Comparative Dentoalveolar Assessment of Molar Distalization using Pendulum Appliance and Implant Supported Distalization Appliance – A Prospective Study

Madhuli Bhide[1], Tejashri Pradhan[2], Abhishek Jain[1], Roopa Jatti[3]

ABSTRACT

Introduction: Maxillary molar distalization for nonextraction treatment of crowding is a known treatment modality. The aim and objectives of this study was to assess and compare the dentoalveolar effects of treatment with pendulum and implant supported distalization appliance using cephalometric data and model analysis.

Material and Methods: The study was carried out using pendulum appliance (Group A) and implant supported appliance (Group B) for distalization of maxillary molars. Total sample size of the study was 10 with each group consisting of 5 patients. Cephalometric and model analysis was done in both the groups.

Results: Comparative analysis of pendulum and implant supported distalization appliance using Mann-Whitney U test indicated that there was increased distal inclination of the maxillary Ist molar and proclination of the incisors seen in pendulum group compared to implant group where there was more bodily movement of the Ist molar and retroclination of the incisors. The increase in arch length was similar in both the groups showing no statistically significant difference between the two groups. Molar angulation of both maxillary right and left Ist molars with P values of 0.0216 and 0.0090 respectively indicated increased disto-palatal molar rotation in the pendulum group.

Conclusion: The pendulum group showed marked distal molar movement as compared to implant group. The distal molar movement achieved by pendulum group was more on account of tipping movement than that of bodily movement achieved by implant.

Keywords: Pendulum Appliance, Implant Supported, Molar Distalization

INTRODUCTION

Maxillary molar distalization for nonextraction treatment of Class II dental malocclusion patients has become increasingly popular in the last 10 years. Traditional appliances for molar distalization such as extraoral traction, Cetlin removable plate, and Wilson distalizing arches require patient cooperation to achieve molar distal movement.

Recently, problems related to patient compliance have led many clinicians to prefer intraoral distalizing systems that minimize reliance on the patient and are under the orthodontist's control[1]. Numerous alternative intraoral noncompliant appliances such as repelling magnets, the distal jet, implant supported distalization appliances and the pendulum have been developed, and many well-documented studies have substantiated their effects.

This study was planned to compare the distalization effects between pendulum and implant supported distalization appliance as no previous study directly comparing the treatment changes between pendulum and implant supported distalization appliance has been done.

The aim and objectives of the study were to assess and compare the dentoalveolar effects of treatment with pendulum and implant supported distalization appliance using cephalometric data and model analysis and to assess the dentoalveolar changes brought about by the pendulum appliance and by the implant supported distalization appliance and to compare them.

MATERIAL AND METHODS

Study was caried out in Department of Orthodontics and Dentofacial Orthopedics KLE's V.K Institute of Dental Sciences, Belgaum. The total sample size of the study was 10 patients, 5 in each group. The study was carried out using pendulum appliance (Group A) and implant supported appliance (Group B) for distalization of maxillary molars.

Inclusion criteria

1. Patients with fully erupted 2nd molar
2. Skeletal Class I with bilateral Class II molar relationship (defined by at least an end to end molar relationship)
3. Patients with normal or hypodivergent growth pattern;
4. No transverse discrepancy
5. No temporomandibular joint disorder
6. Patients willing for third molar extraction

Exclusion criteria

1. Patients having skeletal relationship other than Class I
2. Patients with dental relationship other than Class II
3. Medically compromised patients
4. Patients with deformities in maxilla and mandible
5. Patients with history of extraction of teeth other than

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third molar/loss of permanent teeth

Pre- and Post-distalization lateral cephalograms and study models were utilized for the study.

The following cephalometric parameters (fig 1) were used for the study.

Angular parameters

1. SN U1-Angle formed by the intersection of long axis of the maxillary central incisor and SN line
2. SN-U5- Angle formed by the intersection of long axis of maxillary 2nd premolar and SN line
3. SN-U6-Angle formed by the intersection of long axis of the maxillary first molar and the SN line. The long axis will be determined by a line passing through the central point between the 2 root apices and the centroid point

Linear parameters

1. PTV-U1- Linear distance from the tip of the maxillary central incisor perpendicular to the pterygoid vertical plane (PTV)
2. PTV-U5- Linear distance from the centroid of maxillary second premolar perpendicular to the PTV
3. PTV-U6- Linear distance from the centroid of maxillary first molar perpendicular to PTV
4. PP-U1- Linear distance from the tip of the maxillary central incisor perpendicular to the palatal plane(PP)
5. PP-U5- Linear distance from the centroid of maxillary second premolar perpendicular to the PP
6. PP-U6- Linear distance from the centroid of maxillary first molar perpendicular to the PP

Study model analysis (fig 2)

The acquired arch lengths will be calculated. The total arch length will be measured from mesial of one upper first molar to the other. This measurement will be done over the contact points of the posterior teeth and the incisal edges of the incisors, both before and after distalization treatment. A piece of ligature wire will be contoured and straightened for measurement.

