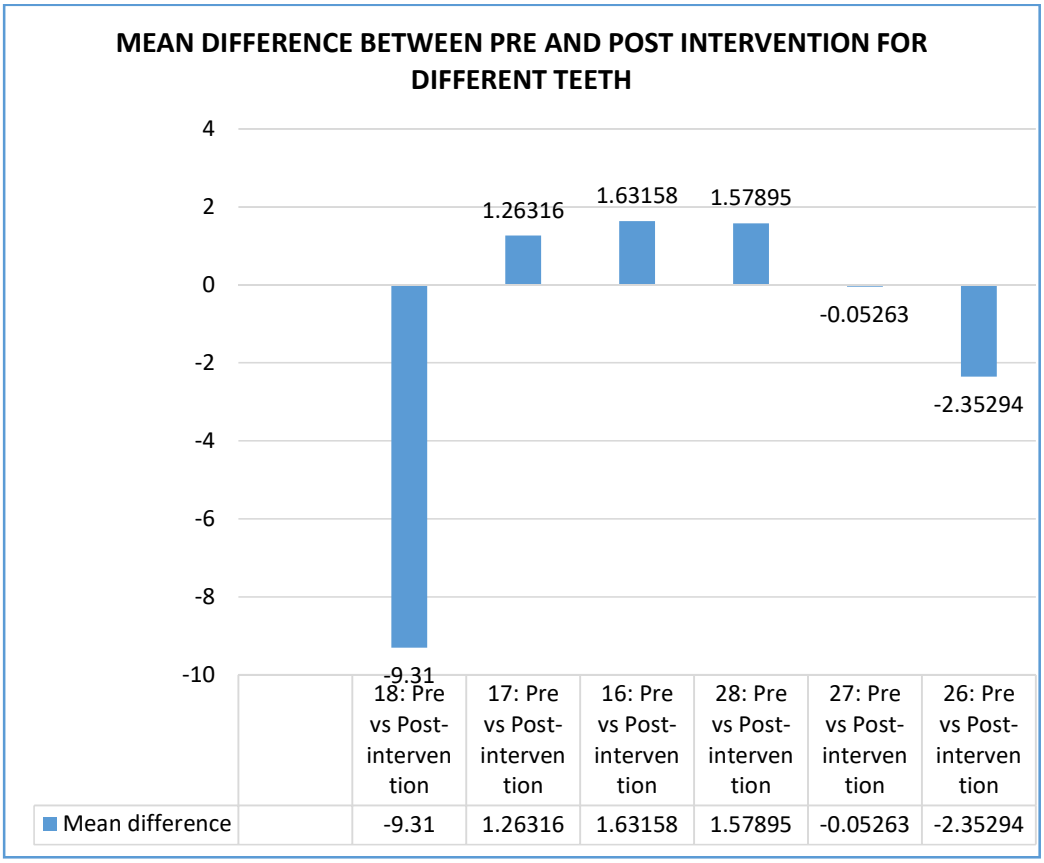
Graph 3: Descriptive statistics of the angle of different teeth that were untreated on the Right side

The descriptive statistics of the angles of the first, second and third molar on the right side of the untreated jaw has been denoted in **Graph 3**. The mean value for 3rd molar, 2nd molar and 1st molar are 59.47, 72.53 and 83.58 degrees respectively.



