EFFECTS OF DISTAL JET APPLIANCE IN CLASS-II MOLAR CORRECTION

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ABSTRACT

This study was conducted on a sample of thirty patients selected from Orthodontics department de'Montmorency College of dentistry / Punjab dental Hospital, Lahore. The purpose of study was to evaluate treatment effects of Distal Jet Appliance during Class-II molar correction with a focus on the magnitude of Maxillary first molar distalization, its tipping, extrusion, rotation as well as anchorage loss at premolar-incisor unit. Pre and post distalization lateral cephalogram and study cast were used as evaluation tools. Results showed that there was 3.88 mm space created during 7.11 months; out of which 2.93 mm (75.52 %) showed molar distalization while 0.93 mm (24.48 %) premolar mesialization as anchorage loss. There was 3.41° molar tipping with 0.20 mm extrusion and second premolar showed 7.33 ° distal tipping, 0.90 mm extrusion whereas Incisors showed 1.65 ° labial tipping.

Key words: *Molar Distalization, Distal Jet, Molar Correction*

INTRODUCTION

The primary goal of orthodontic treatment is attainment of an "ideal occlusion", which involves molars placement in class I relationship. Class-II malocclusion usually requires distal movement of maxillary first molars in order to achieve class-I molars and canine relationship.[1,2]

Many researchers have developed numerous treatment modalities for Class-II molar correction from compliance oriented treatment with headgear, Class-II intermaxillry elastics to sliding mechanics, Wilson bimetric distalizing arch system, Molar distalizing bow, Acrylic Cervical Occipital appliance (A.C.C.O) and removable functional appliances to non-compliance treatments using intra-oral devices to distalize the maxillary first molars in to class-I occlusion.[3-6] These intraoral devices consist schematically of an anchorage unit (usually comprising premolars or deciduous molars and an acrylic Nance button) and an active unit. Various force-generating devices for molar distalization have been proposed, including repelling magnets, coil springs on continuous archwire, super elastic nickel-titanium arch wires, Jones jig, distal jet, and Keles slider, springs in beta titanium alloy (pendulum, pendulum with distal screw, K-loop, intraoral bodily molar distalizer), and vestibular screws combined with palatal nickel-titanium coil spring (first class) appliances.[7-20]

These appliances rely on Nance button for anchorage reinforcement. Anchorage is considered the most critical factor when correcting Class II- malocclusion not only for initial maxillary molar distalization, but also for subsequent anterior tooth retraction. Anchorage control is of great importance in orthodontic treatment, and researchers have made many modifications to minimize anchorage loss. [4, 21-24] Recently, miniscrew implants have been proposed to be used clinically as temporary stationary anchorage for orthodontic movements because of their ability to provide absolute anchorage.[25]

The distal jet is one of the more commonly used "noncompliance appliances" for molar distalization. Few studies, however, have investigated the dentoalveolar and skeletal postdistalization changes induced by the distal jet.[2, 4, 26]

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The distal jet (Figure 1) is a fixed lingual appliance that can produce bilateral or unilateral molar distalization in permanent as well as mixed dentition. The appliance consists of a bilateral piston and tube system with the tube embedded in an acrylic button in the palate, supported by attachments on the maxillary second premolars. The tube extends distally, adjacent to the palatal tissues and parallel to the occlusal plane up to the molars. A bayonet wire, inserted into the lingual sheath on the first molar bands, extends into the tube like a piston. A super elastic nickel titanium open coil spring (180gm or 240gm) is placed around this tube and piston arrangement along with an activation lock that is used to compress the spring distally. The springs with 180 grams force are recommended for distalization during mixed dentition while springs exerting 240 grams force are used during permanent dentition with erupted second molars. The activation lock is pushed distally to compress the spring and locked on the tube with a small Allen hex wrench.[2]

Once distalization is complete, the appliance is converted to a Nance holding arch by removing the coil spring and locking the activation collar over the junction of tube and piston wire. The supporting wires are then sectioned from the premolars and the Nance button to let the premolars move distally by driftodontics. The distalization of maxillary molars takes place with less distal tipping and without lingual movement that occurs with the pendulum, and the distal jet can be easily converted into Nance holding arch to maintain the corrected molar position.[2, 27]

Present study tried to evaluate the treatment effects of distal jet appliance in class-11 molar correction.