1. Maxillary first molar- median palatal plane (Angle between a line drawn through the mesio buccal cusp to disto palatal cusp and the median palatal plane)

STATISTICAL ANALYSIS

Mean and standard deviation of different measurements at pre and post treatment in Pendulum and Implant groups was analyzed. Intragroup analysis of pendulum and implant groups was done by Wilcoxon Matched pairs test. Intergroup analysis between pendulum and implant groups was done by Mann-Whitney U test.

RESULTS

On comparative analysis it was seen that

U1-SN- showed statistically significant (P = 0.0090) increase (Table 1) indicating there was increased proclination of the upper central incisor seen in pendulum group compared to implant group.

U6-SN- showed statistically significant (P = 0.0283) increase, indicating increased distal inclination of the maxillary Ist molar seen in pendulum group compared to implant group.

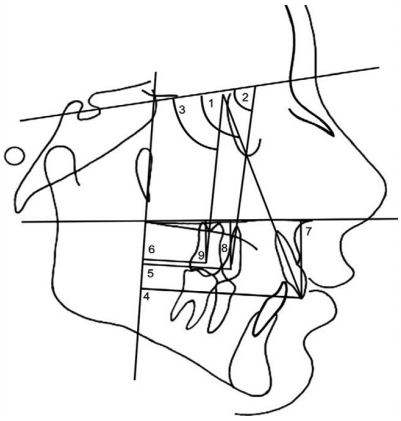


Figure-1: Angular and linear dentoalveolar measurements

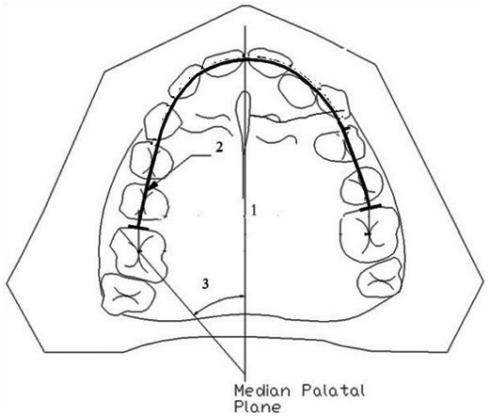


Figure-2: Maxillary model measurements. 1. Median palatal plane 2. Length of total arch perimeter 3. Maxillary first molar-Median palatal plane.