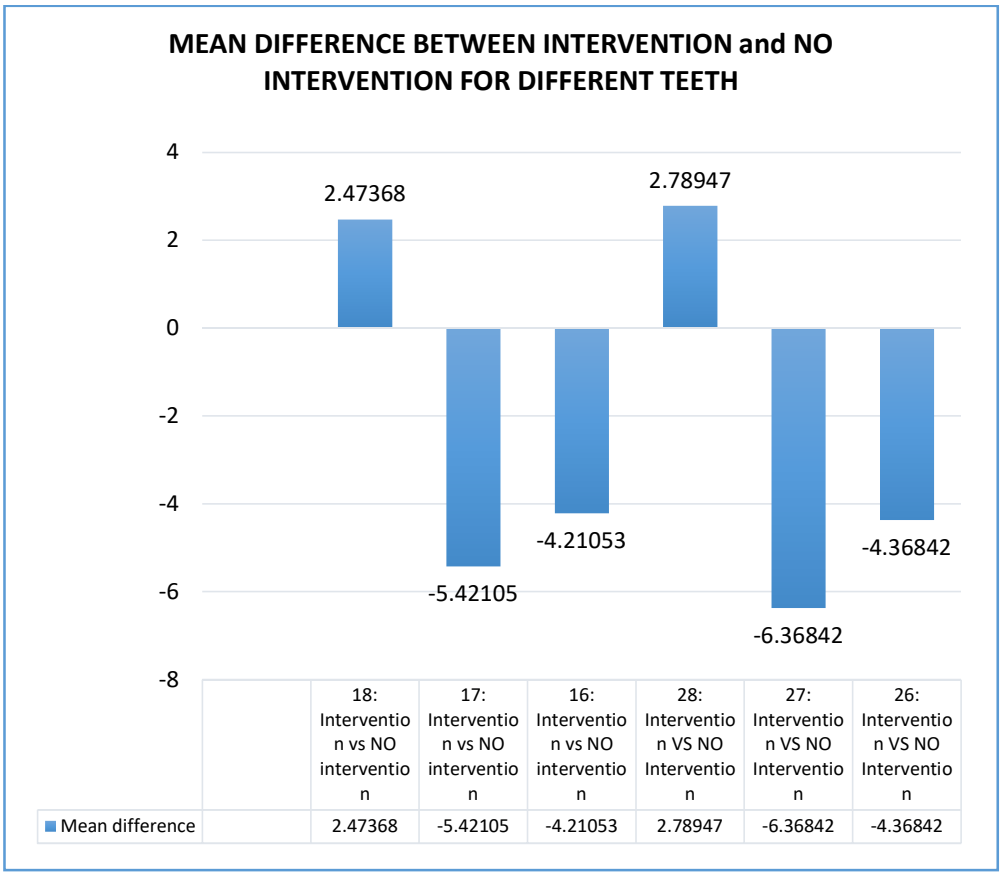
Graph 4: Descriptive statistics of the angle of different teeth that were untreated on the Left side

Graph 4 denotes the descriptive statistics of the three molar teeth on the left side of the untreated jaw. The mean value of the third molar was 84.47 degrees, for the second molar it was 73.89 degrees and for the first molar it was 54.89 degrees.



Graph 5: Pre and post-intervention comparison of angle amongst different teeth for the Right and Left side.

The comparison of the angles between the pre-intervention stage and the post-intervention stage for the three molar teeth for both the left and right side of the jaw has been depicted in **Graph 5**. The result has been given in terms of mean difference between the pre and post-intervention stage. For the 3rd molar on the right side, the mean difference is 9.31 degrees, for the 2nd molar it is 1.26 degrees and for the 1st molar it is 1.63 degrees. A similar result has been obtained on the left side. The mean difference for the 3rd molar, 2nd molar and 1st molar are 1.57, 0.05 and 2.35 respectively.



Graph 6: Comparison of angle between intervention and NO intervention amongst different teeth for the Right and Left side

Graph 6 denotes the comparison of the angles between the intervention and no intervention of the three teeth for both the right as well as the left side of the jaw. For the 3rd molar on the right side, the mean difference is 2.47 degrees, while for the 2nd molar and 1st molar, it is 5.42 degrees and 4.21 degrees respectively. The mean differences on the left side are 2.78, 6.36 and 4.36 for the 3rd molar, 2nd molar and 1st molar teeth.

OVERALL INTERPRETATION

1. The pre and post values before and after expansion respectively for the third , second and first molar are as follows on the right side:

   Third molar - The difference in the mean values of pre and post expansion were found to be statistically significant with the p=0.000 and the difference was -9.31. This change was explained by the increase in the third molar angulation of 9.31˚which concluded that the molar uprighting had taken place post expansion.

   Second molar - The difference in the mean values of pre and post expansion were found to be statistically insignificant with the p=0.699.

   First molar - The difference in the mean values of pre and post expansion were found to be statistically insignificant with the p=0.446.

   The pre and post values before and after expansion respectively for the third , second and first molar are as follows on the left side:

   Third molar - The difference in the mean values of pre and post expansion were found to be statistically significant with the p=0.000 and the difference was 1.57. This change was explained by a minimal decrease in the third molar angulation of 1.57˚which

   Second molar - The difference in the mean values of pre and post expansion were found to be statistically insignificant with the p=0.978.