METHODOLOGY

After carefull evaluation of pretreatment records, thirty patients (16 males and 14 females) with an age range of 12-14 years (mean age 12 years 10 months; 154.26±2.04 months) were selected from patients attending the orthodontics department, de,Montmorency College of Dentistry/ Punjab Dental Hospital, Lahore, Pakistan. Gender differences were not considered because of the short-term use of the distalizing appliance.

After careful screening and selection of suitable patients, a complete set of pretreatment records was taken and same records were repeated after distalization. An informed written consent was taken from parents/ guardians or patients.

Selection Criteria: *Patients with the following criteria were included in this study:*

Bilateral angle's Class-II malocclusion

Non-extraction treatment plan

Normal or low angle vertical pattern with SN-mandibular plane angle 32 degrees or less, maxillary – mandibular plane angle 25 degrees or less

Mild Class-II skeletal pattern with ANB 4-5 degrees

Class-II division I with mild proclination and Class-II division II with mild crowding

No other orthodontic treatment or molar distalization procedure performed before or during the study

All the second molars especially maxillary second molars fully erupted into the occlusion

Good oral hygiene and commitment to maintain proper oral health

Appliance Insertion, activation and reactivation

After achieving sufficient separation and cleansing interproximal area between molars and premolars appliance was seated and checked for passive insertion. Distal jet appliance was cemented as single unit with glass ionomer luting cement (Figure 1). All excessive cement was removed and then appliance activated. Activation lock was slide distally to compress 3mm of the 7mm nickel titanium spring to apply 100 gram force as measured with Corex force measuring gauge. Appliances were reactivated on monthly visits till Class-II molar occlusion got over-corrected to slight Class-III relationship. All the patients were instructed to maintain oral hygiene and use 0.2% Chlorhexidine mouth wash twice daily.

On achievement of desired result, the same distal jet appliance was converted in to Nance holding appliance for retention and stability of distalized molars. The coil springs were removed and activation lock slide over bayonet wire and director to touch distal stop and then locked. The transpalatal connector wires soldered to premolar bands were sectioned.[2, 27]

EVALUATION

Data collection

Cephalometric Analysis

Study cast Analysis

Statistical analysis

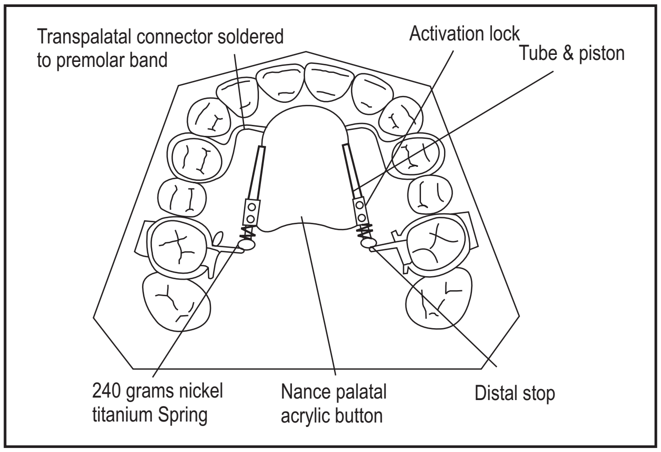

Fig 1: Distal Jet Appliance

a Data collection

Cephalometric radiographs were taken at pre-treatment and post distalization on an X-ray machine under standardized condition in the department of radiology, de,Montmorency College of Dentistry/ Punjab Dental Hospital, Lahore, Pakistan. As all the radiographs were taken on same machine, with same size and brand films. All films were developed under similar conditions magnification factor was not considered.

Cephalometric radiographs and study cast were taken at the following times:

T1 - Immediately prior to placement of appliance.

