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Measurement of the rate of maxillary molar distalization using steel bar distalizer

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ABSTRACT

Background: The treatment of Class II malocclusions has always been a subject of great interest for orthodontists. The use of distalization mechanics to correct Class II malocclusions is a common treatment modality. Many devices have been developed and used to distalize the maxillary molars and show positive clinical results.

Aim of the Work: The aim of this study was to evaluate the rate of tooth movement on digital casts caused by distalization of maxillary molars using steel bar distalizer in the treatment of class II malocclusion.

Materials and Methods: Twenty patients with age ranging from 15 to 30 years were recruited from the out-patient clinic of the Orthodontic Department of the Faculty of Dentistry Ain-Shams University. All patients required maxillary molar distalization as part of their orthodontic treatment plan. Impression for appliance fabrication was done then mini-screws were inserted after appliance cementation. The rate of maxillary first molar movement was assessed through the analysis of successive digital model scans taken every 4 weeks.

Results: The changes accompanying the maxillary first molar distalization were evaluated by analyzing digital models showed the mean rate of tooth movement was 0.3 mm/month.

Conclusion: The steel bar distalizer is an efficient and cheaper alternative in maxillary molar distalization.

Keywords: Three Dimensional, Maxillary Molar Distalization, Distalizing Steel Bar, Class II Malocclusion

INTRODUCTION

Class II malocclusion is a commonly encountered problem in the orthodontic practice, having an incidence of 19.56 % which represents the second most prevalent malocclusion worldwide.[1] It was found to be the most common malocclusion among Egyptian population with incidence of 21% in which division 1 constitutes 16.2 % and division 2 composes 4.8 %.[2]

There have been several attempts to find alternative solutions in order to avoid premolar extraction in dental Class II cases. The majority of non-extraction treatment strategies for class II malocclusion include maxillary molar distalization which is an integral component, starting with the application of extra-oral traction, a variety of

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distalization techniques and several distalization appliances were developed such as compliant distalizers.

The Carrière Motion Distalizer is one of the successful appliances in distalizing the upper posterior segment. However, Carrière Motion Distalizer had unfavorable dental consequences brought on by the reciprocal forces as the proclination of lower incisors and the anterior loss of anchorage along with its high cost and frequent debonding[3]. A new steel bar distalizer appliance was developed by the authors of this study which could offer a simpler, more cost effective and sustainable substitute to the Carrière Motion Distalizer with less chance for appliance debonding.

Therefore, this study was conducted to evaluate the rate of tooth movement on digital casts caused by distalization of maxillary molars using steel bar distalizer in the treatment of class II malocclusion.

MATERIALS AND METHODS

This prospective study was conducted on 20 patients with age ranging from 15 to 30 years, selected from the outpatient clinic of the Orthodontic Department, Faculty of Dentistry, Ain Shams University and the subjects were assessed for eligibility according to the following inclusion and exclusion criteria.

The inclusion criteria included bilateral Class II molar relationship (full unit or half unit) with or without Increased overjet, presence of full permanent dentition with the exception of upper 3rd molars and skeletal class II malocclusion with ANB angle not exceeding 6 degrees. While the exclusion criteria included severe space deficiency or any other malocclusion requiring extraction, previous orthodontic treatment and any dental anomaly e.g. (tooth size discrepancy, tooth shape deformation or enamel hypoplasia)

A statistical power analysis was performed for sample size estimation, based on data from published study by Sandifer CL, et al., Treatment effects of the Carrière Motion Distalizer using lingual arch and full fixed appliances, Journal of the World Federation of Orthodontists (2014), projected sample size needed with this effect size (GPower 3.1) was approximately N=16. Thus our sample size of 20 would be more than adequate for the main objective of the study and should also allow for expected attrition and our additional objectives of controlling for possible mediating/moderating factors/subgroup analysis, etc.

The ethical committee at the Faculty of Dentistry Ain-Shams University approved the study design. Before treatment was carried out a detailed written Arabic consent, assent form for participants less than 18 years were signed by all the subjects after full explanation of the procedure and the aim of the study.

Methods

Detailed medical and dental history as well as extra-oral and intra-oral examination was carried out, extra-oral and intraoral photographs, orthodontic study casts, lateral cephalometric radiographic and panoramic radiograph were taken for each patient before commencement of treatment.

The appliance consists of 2 metal bands each on both right and left maxillary permanent first molars, another 2 metal bands with hooks each on both right and left maxillary permanent canines. The band of each maxillary permanent molar is connected with the band with hooks of maxillary permanent canine of the same side through a 1.2 mm diameter stainless steel surgical wire soldered to the bands running anteroposteriorly and buccally across the maxillary permanent 1st and 2nd premolars at the level of gingival margins for hygienic purposes. This procedure was done by the same lab technician under strict sanitary procedures.