   First molar - The difference in the mean values of pre and post expansion were found to be statistically insignificant with the p=0.431.

2. The non-intervention group on the right and left side showed the average angulation values of 59.47˚ and 84.47˚ respectively for the third molars.

The non-intervention group on the right and left side showed the average angulation values of 72.53˚ and 73.89˚ respectively for the second molars.

The non-intervention group on the right and left side showed the average angulation values of 83.58˚ and 54.89˚ respectively for the first molars.

3. The comparison of the angle between the intervention and non-intervention group of the third molars on the right side was statistically significant with the p=0.050 and the mean difference was 2.47.The angle was increased by 2.47˚.

   The comparison of the angle between the intervention and non-intervention group of the second molars on the right side was statistically insignificant with the p=0.278 and the mean difference was -5.42. The angle was decreased by 5.42˚.

The comparison of the angle between the intervention and non-intervention group of the first molars on the right side was statistically significant with the p=0.160 and the mean difference was -4.21 The angle was decreased by 4.21˚.

The comparison of the angle between the intervention and non-intervention group of the third molars on the left side was statistically significant with the p=0.002 and the mean difference was 2.78. The angle was increased by 2.78˚.

The comparison of the angle between the intervention and non-intervention group of the second molars on the left side was statistically insignificant with the p=0.083 and the mean difference was -6.36. The angle was decreased by 6.36˚.

The comparison of the angle between the intervention and non-intervention group of the third molars on the left side was statistically significant with the p=0.314 and the mean difference was -4.36. The angle was decreased by 4.36˚.

DISCUSSION

Impaction of third molars is widely due to the unavailability of space in the dental arches. Increasing the arch perimeter so that the impacted molar could erupt as well as in cases of mesially and distally tipped molars the expansion could help in more vertical eruptive pattern by increasing the arch length.

In orthodontics,to overcome the deficiency in the arch length so that the arch length tooth size ratio can be maintained are done through various methods of gaining space such as proclination of teeth , reduction in tooth size , derotation of teeth , extractions , distalization or uprighting of molars as well expansion.[23]

Expansion is one of the common procedure which uses orthodontic or orthopedic forces and is a conservative procedure as well. [23]

Research has been done to study the correlation of the extraction of premolars[5] and its effect on third molar angulation as well as effect of functional appliance treatment and its effect on third molar eruption.[22]

Few studies have been done to see the effect of expansion and third molar angulation therefore the present study was undertaken.

According to Adkins in his study the use of rapid palatal expansion was also seen beneficial to increase the arch perimeter as the procedure caused the expansion of the palate transversely.[12]

Germane et al also supported this in their study stating that expansion caused a significant amount of increase in the arch perimeter which could also eliminate dental crowding.[24]

Staggers in his study mentioned that not only extractions but other factors could also influence the inclination and eruption path of third molars. The angulation of the third molars initially also has an impact on the subsequent eruption.[25]

Third molar angulations have been examined in lateral cephalograms in many studies done previously.

In the present study a control group undergoing no orthodontic treatment was taken to compare and evaluate the changes that were occurring in the treatment group . The control group also helped in understanding that the molar angulation effect had a positive response after the expansion protocol, another reason for this could be the increase in arch perimeter after expansion. In a study done by Sokucu et al a control group was taken to compare with the expansion group and the study was done using lateral cephalograms.[6]

Frankfort Horizontal Plane was introduced and established in Frankfort , Germany in the year 1884. It is defined as the plane extending from the porion to the orbitale . It is considered as a reference plane for the skull and is used in various craniofacial studies and orthodontics.

Measurement of third molar angulation on lateral cephalograms as seen in previous studies might be subject to error because of the superimposition of the contralateral images of third molars. This problem might be eliminated by using panoramic radiographs of the same magnification. Tronje et al [26] suggested that rotational panoramic radiography causes inbuilt distortion effect; however, they also stated that panoramic radiograph images can be reliable for geometric measurements in clinical practice, as long as they are recorded on the same machine at different

times. Stramotas et al [27] noted that liner vertical , angular measurements and ratio calculations can be accurately made on panoramic radiographs . Larheim et al [28] and Olive et al[29] also vouched for the reliability of panoramic radiographs in assessing third molar position. Therefore in this study, all the angular measurements were done on a panoramic radiograph.