T2 - Immediately after the removal of appliance.

b Cephalometric Analysis

Method of Tracing

Cephalometric radiographs were traced manually using 0.1 mm black marker on 0.003-inch thick acetate paper. The Cephalometric landmarks were marked and all planes and angles were constructed. All double images were traced with the distal and smaller outline of the structure. The term centroid was used in this analysis to signify a constructed point on the permanent molars and premolars. The centroid is located at the midpoint of a line drawn from the mesial and distal greatest convexity of the individual molars and premolars.[4,6.] All the measurements were made nearest to 0.5° for angular and 0.1mm for linear changes.[28]

Method Error

Fifteen cephalogram were randomly selected and retraced by the same examiner after one month of the original tracing. All the variables of the original tracings were compared to the retracing variables and paired t-test was applied to determine significance of difference. The results of the statistical analysis demonstrated that none of the variables used in this study showed an error of statistical significance at $p<0.05$.

All measurements were analyzed for Cephalometric changes in the following way:

Cephalometric measurements at T1.

Cephalometric measurements at T2.

T1-T2 Changes

All Cephalometric values were measured and divided in following four groups.[29]

Dental Linear (Fig 2)

PTV- maxillary first molar centroid (mm)

PTV- maxillary second premolar centroid (mm)

PTV- maxillary central incisor tip (mm)

PP- maxillary first molar centroid (mm)

PP- maxillary second premolar centroid (mm)

Dental Angular (Fig 3)

SN- Maxillary central incisor long axis (degrees)

SN- Maxillary first molar long axis (degrees)

SN- Maxillary second premolar long axis (degrees)

PTV-maxillary first molar centroid

PTV-maxillary second premolar centroid

PTV-maxillary second molar centroid

PTV-maxillary incisor tip

PP **-**maxillary first molar centroid

PP **-**maxillary second premolar centroid

PP **-**maxillary second molar centroid

SN-maxillary central incisor

SN-maxillary premolar

SN-maxillary first molar

SN-maxillary second molar

Pre-treatment (T1) and post-distalization (T2) maxillary casts were taken and analyzed to determine mesial and distal rotations of the maxillary first molars.[4, 27,30] The models were photocopied to a 1:1 ratio.[31] A line was drawn from incisive papilla along the median palatal raphae to construct midline. The angle formed between the midline and a line passing through the mesiobuccal and mesiopalatal cusp tips of the maxillary first molars determined the rotation of the molars (Fig 4). All the measurements were made nearest to the 0.5° for angular changes.[28]