Figure-3: Pre-treatment and post distalization with pendulum appliance

Variable	Sub variables	Time	Implant			Pendulum			Z value	p level
			Mean	Std. Dev.	Rank Sum	Mean	Std. Dev.	Rank Sum		
U1- SN		Pre treatment	111.60	14.79	29.50	103.60	2.97	25.50	-0.4178	0.6761
		Post treatment	101.20	13.26	25.00	108.00	2.55	30.00	-0.5222	0.6015
		Difference	10.40	2.30	40.00	-4.40	1.14	15.00	-2.6112	0.0090*
U5-SN		Pre treatment	78.40	2.70	33.50	74.00	9.70	21.50	-1.2534	0.2101
		Post treatment	72.20	3.19	34.00	67.00	7.75	21.00	-1.3578	0.1745
		Difference	6.20	1.64	28.50	7.00	4.18	26.50	-0.2089	0.8345
U6-SN		Pre treatment	74.70	5.33	34.50	69.60	2.41	20.50	-1.4623	0.1437
		Post treatment	70.10	5.46	38.00	59.40	4.77	17.00	-2.1934	0.0283*
		Difference	4.60	1.78	20.50	10.20	6.72	34.50	-1.4623	0.1437
PTV-U1	Crown	Pre treatment	53.60	8.88	24.00	56.40	5.03	31.00	-0.7311	0.4647
		Post treatment	52.60	5.77	19.00	58.50	5.14	36.00	-1.7756	0.0758
		Difference	1.00	4.53	35.00	-2.10	0.65	20.00	-1.5667	0.1172
PTV-U1	Root	Pre treatment	44.00	3.87	22.00	50.50	6.91	33.00	-1.1489	0.2506
		Post treatment	44.30	3.15	20.50	49.90	4.72	34.50	-1.4623	0.1437
		Difference	-0.30	1.92	25.50	0.60	2.70	29.50	-0.4178	0.6761
PTV-U5	Crown	Pre treatment	30.20	4.01	30.50	27.80	5.40	24.50	-0.6267	0.5309
		Post treatment	27.10	3.75	33.00	23.20	6.06	22.00	-1.1489	0.2506
		Difference	3.10	1.14	19.00	4.60	1.14	36.00	-1.7756	0.0758
PTV-U5	Root	Pre treatment	30.90	3.09	33.50	27.60	4.72	21.50	-1.2534	0.2101
		Post treatment	29.50	3.39	33.50	25.60	6.31	21.50	-1.2534	0.2101
		Difference	1.40	1.52	26.00	2.00	3.39	29.00	-0.3133	0.7540
PTV-U6	Crown	Pre treatment	20.90	3.97	31.00	19.80	2.77	24.00	-0.7311	0.4647
		Post treatment	16.00	4.18	33.00	13.70	2.86	22.00	-1.1489	0.2506
		Difference	4.90	0.89	20.00	6.10	1.14	35.00	-1.5667	0.1172
PTV-U6	Root	Pre treatment	22.70	2.82	34.00	20.40	3.05	21.00	-1.3578	0.1745
		Post treatment	18.70	3.63	30.00	17.60	3.21	25.00	-0.5222	0.6015
		Difference	4.00	2.65	30.00	2.80	1.64	25.00	-0.5222	0.6015
PP-U1		Pre treatment	29.20	0.84	37.50	26.60	1.82	17.50	-2.0889	0.0367*
		Post treatment	29.10	0.74	35.00	27.50	1.58	20.00	-1.5667	0.1172
		Difference	0.10	0.22	35.00	-0.90	1.14	20.00	-1.5667	0.1172
PP-U5		Pre treatment	25.30	1.75	40.00	19.80	2.39	15.00	-2.6112	0.0090*
		Post treatment	24.90	1.34	40.00	20.40	2.41	15.00	-2.6112	0.0090*
		Difference	0.40	0.42	38.00	-0.60	0.55	17.00	-2.1934	0.0283*
PP-U6		Pre treatment	21.80	1.10	38.50	18.00	1.87	16.50	-2.2978	0.0216*
		Post treatment	21.70	1.20	36.50	19.20	2.08	18.50	-1.8800	0.0601
		Difference	0.10	0.74	38.50	-1.20	0.27	16.50	-2.2978	0.0216*
Arch perimeter		Pre treatment	73.80	5.36	27.00	73.60	4.94	28.00	-0.1044	0.9168
Perimeter		Post treatment	83.70	1.40	22.00	86.60	5.33	33.00	-1.1489	0.2506
		Difference	9.90	4.77	24.00	13.00	1.00	31.00	-0.7311	0.4647
Molar angulations	Right	Pre treatment	28.80	1.30	30.00	26.60	5.64	25.00	-0.5222	0.6015
		Post treatment	32.60	1.95	24.00	34.60	4.93	31.00	-0.7311	0.4647
		Difference	3.80	1.92	16.50	8.00	2.24	38.50	-2.2978	0.0216*
	Left	Pre treatment	30.40	1.14	34.00	28.40	2.30	21.00	-1.3578	0.1745
		Post treatment	34.40	1.14	18.00	37.40	2.61	37.00	-1.9845	0.0472*
		Difference	4.00	0.71	15.00	9.00	1.58	40.00	-2.6112	0.0090*

Table-1: Comparison of Implant and Pendulum groups with respect to different measurements at pre and post treatment by Mann-Whitney U test (*p<0.05)

PTV – U1, U5 and U6 - was not statistically significant.

PP-U5 and PP-U6 showed statistically significant (P = 0.0283 and 0.0216 respectively) decrease, indicating intrusion of the IIndpremolar and Istmolar in the pendulum group (graph 1,2).

Arch perimeter analysis- was not statistically significant.

Molar angulation- showed statistically significant (P = 0.0216 and 0.0090) difference in right and left Ist molar angulation respectively indicating increased disto palatal molar rotation in the pendulum group.