Frankfort horizontal plane which has been used in the study had been selected as the reference plane as it does not change due to remodeling.

In a study done by Gohilot et al the outer angle from the long axis to the Frankfort Horizontal Plane was considered.[5]

In the present study the measurement of the angulation is done by using the outer angle from the long axis of the tooth to the Frankfort Horizontal Plane on the orthopantomogram. The increase in the molar angulation explained that the molar tooth was moving towards a more vertical path of eruption. A significant increase in the angulation of the third molars on the left and right sides after expansion procedure was seen.

In the present study the mean of the third molar angulation on the right side pre and post expansion were seen to be 52.6˚ and 61.9 ˚ respectively. The mean values on the left side pre and post expansion were seen to be 79.2˚ and 77.6 ˚ respectively.

The mean values of the control group who did not undergo orthodontic treatment were 59.4 ˚ on the right and 84.4 ˚ on the left side.

The mean difference between the pre and post expansion third molar angulation was found to be -9.31 on the right side and 1.5 on the left side which was statistically significant p=0.000 and p=0.043 respectively ($p < 0.05$) which indicated

that in the group that underwent expansion showed an increase in the third molar angulation of 9º on the right side which led to more vertical path of eruption and a minimal decrease of 1º on the left side which merely angulated the tooth distally.

The results of our study are in accordance with a study done by Sokucu et al where there was significant change immediately after expansion procedure(T1-T2).[6]

The correction of third molar angulation achieved after expansion are similar to the results obtained after treatment carried out with premolar extraction as a method of gaining space.

The molar angulation after the premolar extraction improved by 17˚ and 4 ˚ on the right and left side respectively.

In our study the mean difference in the molar angulation of the expansion group when compared to the non treatment group was found to be 2.4˚ on the right and 2.7˚ on the left statistically significant p=0.050 and p=0.002 respectively ($p < 0.05$).

There have been various studies conducted to evaluate the effect of third molar angulation after the extraction of upper premolars. Though this would also lead to the loss of two healthy teeth, still many authors in their studies have mentioned the change in molar angulation after extraction protocol. Kim et al in his study found significant changes in the impaction of the third molars when compared with the non-extraction group.[17]

Another study done to compare the third molar angulation after the first premolar extractions by Saysel et al stated that there was no significant difference in the third molar angulation between extraction and non-extraction group. He also mentioned that there were factors other than extractions that could influence the angulations and eruption of third molars.[30]

Tendulkar et al in their study of fixed twin block and forsus fatigue resistance device showed an increase in the retromolar space and space width ratio and the distance of the mandibular second molar, these changes were more pronounced in the fixed twin block group. Both the groups showed improvement in the third molar angulation but significantly higher in the fixed twin block group.[22]

In this study, the angulation of the third molars following an expansion protocol without extraction of any teeth seemed to improve with the increase in molar angulation. This was in accordance with the study by Sokucu et al in which the third molar angulations were measured using a lateral and frontal cephalogram and it was observed that the third molar angulation was influenced by the expansion of the maxilla.[6]

In this study when the expansion group third molar angulations were compared to the group with no intervention it was seen that the expansion of the maxilla led to the increase in the molar angulation which led to more uprighting of the molars as compared to the non-intervention group which experienced no change in the molar angulation. The second and first molars on the right side showed a minimal decrease in the molar angulations of 1.2˚ and 1.6 ˚ respectively which was observed by a slight distal angulation but on the left side there was an increase in the molar

angulation of 0.05 ˚ and 2.3 ˚ of the second and first molar respectively on the right side which was observed by a more mesial angulation of the molars.

Since the angulation of the third molars increased it was observed that they would erupt in a more upright manner as compared the angulation of the molar before undergoing expansion.

In the study done by Sokucu et al [6] lateral cephalogram evaluation following the rapid maxillary expansion showed that the third molar teeth showed improvement in their angulation and also established that the expansion led to the increase in the intercanine and intermolar widths and this led to the uprighting of the third molars. This was in accordance with the study by Claro et al in which it was observed that rapid maxillary expansion caused an increase in the intercanine width and arch perimeter.[31]

This could be a valid reason for the increase in arch perimeter as the study done by Claro et al which corelated the amount of expansion with the measurement of intercanine width stated that it provide more space for the eruption of the third molars.[31]

LIMITATIONS OF THE STUDY

- This study was conducted on a sample size of 19 subjects in the age group of 14-19 years. Even though both male and female subjects were included in the study, gender was not considered as a differentiating criterion in the present study.
- All the landmarks were estimated from orthopantomograms which could also have image distortions which could affect the sharpness.
- CBCT imaging could provide a better view and the expansion could also be measured in terms of arch width increase.