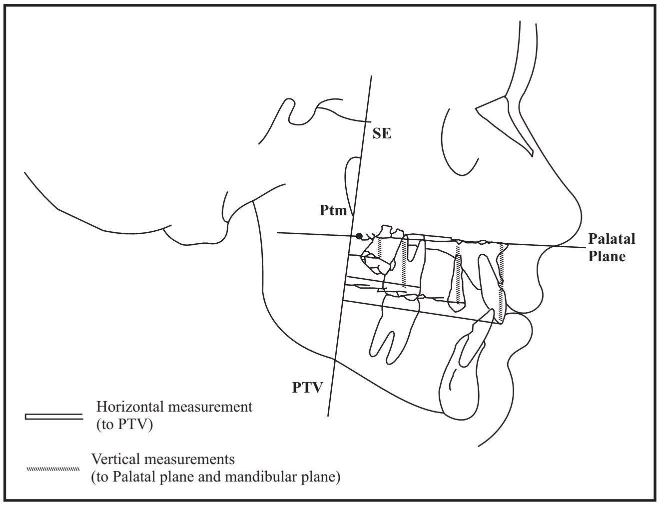

Fig 2: Cephalometric Dental Linear Measurements

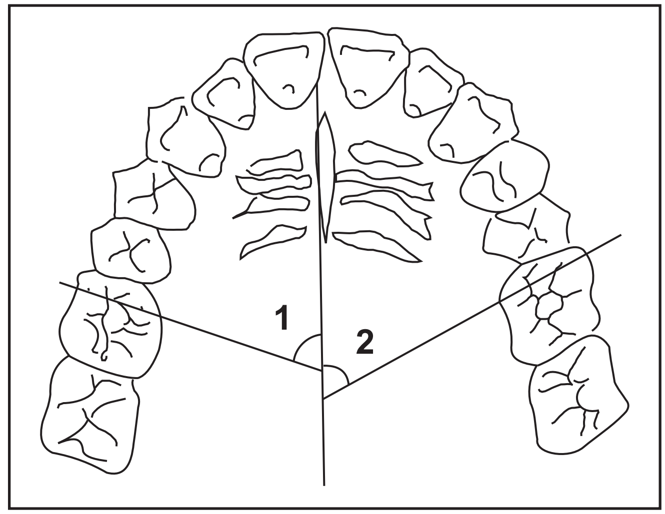

Fig 4: Study Cast Analysis

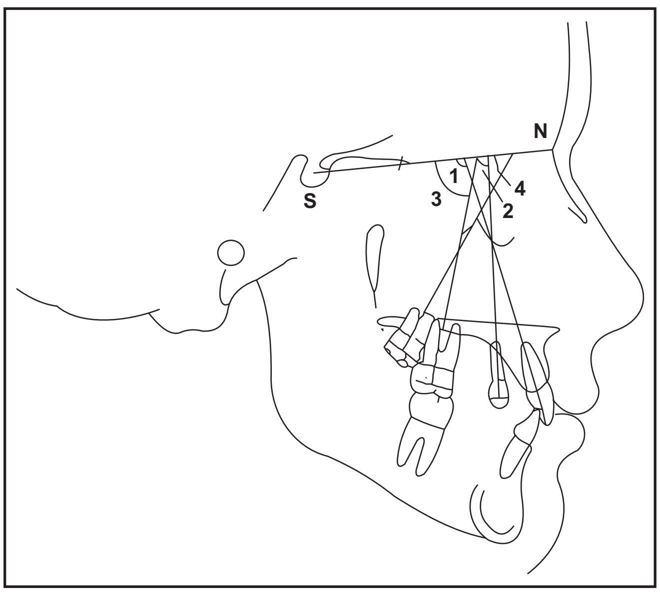

Fig 3:Cephalometric Dental Angular Measurements

Maxillary Model Measurements: 1) Angle between palatal midline and a line bisecting the right mesiobuccal and mesiolingual cusp tips, 2) Angle between palatal midline and a line bisecting the left mesiobuccal and mesiolingual cusp tips.

Measurements

Dental Linear and Angular Changes (Figure-2&3)

The maxillary first molars and second premolars were represented by their mesial height of contour and distal height of contour. Linear and angular changes were measured from the centroid of these teeth. Pterygoid vertical (PTV) was used as the reference plane to evaluate linear changes of maxillary first molar and second premolar in Sagittal plane by constructing lines perpendicular to PTV- plane passing through the centroid of each tooth. Dental changes in vertical plane as extrusion of maxillary first molar and second premolar were assessed by measuring the vertical distance from palatal plane to the centroid of these teeth. Linear distance of maxillary incisor was measured by drawing perpendicular line from PTV-plane to incisor tip (Fig2).

Angular measurements were obtained by constructing a line from centroid of each molar and premolar perpendicular to the mesial- distal line of the respective tooth being measured. The angle that was formed between perpendicular line from the centroid of each tooth and SN plane was used to measure angular changes associated with distalization. The inclination of maxillary central incisor was measured to the anterior cranial base by passing a line through the long axis of tooth and measuring the inferior posterior angle relative to SN plane. Molar and premolar inclinations were evaluated by a line through centroid making an angle with SN plane (Fig.3).

d) STATISTICAL ANALYSIS

The data was analyzed and compared i.e. before and after treatment by student't' test using SPSS Computer Software Program Version 12. A paired t-test was applied to analyze within group differences between pre and post-distalization variables to determine significant changes.