Two miniscrews, each 12 mm in length and 2 mm in diameter were inserted in the Buccal shelf area of the mandible as an alternative. The miniscrews were mounted on the screw driver and inserted into the mandibular buccal shelf area with an angle perpendicular to the bone surface initially then the angle to be distally and parallel to the roots of the lower molars to avoid screw-to-root contact taking in consideration that the screw head pointing distally to support the attachment of the class II elastics[4,5].

After appliance cementation & miniscrew insertion, Class II elastics delivering a posterior distalizing force were applied from the upper canine band hook to the miniscrew between lower permanent 2nd premolar and 1st permanent molar in the lower arch on both sides. The patients were instructed to wear heavy class II elastics (¼ inch) for 1 month from the beginning of the treatment[6]. The next month 3/16 heavy class II elastics was used continued till the end of intervention period[7].

The patients were instructed to wear the elastics 24 hours per day and except during meals, and to change them daily.[7] Strict oral hygiene instructions were given to the patients to maintain an inflammatory-free area around the miniscrews. A follow up sheet was given to the patients to monitor the elastics wearing on daily basis.

Raising the bite after dryness by adding glass ionomer on lower first molars occlusal surfaces was done to disocclude the bite.

Figure 1: Class II elastics attachment

Subjects were recalled for follow up every month till completion of distalization. Impression of the upper and lower arches was taken at the end of each follow up visit and scanned digitally and saved to obtain distalization records later.

Our cut off point was when molar relationship reached class I or after 9 months from the start of the treatment. Post treatment records were then obtained and case progress was evaluated to decide the following treatment procedure best for each patient.

Methods of data collection:

Alginate impressions taken for patients were poured. Stone casts were scanned using 3-shape R-750 scanner[1] in the digital orthodontic center at Ain-Shams University.

Analysis of the produced digital models to assess the rate of tooth movement was done using GOM Inspect 2019 software. For each patient the pre-treatment digital model was first oriented on the program's mesh then a fixed horizontal plane (HP) was constructed perpendicular to the mid-sagittal plane passing through the medial end of the third left palatal rugae[8,9]. Each following model was superimposed over the pre-treatment model using local best-fit alignment and the distance between right and left mesio-buccal cusps of maxillary first molars and the horizontal plane was measured to track maxillary first molar movement during distalization each month. (Figure 2)

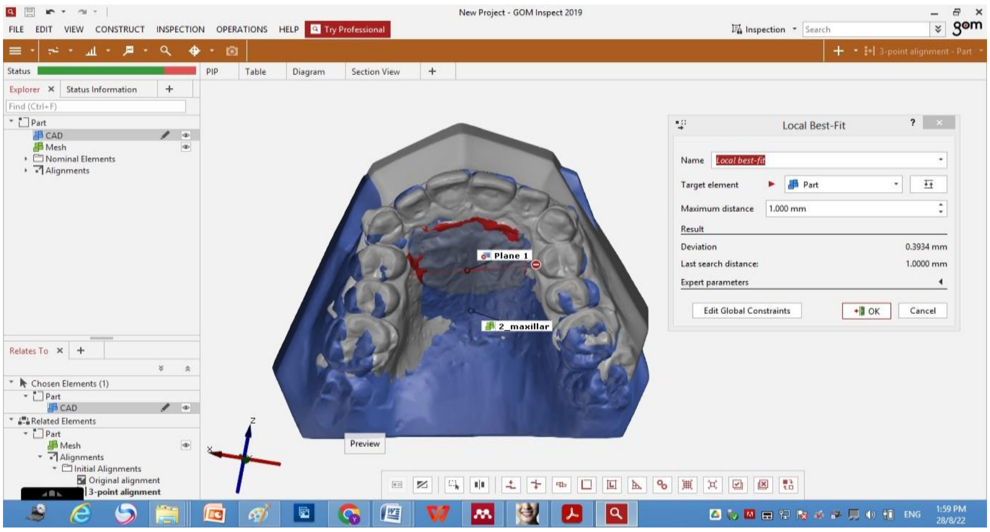

Figure 2: Digital models superimposition using local best-fit

[1] 3shape A/S. Copenhagen, Denmark.

Method Error

Intra-operator and inter-operator error of measurement were done to assess the reliability of measurements. Eight subjects were randomly selected for assessment of the reliability of measurements. For intra-operator error, the measurements were repeated by the same operator after at least two weeks of the first measurement. For inter-operator error, another trained orthodontic operator analyzed the measurements on the same eight subjects.

Statistical Analysis:

All Data were collected, tabulated and subjected to statistical analysis. Statistical analysis was performed by **SPSS** in general (version 17), while **Microsoft office Excel** was used for data handling and graphical presentation. Significance level was considered at **P < 0.05** (S); while for **P < 0.01** was considered highly significant (HS). Two Tailed tests were assumed throughout the analysis for all statistical tests.