SCOPE OF THE STUDY

- A similar study can be done considering the gender of a larger sample to derive conclusive results.
- 3-dimensional comparative analysis of maxillary expansion and molar angulation could be studied using the CBCT imaging technique.
- Dentofacial orthopedic approach can also be considered by practitioners while planning treatment as it would help reduce the extraction of teeth during treatment.
- Mild crowding cases can be treated by expansion protocol as it increases the arch perimeter and width.

CONCLUSION

The effect of rapid maxillary expansion on the third molar angulations led to the following conclusions :

- The upper third molar was influenced by expansion.
- The non treated group showed no change in the third molar angulation.
- The expansion procedure not only helped improve the angulation but also reduced the chances of extracting premolars to improve the eruption pattern of third molars.

SUMMARY

The purpose of this study was to evaluate the changes in the third molar angulation following rapid maxillary expansion in patients undergoing orthodontic treatment and comparing the changes achieved by the expansion protocol with the patients who refused to undergo orthodontic treatment. The study was aimed at measuring the third molar angulation by measuring the outer angle which was formed by the long axis of the third molar to the Frankfort Horizontal Plane. An increase in the angulation post expansion protocol improved the molar position and helped in a better eruptive path.

This helped us understand the importance of dentofacial orthopedics and reduced the chances of extraction of two healthy teeth, the premolars. The rapid maxillary expansion also leads to an increase in the arch width which also provides more space for the third molars to erupt.

Statistical analyses were performed for parameters to obtain mean values for each of the two groups, and their comparison was conducted by unpaired t-test. There was no statistically significant difference in the molar angulation of first and second molar but a significant difference in the angulation of third molars. There was an increase in the molar angulation on the right and left side after rapid maxillary expansion. An important consideration should be given to dentofacial orthopedics in orthodontic diagnosis and treatment planning.

BIBLIOGRAPHY

1. Almpani K, Kolokitha OE. Role of third molars in orthodontics. World Journal of Clinical Cases: WJCC. 2015 Feb 16;3(2):132.
2. Santosh P. Impacted mandibular third molars: Review of literature and a proposal of a combined clinical and radiological classification. Annals of medical and health sciences research. 2015 Jul 21;5(4):229-34.
3. Zhang W. Third molar eruption mechanisms and patterns. Dentistry 3000. 2016 Sep 28;4(1):11-6.
4. Sadry S, Ok U. An evaluation of the relation between the maxillary third molars and facial proportions using cephalometric image. Journal of Oral and Maxillofacial Radiology. 2019 Sep 1;7(3):49.
5. Gohilot A, Pradhan T, Keluskar KM. Effects of first premolar extraction on maxillary and mandibular third molar angulation after orthodontic therapy. Journal of oral biology and craniofacial research. 2012 May 1;2(2):97-104.
6. Sökücü O, Öztürk F, Babacan H, Bıçakçı AA. Does rapid maxillary expansion affect the eruption of upper third molars?. The Angle Orthodontist. 2008 Mar;78(2):195-200.
7. Niedzielska I. Third molar influence on dental arch crowding. The European Journal of Orthodontics. 2005 Oct 1;27(5):518-23.
8. Tassoker M, Kok H, Sener S. Is There a possible association between skeletal face types and third molar impaction? A retrospective radiographic study. Medical Principles and Practice. 2019;28(1):70-4.
9. Alpern MC, Yurosko JJ. Rapid palatal expansion in adults: with and without surgery. The Angle Orthodontist. 1987 Jul;57(3):245-63.