The level of significance was chosen at:

$P < 0.01$ = Significant

$P < 0.001$ = Highly significant

NS = Non significant

RESULTS

Thirty patients with class-II molar relationship were successfully treated with Distal jet appliance. Mean treatment time was 7.11 months. Mean age of the entire sample was 12 years 10 months (154.26 ±2.04 months) with range of 12-14 years.

The Cephalometric and cast analysis results with statistical analysis for the patients sample are given in table 1-5, where **Table 1 and 2** shows number of patients, mean, standard deviation, minimum and maximum dental linear, dental angular, pre and post-distalization Cephalometric measurements made at T1and T2.

TABLE 1: DENTAL LINEAR AND ANGULAR MEASUREMENTS WITH MEAN±SD MINIMUM AND MAXIMUM PRETREATMENT CEPHALOMETRIC MEASUREMENTS (T1)

MEASUREMENTS	Mean±SD	Minimum	Maximum
Dental linear (30)			
PTV- maxillary first molar centroid (mm)	22.30±1.74	19.50	26.00
PTV- maxillary second premolar centroid (mm)	31.52±1.84	26.00	33.50
PTV- maxillary incisor tip (mm)	53.58±2.58	48.00	58.00
PP- maxillary first molar centroid (mm)	18.58±1.73	16.00	20.00
PP- maxillary second premolar centroid (mm)	19.26±1.64	16.50	23.50
Dental angular (30)			
SN-maxillary incisor (degrees)	101.63±6.34	89.00	111.00
SN-maxillary second premolar centroid (degrees)	75.40±4.58	66.00	85.00
SN-maxillary first molar centroid (degrees)	74.52±4.65	65.00	84.00

TABLE 2: DENTAL LINEAR AND ANGULAR MEASUREMENTS WITH MEAN±SD, MINIMUM AND MAXIMUM POST-DISTALIZATION CEPHALOMETRIC MEASUREMENTS (T2)

MEASUREMENTS	Mean±SD	Minimum	Maximum
Dental linear (30)			
PTV- maxillary first molar centroid (mm)	19.37±1.75	16.40	22.50
PTV- maxillary second premolar centroid (mm)	32.47±2.91	21.00	36.50
PTV- maxillary incisor tip (mm)	55.00±3.20	50.00	62.00
PP- maxillary first molar centroid (mm)	18.78±1.72	16.20	22.50
PP- maxillary second premolar centroid (mm)	20.16±1.41	18.00	24.00
Dental angular (30)			
SN-maxillary incisor (degrees)	103.28±6.55	89.00	111.00
SN-maxillary second premolar centroid (degrees)	68.07±4.81	59.00	79.00
SN-maxillary first molar centroid (degrees)	71.11±4.26	63.00	80.00

TABLE 3: DENTAL LINEAR AND ANGULAR MEASUREMENTS INCLUDING MEAN TREATMENT TIME, DIFFERENCE OF MEANS, SD AND P-VALUE FROM PRE TO POST-DISTALIZATION (T1-T2)

MEASUREMENTS	Rx time Months	Pre Rx T1 mean±SD	Post Rx T2 mean±SD	Diff of means	P-value
Dental linear (30)					
PTV-maxillary first molar centroid (mm)	7.11	22.30±1.74	19.37±1.75	2.93	P<0.001
PTV- maxillary second premolar centroid (mm)	7.11	31.52±1.84	32.47±2.91	0.95	NS
PTV- maxillary incisor tip (mm)	7.11	53.58±2.58	55.00±3.20	1.42	P<0.01
PP- maxillary first molar centroid (mm)	7.11	18.58±1.73	18.78±1.72	0.20	NS
PP- maxillary second premolar centroid (mm)	7.11	19.26±1.64	20.16±1.41	0.90	NS
Dental angular (30)					
SN-maxillary incisor (degrees)	7.11	101.63±6.34	103.28±6.55	1.65	NS
SN-maxillary second premolar (degrees)	7.11	75.40±4.58	68.07±4.81	7.33	P<0.001
SN-maxillary first molar (degrees)	7.11	74.52±4.65	71.11±4.26	3.41	P<0.001