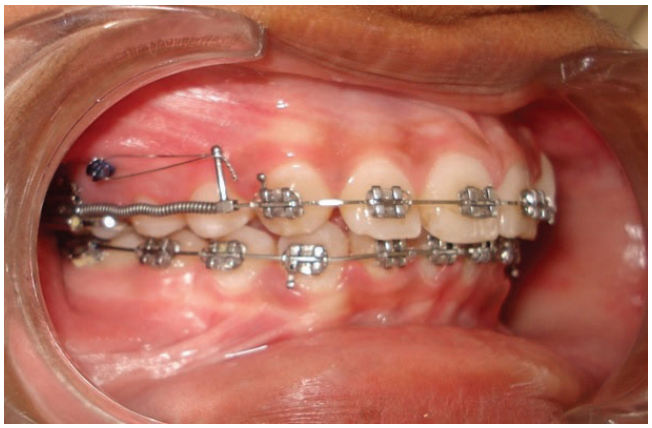
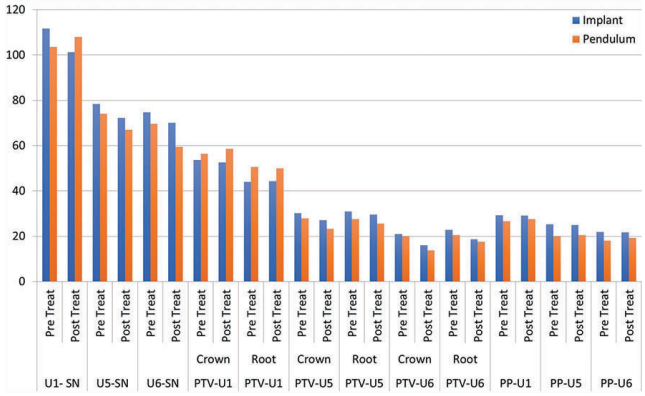
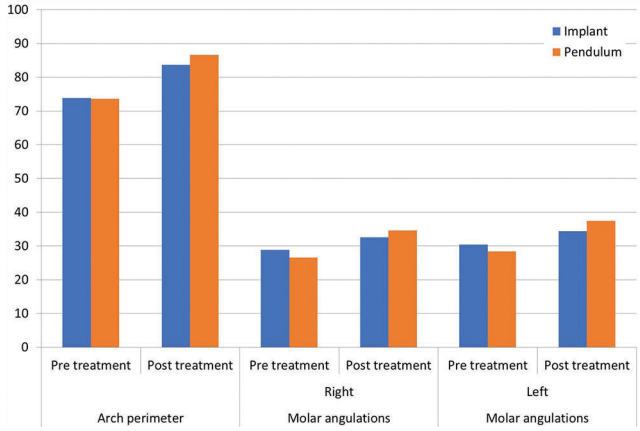


Figure-4: Buccal implant supported distalization appliance



Graph-1: Comparison of pre and Post treatment scores of cephalometric measurements in Implant and pendulum group



Graph-2: Comparison of pre and Post treatment scores of model analysis measurements in Implant and pendulum group

DISCUSSION

Pendulum appliance

The use of distalization mechanics to correct Class II malocclusions is a common treatment modality. This type of mechanotherapy typically is used in patients with maxillary skeletal or dentoalveolar protrusion or both. Molar distalization also can be used when extraction of maxillary teeth is not indicated and the mandibular tooth-size/arch-perimeter relationship does not permit mesial movement of the lower molars[4].

In a recent survey by Sinclair[6] all responding orthodontists reported using molar distalization, and nearly all indicated that patient cooperation was the most significant problem encountered in distalizing maxillary molars. A number of treatment protocols that minimize the need for patient compliance have been suggested in recent years, including repelling magnets combined with a Nance anchorage appliance.[7-12]

The pendulum/pendex appliance used in this study was similar to that described by Hilgers[2]. With the appliance in place, the 0.032-in TMA springs were placed in the lingual sheaths on maxillary first molar bands. A 60° activation exerted approximately 230 g of distalizing force. The pendulum appliance was removed when a "super Class I" molar relationship was achieved. A Nance holding arch was placed after molar distalization. Typically, the occlusal rests were removed from the second premolars, and the premolars were allowed to drift posteriorly. Comprehensive fixed appliances followed molar distalization.

The distal tipping seen with the molar was 10.20 ± 6.72 mm. Also in our study linear measurements from the pterygoid vertical to the crown and root were taken separately so that the amount of tipping can be measured. The mean distal crown movement was 6.10 mm ± 1.14 mm and root movement was 2.80 mm ± 1.64 mm which indicated increased distal tipping of the molars. A significant amount of distal tipping of 14.50 ± 8.33 mm was also seen by Byloff and Darendeliler[3,4] who suggested that the distal tipping can be attributed to the trajectory of the TMA springs. Also Alberto et al reported a distal tipping of −9.0 ± 4.1 mm which is similar to this study. Proclination of 4.40° ± 1.14° and 2.10 ± 0.65 mm was seen in the upper incisors and mesial tipping of 7.00° ± 4.18° and 4.60 ± 1.14 mm of the second premolar in the pendulum group indicated anchor loss. This result was similar to the study done by Polat-Ozsoy et al[19].