10. Bruder C, Ortolani CL, Lima TA, Artese F, Faltin Junior K. Evaluation of palate area before and after rapid maxillary expansion, using cone-beam computed tomography. Dental press journal of orthodontics. 2019 Oct;24(5):40-5.
11. Haas AJ. Palatal expansion: just the beginning of dentofacial orthopedics. American journal of orthodontics. 1970 Mar 1;57(3):219-55.
12. Adkins MD, Nanda RS, Currier GF. Arch perimeter changes on rapid palatal expansion. American Journal of Orthodontics and Dentofacial Orthopedics. 1990 Mar 1;97(3):194-9.
13. Golovcencu L, Anistoroaei D, Saveanu IC, Toma V, Zegan G. Third Maxillary Molar Assessment Using Orthopantomography. Romanian Journal of Oral Rehabilitation. 2019 Jan;11(1).
14. D'Souza IM, Kumar HK, Shetty KS. Dental arch changes associated with rapid maxillary expansion: A retrospective model analysis study. Contemporary Clinical Dentistry. 2015 Jan;6(1):51.
15. Akkaya S, Lorenzon S, Üçem TT. A comparison of sagittal and vertical effects between bonded rapid and slow maxillary expansion procedures. The European Journal of Orthodontics. 1999 Apr 1;21(2):175-80.
16. Berlocher WC, Mueller BH, Tinanoff N. The effect of maxillary palatal expansion on the primary dental arch circumference. Pediatr Dent. 1980 Mar 1;2(1):27-30.
17. Kim TW, Årtun J, Behbehani F, Artese F. Prevalence of third molar impaction in orthodontic patients treated nonextraction and with extraction of 4 premolars. American journal of orthodontics and dentofacial orthopedics. 2003 Feb 1;123(2):138-45.

18. Årtun J, Behbehani F, Thalib L. Prediction of maxillary third molar impaction in adolescent orthodontic patients. The Angle Orthodontist. 2005 Nov;75 (6):904-11.
19. Jain S, Debbarma S, Prasad SV. Prevalence of impacted third molars among orthodontic patients in different malocclusions. Indian Journal of Dental Research. 2019 Mar 1;30(2):238.
20. Weyrich C, Noss M, Lisson JA. Comparison of a modified RME appliance with other appliances for transverse maxillary expansion. Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie. 2010 Jul;71(4):265-72.
21. Garrett BJ, Caruso JM, Rungcharassaeng K, Farrage JR, Kim JS, Taylor GD. Skeletal effects to the maxilla after rapid maxillary expansion assessed with cone-beam computed tomography. American journal of orthodontics and dentofacial orthopedics. 2008 Jul 1;134(1):8-e1.
22. Tendulkar PM, Pradhan T. Effects of fixed twin-block and forsus fatigue resistant device on mandibular third molar angulation–A comparative study. Indian Journal of Health Sciences and Biomedical Research (KLEU). 2021 Sep 1;14(3):340.
23. Kulshrestha R, Parkar A, Vibhute PK, Chetan Patil UV, Chandurkar K. Methods of Gaining Space:-A Review. ES J Dent Sci. 2020;1(2):1012
24. Germane N, Lindauer SJ, Rubenstein LK, Revere Jr JH, Isaacson RJ. Increase in arch perimeter due to orthodontic expansion. American Journal of Orthodontics and Dentofacial Orthopedics. 1991 Nov 1;100(5):421-7.
25. Staggers JA, Germane N, Fortson WM. A comparison of the effects of first premolar extractions on third molar angulation. The Angle Orthodontist. 1992 Jun;62(2):135-8

26. Tronje G, Eliasson S, Julin P, Welander U. Image distortion in rotational panoramic radiography: II. Vertical distances. Acta Radiologica. Diagnosis. 1981 Jul;22(4):449-55.

27. Stramotas S, Geenty JP, Darendeliler MA, Byloff F, Berger J, Petocz P. The reliability of crown–root ratio, linear and angular measurements on panoramic radiographs. Clinical orthodontics and research. 2000 Nov;3(4):182-91.

28. Larheim TA, Svanaes DB. Reproducibility of rotational panoramic radiography: mandibular linear dimensions and angles. American Journal of Orthodontics and Dentofacial Orthopedics. 1986 Jul 1;90(1):45-51.

29. Olive RJ, Basford KE. Transverse dento-skeletal relationships and third molar impaction. The Angle Orthodontist. 1981 Jan;51(1):41-7.

30. Saysel MY, Meral GD, Kocadereli İ, Taşar F. The effects of first premolar extractions on third molar angulations. The Angle Orthodontist. 2005 Sep;75 (5):719-22.

31. Claro CA, Abrão J, Reis SA, Fantini SM. Correlation between transverse expansion and increase in the upper arch perimeter after rapid maxillary expansion. Brazilian Oral Research. 2006;20:76-81.