N.S =Non significant difference;*P<0.01= Significant difference;** P<0.001=Highly significant difference

TABLE 4: MEAN STUDY MODEL VALUES, STANDARD DEVIATION, NET ROTATION AND P VALUE OF MAXILLARY FIRST MOLAR ROTATION AT PRE AND POST DISTALIZATION (T1-T2)

Measurement (30)	T1 Mean +-SD	T2 Mean ±SD	Rotation T1-T2	p-value
Right Maxillary 1st Molar	56.03±3.72	57.33±3.52	2.55	NS
Left Maxillary 1st Molar	56.40±3.71	56.40±3.61	1.18	NS

N.S=Non significant difference

TABLE 5: OVER ALL DENTAL EFFECTS OF DISTAL JET APPLIANCE

CHANGES (30)	Distal jet
Treatment time (months)	7.11
Total space created (mm)	3.88
Maxillary first molar	
Distalization (mm)	2.93
Percentage (%age)	75.52
Rate per month (mm/month)	0.54
Tipping (Degrees)	3.41
Extrusion (mm)	0.20
Right molar rotation (Degrees)	1.3
Left molar rotation (Degrees)	1.18
Anchorage loss (second premolar)	
Mesial movement (mm)	0.95
Percentage (%age)	24.48
Mesial (-), distal (+) tipping (Degrees)	+7.33
Extrusion (mm)	0.90
(Maxillary incisor)	
Proclination (Degrees)	1.65

Table 3 shows mean treatment time, pretreatment T1 and post treatment T2 means, standard deviation, difference of means and p-value from pretreatment to post distalization dental linear and angular, Cephalometric measurements..

Table-4 shows results of cast analysis with mean ±SD, pre and post-distalization measurements for right and left maxillary first molars.

Table-5 shows over all treatment effects of distal jet appliance

DISCUSSION

Non-extraction treatment of angles Class-II malocclusion most often is attempted with maxillary molars distalization.[29] Numerous methods have been advocated for maxillary molars distalization, distal jet is real innovative molar distalizing appliance used in this study. This clinical prospective study was carried out on a large sample of 30 patients. Iin the literature, the optimum force for maxillary molar distalization ranges from 100-230 grams,[32,33,34] while in this study, 100 grams force was applied.

TABLE-6: MAXILLARY FIRST MOLAR DISTALIZATION AND ANCHORAGE LOSS WITH DISTAL JET APPLIANCE (A COMPARISON OF STUDIES)

REPORT	Time Months	N	SPACE CREATED PER SIDE Total mm)	Molar Distalization (mm)	(%)	RatePer month	Anchorage loss (mm)	(%)
Patel, 1999	10.5	35	4.7	1.9	40.0	0.18	2.8	60.0
Huerter, 1999	6.8	28	5.2	3.1	59.6	0.45	2.1	40.4
Gutierrez, 2001	7.8	30	–	2.6	–	0.33	–	–
Gutierrez, 2001	5.6	20	–	3.7	–	0.66	–	–
Ngantung et al., 2001	6.7	33	4.7	2.1	44.6	0.31	2.6	55.4
Lee, 2001	7.0	25	5.2	3.2	61.5	0.45	2.0	38.5
Davis, 2001	7.9	30	–	3.0	–	0.37	–	–
Chiu, 2001	10.0	33	5.5	3.0	54.5	0.30	2.5	45.5
Chiu, 2001	10.5	20	5.4	3.4	62.9	0.32	2.0	37.1
Bolla et al., 2002	5.0	33	4.6	3,2	69.5	0.64	1.3	30.5
Present sample	7.11	30	3.8	2.93	75.5	0.54	0.95	24.48

Data with courtesy from Bolla et al.[39]

Molar Distalization, Tipping and Extrusion

During a period of 7.11months, distal jet appliance showed 2.93 mm distalization of maxillary first molar with 3.41° distal tipping, 0.95 mm mesial movement of second premolar with 7.33° distal tipping. The total space created was 3.88 mm on each side, out of which 2.93 mm (75.52 %) resulted from first molar distalization while 0.93 mm (24.48%) from anchorage loss as mesial movement of second premolar. Maxillary first molar showed extrusion of 0.20 mm and second premolar extruded 0.90 mm. Right and left molars showed 1.30° and 1.18° rotation respectively. There was insignificant 1.65° proclination of maxillary incisors.