On model analysis it was seen that there was a total increase in the arch perimeter of 13 ± 1 mm. In a study done by Acácio Fuziy et al[20] the mean space openings on the right and left sides were 6.12 and 6.5 mm, respectively. Also, angular measurement of molar rotation was done which showed disto-palatal rotation of 8° ± 2.24° and 9° ± 1.58° on the right and left side respectively which was also statistically significant. However no studies have conducted model analysis with pendulum appliance.

Implant supported distalization appliance

The selection of a proper anchorage is an essential factor for the successful orthodontic treatment. Every orthodontic device, which exercises a force onto the tooth, generates an opposite force which then affects the anchorage.

The implant in the bone remains stable, which ensures a secure anchorage when no teeth are used[21]. Anchorage stability is often an essential factor for the successful treatment of Class II malocclusions, and unstable anchorage can lead to unfavourable occlusal relationships and complicate subsequent treatment procedures[22].

The slight distal tipping seen in the molar was 4.60° ± 1.78°. The mean distal molar crown movement of 4.90 mm ± 0.89

mm and root movement of 4 mm ± 2.65 mm which indicated towards a bodily movement of the molars and these results are consistent with the study done by Yamada et al[23] where there was a distal molar movement of 2.8 mm ± 1.6 mm and distal tipping of 4.8° ± 4.5°. Proximity of the force to the centre of resistance of the first molar provided more bodily distal movement. Slight distal tipping was seen which was statistically not significant.

In our study there was distal movement of the second premolars and retroclination of incisors which was consistent with the results obtained by Caprioglio[24] et al and Yamada et al[23] respectively. These results are advantageous, especially in Class II division 1 cases. The distal movement was seen as a result of the effects of the transeptal fibres.

The molar, premolar and incisors showed slight extrusion of 0.10 mm ± 0.74 mm 0.40 mm ± 0.42 mm and 0.10 mm ± 0.22 mm respectively. This is consistent with the study done by Amit Goyal[25] where they have mentioned slight extrusion of the molar, premolar and incisors which was not statistically significant.

Model analysis showed an increase in the arch perimeter of 9.90 ± 4.77 mm which was in accordance with a study done by Kircelli et al[26] where the total arch perimeter length increased by 13.9 ± 4.1

Angular measurement of molar rotation showed disto-palatal rotation of 3.80° ± 1.92° on the right and 4° ± 0.71° on the left. None of the studies have measured any rotation of the molars. The molar rotation seen in our study may be attributed to the buccal force that was applied for distalization and no palatal traction to counter the rotation.

Comparison of the two groups

There was an increased amount of incisor proclination and distal tipping of the Ist molar seen in the pendulum group compared to the implant group.

The premolar in the pendulum group showed mesial movement due to anchor loss whereas in the implant group the premolar showed a more distal movement owing to the stretch of trans-septal fibres.

The pendulum group showed more distalization of the molar mainly due to tipping of the molar whereas there was more bodily movement of the molar seen in implant group.

Also the degree of molar rotation was more in the pendulum group than the implant group as the sliding of molar over SS wire prevented the rotation of molars in implant group.

Friction-free appliances, namely the pendulum, produced a large amount of mesiodistal movement and tipping, if no therapeutic uprighting activation was applied. There are no studies comparing pendulum appliance with buccal implant supported appliance. A few case reports on the buccal implant supported molar distalization appliance have consistent findings with our study.

limitation of the study

1. The sample size was small consisting of a total of ten patients, five in each group.
2. The site of anchorage is different in both groups, pendulum being palatal and implant placed buccal, which may alter the results
3. Studies have shown that there is an increase in the mandibular plane angle which in turn increases the lower facial height which was not considered in this study

Scope for study

1. A similar study with larger samples can be done on the same grounds.
2. The effect of distalization before eruption of second molars can also be studied with the implant supported appliance
3. Long term stability of the distalization and relapse of the distalization can be studied.

CONCLUSION

In the present study there was a significant difference in dentoalveolar molar distalization with pendulum appliance and implant supported distalization appliance

The pendulum group showed increased distal molar movement due to distal tipping of molars. Also there was a significant amount of anchor loss seen in the pendulum group which was demonstrated by the mesial movement of premolars and anterior teeth.

The implant group showed more bodily distal movement of the molars as the force application was at the centre of resistance in this group. There was no anchor loss seen in the implant group. Distal movement of the incisors and premolars was seen as a result of stretch of trans-septal fibres.

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