ANNEXURE-1 : ETHICAL CLEARANCE CERTIFICATE

Research and Ethics Committee
KLE V K INSTITUTE OF DENTAL SCIENCES
KLE University
Accredited 'A' Grade by NAAC Placed in Category 'A' by MHRD (GoI)
Nehru Nagar, Belagavi - 590 010, Karnataka State
☎: 0831-2470362 Web: http://www.kledental-bgm.edu.in
FAX: 0831-2470640 E-mail:principal@kledental-bgm.edu.in

Sl. No. : 1479

CERTIFICATE

This is to Certify that the synopsis titled

Effects of Rapid maxillary expansion on maxillary third molar angulation after orthodontic triumphy - A retrospective cohort study

Submitted by

Dr. REG. No. II0220005 *P. G. Student /*

Staff, Guided by *om Department of*

orthodontics & dentofacial orthopaedics *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date : 5/5/21

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Research and Ethical Committee
KLEVK Institute of Dental Sciences
BELAGAVI.

Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belgaum

EXPERIMENTAL GROUP VALUES												
S No	Right						Left					
	8		7		6		8		7		6	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
1	45◦	57◦	70◦	68◦	76◦	70◦	76◦	68◦	65◦	62◦	63◦	45◦
2	48◦	62◦	70◦	71◦	80◦	78◦	83◦	84◦	77◦	76◦	56◦	45◦
3	44◦	47◦	74◦	74◦	77◦	89◦	88◦	88◦	69◦	72◦	45◦	52◦
4	57◦	76◦	60◦	42◦	83◦	70◦	84◦	82◦	81◦	62◦	NA	73◦
5	32◦	50◦	65◦	76◦	78◦	85◦	93◦	81◦	72◦	74◦	45◦	62◦
6	40◦	52◦	47◦	53◦	78◦	75◦	76◦	70◦	63◦	65◦	49◦	42◦
7	48◦	60◦	92◦	80◦	90◦	83◦	90◦	73◦	62◦	54◦	60◦	48◦
8	56◦	63◦	55◦	70◦	66◦	75◦	60◦	73◦	57◦	64◦	69◦	76◦
9	95◦	85◦	90◦	60◦	95◦	80◦	67◦	66◦	65◦	63◦	64◦	66◦
10	68◦	73◦	66◦	73◦	80◦	84◦	77◦	82◦	67◦	76◦	62◦	80◦
11	46◦	57◦	69◦	72◦	81◦	78◦	82◦	85◦	76◦	77◦	55◦	46◦
12	47◦	52◦	73◦	75◦	78◦	89◦	87◦	89◦	68◦	73◦	44◦	53◦
13	44◦	47◦	59◦	43◦	84◦	70◦	83◦	84◦	80◦	63◦	NA	74◦
14	60◦	76◦	64◦	77◦	79◦	85◦	92◦	82◦	71◦	75◦	44◦	63◦
15	32◦	50◦	46◦	54◦	79◦	75◦	75◦	71◦	62◦	66◦	48◦	45◦
16	45◦	52◦	91◦	81◦	91◦	83◦	91◦	74◦	61◦	55◦	59◦	49◦
17	46◦	60◦	54◦	71◦	67◦	75◦	61◦	74◦	56◦	65◦	68◦	77◦
18	56◦	63◦	89◦	61◦	96◦	80◦	65◦	67◦	64◦	64◦	63◦	67◦
19	91◦	95◦	65◦	74◦	81◦	84◦	76◦	83◦	66◦	77◦	61◦	79◦

CONTROL GROUP DATA						
	Right			Left		
S.No.	8	7	6	6	7	8
1	55	71	87	90	73	33
2	45	66	87	85	73	59
3	43	63	82	88	42	41
4	89	71	80	84	80	75
5	45	75	78	88	73	47
6	31	56	66	76	60	57
7	62	72	81	62	67	57
8	58	61	77	83	67	47
9	62	67	85	85	70	69
10	33	73	76	77	67	36
11	88	72	66	85	78	60
12	80	78	78	82	70	40
13	40	84	89	94	90	50
14	77	79	89	97	90	60
15	56	86	102	81	83	79
16	64	77	90	91	85	60
17	59	74	86	89	72	60
18	61	75	98	72	90	52
19	82	78	91	96	74	61