The changes including molar Distalization, tipping and extrusion are similar but slightly differ from other studies carried out with same appliance. Patel[35] showed 1.9 mm maxillary first molar distalization with 2.2° distal tipping. Heurter [36] showed 3.1 mm maxillary first molar distalization with 5.6° distal tipping. The results of Lee[37] showed 3.2 mm maxillary first molar distalization with 2.8° distal tipping. Davis[27] found 3.0 mm distalization of maxillary first molar with 6.0° distal tipping. Chi [38] in his study with distal jet alone and along with fixed brackets found 3.4 mm and 3.0mm maxillary first molar distalization with 3.8° & 5.0° distal tipping. Keles and Sayinsu[30] evaluated the effects of intraoral bodily molar distalizer and concluded 5.23 mm maxillary first molar distalization with out any tipping or extrusion.

Rate of Molar Distalization

The rate of maxillary molar distalization seen in this study was 0.54 mm per month as compared to 0.32 mm per month in Davis[27], 0.30 mm per month in Chiu PP,[39] and 0.64 mm per month in Bolla et al.[40] studies with distal jet appliance.

Space Creation

In the present sample 3.88 mm space was opened between maxillary first molar and second premolar, out of which 75.52 %(2.93 mm) resulted from molar distalization while remaining 24.48% (0.95 mm) was due to mesial movement of second premolars.

Anchorage Loss

In this study maxillary second premolars were mesialized 0.95 mm (24.48%), tipped distally 7.33° and extruded 0.90 mm. Other similar studies conducted on molar distalization with distal jet appliance exhibited more anchorage loss. Ngantung et al.[40] noted 4.3 mm (54.4%), mesial movement of second premolar, 4.3° distal tipping of maxillary second premolars. Lee[37] found 2.0 mm (38.5%) distal movement of second premolar, 2.3° distal tipping of maxillary second premolars, Chiu[38] noted 2.4 mm (45.5%) mesial movement of second premolar, 2.4° distal tipping of maxillary second premolars.

The results of this sample showed comparatively less anchorage loss at second premolar as compared to the results of other studies with distal jet appliance (Table-6). Ghosh and Nanda[4] found 2.55 mm mesial translation with 1.29° tipping and 1.77 mm extrusion of maxillary premolars when first molars were distalized by pendulum appliance. Bussick and McNamara[41] found 1.8mm mesial movement of first premolar with 1.5° mesial tipping with pendulum appliance. Results of Keles and Sayinsu[30] with intraoral bodily molar distalizer showed 4.33 mm mesial movement of maxillary first premolars with 2.73° distal tipping.

In comparison with other distalizing appliances this study exhibited less incisor labial tipping as 2.4° reported by Ghosh and Nanda[4] with the pendulum appliance and 6.73° by Keles and Sayinsu [30] with intraoral bodily molar distalizer. Although 100 grams force was applied to maxillary first molars in this study which is less than other studies. There was less anchorage loss compared to other similar studies that may be due to less force applied for molar distalization.

CONCLUSIONS

It is concluded that distal jet effectively distalize the maxillary first molars and it is a better and reliable method for every day clinical application in molar distalization, especially in uncooperative patients, however, to date, a totally non-compliant appliance does not exist.

There was 3.38 mm space created between maxillary first molar and second premolar, out of which 2.93 mm molar distalization while 0.95 mm premolar mesial movement as anchorage loss. Some undesired effects were also noted in the form of molar and premolar tipping, extrusion as well as molar rotation. Hence Distal Jet is Simple, Easy to use and comfortable appliance for molar distalization with minimum unwanted effects.

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