RESULTS

Numerical data were explored for normality by checking the data distribution and using Shapiro-Wilk tests. All data showed normal parametric distribution

the mean amount of distalization using the steel bar distalizer was 2.35±0.3 mm, the type of tooth movement during distalization period was mainly through tipping tooth movement.

Minimum, maximum, mean, and standard deviation of digital model's measurements at different intervals were presented in table (1). At M0 mean ± standard deviation was (12.40 ± 1.75) then increased gradually to (15.14 ± 2.46) at M9, comparison between them was performed by using One Way ANOVA test which revealed insignificant difference between them as P>0.05.

Table 1: Mean and standard deviation of digital model's readings at different intervals:

	N	Minimum	Maximum	Mean	Std. Deviation	P value
M0	18	8.10	15.40	12.40	1.758	0.09
M1	18	8.20	15.88	12.69	1.824	
M2	18	8.23	16.01	12.92	1.796	
M3	18	8.31	16.50	13.12	1.852	
M4	17	8.79	16.80	13.49	1.912	
M5	17	8.99	17.00	13.75	1.912	
M6	16	9.25	17.20	13.96	1.903	
M7	15	9.54	17.45	14.28	1.915	
M8	6	9.72	17.66	14.98	2.498	
M9	6	10.00	17.82	15.14	2.465	

N: count Min: minimum Max: maximum
M: mean SD: standard deviation

Mean difference and standard deviation of reading changes between each 2 successive months was calculated, also comparison between 2 successive months was performed by using Paired t-test which revealed in significant difference in all intervals as P>0.05. Moreover, it was noted that M7-M8 revealed the highest amount of change (0.7 ±0.08), as presented in table (2).

Table 2: Mean difference and standard deviation of digital model's readings changes between different intervals:

	N	M	SD	Paired difference		95%CI		P value
				MD	SD	L	U	
M1	18	12.69	1.82	0.3	0.07	-1.923	1.329	1.000
M0	18	12.40	1.76					
M2	18	12.92	1.80	0.23	0.03	-1.851	1.401	1.000
M1	18	12.69	1.82					
M3	18	13.12	1.85	0.21	0.06	-1.828	1.424	1.000
M2	18	12.92	1.80					
M4	17	13.49	1.91	0.37	0.06	-2.028	1.286	.999
M3	18	13.12	1.85					
M5	17	13.75	1.91	0.25	0.01	-1.940	1.434	1.000
M4	17	13.49	1.91					
M6	16	13.96	1.90	0.22	0.01	-1.902	1.472	1.000
M5	17	13.75	1.91					
M7	15	14.28	1.92	0.32	0.01	-2.038	1.406	1.000
M6	16	13.96	1.90					
M8	6	14.98	2.50	0.7	0.08	-3.182	1.785	.996
M7	15	14.28	1.92					
M9	6	15.14	2.47	0.16	0.03	-2.882	3.201	1.000
M8	6	14.98	2.50					

N: count M: mean SD: standard deviation MD: Mean difference
P: probability level which is significant at $P \leq 0.05$

All results ranged from good (CCC>0.7) to excellent (CCC>0.9) agreement in both inter-observer and intra-observer reliability using Interclass correlation coefficient (CCC) in all measurements of the study as presented in table (2).

The final result after destalization is shown in (Figure 3):

Figure (3): Pre and Post Distalization

DISCUSSION

For the sake of integrity, all study procedures and steps were carried out by the same trained orthodontist and all appliances were fabricated by the same orthodontic lab.

Treatment progress was assessed monthly to ensure compliance of the patients and to ensure precise evaluation of tooth movement. During every follow up visit impressions were taken for each patient during the whole duration of study with the appliance.

The appliance was only attached to the maxillary canines and first molars on both sides in the upper arch and no other teeth in the upper arch received orthodontic tooth movement during the whole course of the study to avoid any interfering factors with posterior segment movement and to remove any variables that could affect our study aiming to evaluate the rate and type of movement of the posterior segment.

The rate of tooth movement in the study group revealed that the minimum rate of maxillary first molar movement was 0.16 mm in the ninth month of distalization and the maximum rate was 0.7 mm between the seventh and eighth months of distalization.

The mean rate of tooth movement was 0.3 mm/month which is slower than expected and this can be explained due to the patient selection criteria for the study. Having a normal to low mandibular plane angle with a more horizontal growth pattern and higher masticatory mucsle forces which may place added resistance to distal molar movement and posterior occlusion movement as a whole[10,11].

This study showed that the rate of tooth movement using steel bar distalizer is comparable to other distalizing appliance within the same category which proves its efficiency in treating dental class II cases[12,13]. The appliance might be superior to other distalizing appliance in being more economic, sustainable, and more resistant to debonding. This might have a positive influence on the patient compliance and acceptance of treatment.

CONCLUSION

The mean rate of tooth movement using steel bar distalizer was 0.3 mm/month with a minimum rate 0.16 mm between eighth and ninth month of distalization and a maximum rate 0.7 mm between the seventh and eighth month of distalization.

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