Egyptian
Orthodontic Journal

MAXILLARY MOLAR DISTALIZATION BY "THE FROG APPLIANCE"

Maher Abd El-Salam Fouda[1], Yasser Lotfy Abdelnaby[2]
Mona Abd El-Aziz Montasser[3], Shacker Mohsen Al-Magaleh[4]

ABSTRACT

Aim of study: *the purpose of this study was to determine dental and skeletal effects of the Frog appliance utilized in distalization of maxillary molars in growing patients.*

Material and method: Ten female patients with Angle Class II molar relation were selected for this study. The mean age of the patients was 11 years and 9 months. All patients were treated with the Frog appliance for an average period of 7 months and 9 days. Cephalometric radiographs and plaster study models were made at two stages; before and after maxillary molar distalization by the Frog appliance. The cephalometric radiographs and the study models were analyzed and the collected data were subjected to statistical analysis. Statistical t-paired test was done to determine the significant difference between the pretreatment and posttreatment measurements.

Results: *The maxillary first molars were distalized an average of 4.85 mm (p≤ .01) into a Class I molar relationship in an average period of 7 months and 9 days. During distalization, the first molars were tipped distally an average of 7.2° (p≤ .02), intruded 4.51 mm (p≤ .01) and rotated mesiobuccaly 7.98° (p≤ .01). Anchorage*

1- Professor of Orthodontics, Faculty of Dentistry, Mansoura University.
2- Associate Professor and Head of Orthodontic Department, Faculty of Dentistry, Mansoura University.
3- Lecturer of Orthodontics, Faculty of Dentistry, Mansoura University.
4- Clinical Demonstrator in Orthodontic Department, Faculty of Dentistry, Ibb University.

loss measured at the first premolars averaged 1.65 mm (p≤ .01), with mesiobuccal rotation of 3.98 (p≤ .01). The maxillary incisors were labially inclined 4° (p≤ .01). No significant skeletal changes were recorded except for A point.

Conclusion: *The first maxillary molars have been distalized by the Frog appliance with significant distal tipping, intrusion and mesiobuccal rotation. Unfortunately it produced reciprocal anchorage loss in the first maxillary premolars and incisors teeth.*

INTRODUCTION

Angle Class II malocclusion represents 21% of Egyptian population with similar incidence in both genders [1]. Treatment of patients with dental Class II due to a tooth size-arch length discrepancy is achieved by creating additional space in the dental arches either by extraction or non-extraction therapy according to the crowding[2]. Non-extraction therapy includes interproximal reduction of teeth (stripping), expansion, uprighting of tilted teeth, derotation of posterior teeth, and/or molar distalization[2,3].

Molar distalization could be accomplished by compliance or non-compliance appliances[4]. Various molar distalizing appliances have been introduced; Wilson bimetric distalizing arch[5], Magnet[6], Pendulum[7], Jones Jig[8], K-Loop Molar Distalizer[9], Greenfield Molar Distalizer[10], First Class Appliance[4], Distal Jet appliance[11], Keles Slider[12], Fast Back appliance[13], New Distalizer[14], and Distal Propeller[15]. Although these intraoral devices require minimal patient collaboration, they have unfavorable side effects, including different degrees of anchorage loss, mesial tipping of premolars, maxillary first molar tipping, posterior rotation of the mandibular plane, proclination of the incisors, and lip protrusion[3].

Recently the Frog appliance has been introduces as noncompliance molar distalizer[16]. The literatures were scarce regarding the effects of this appliance. This study was concerned about evaluating the effects of the Frog appliance in maxillary molar distalization.

MATERIALS AND METHODS

Subjects:

The sample of this study was consisted of ten female patients. The mean age of the patients was 11 years and 9 months. The patients were selected according to the following criteria:

-Age ranged from 11-13 years.

-Angle Class II molar relation with moderate maxillary crowding.

-Straight or flat Profile.

-Good oral hygiene and no oral habit.

All patients were treated with the Frog appliance to distalize the first permanent maxillary molars.

Records:

For all patients the following diagnostic records were made:

I. Photographs: intraoral and extraoral:

II. Upper and lower casts.

III. Radiographs: lateral cephalometric, panoramic, and hand wrist x-ray films.

All records were made before and after one year of treatment with the Frog appliance except the hand wrist and panoramic x-ray films which were taken only before treatment. Hand wrist X-ray films were used to assess the skeletal age. All patients had no sign of calcification of the adductor sesamoid. On the other hand, panoramic x-ray films were utilized to distinguish if there is any pathological condition, root resorption, alveolar bone resorption, supernumerary tooth, and congenital missing tooth.

Lateral cephalometric X-ray analysis:

The pretreatment and posttreatment cephalometric x-ray films were traced on acetate paper. Then the cephalometric points (landmarks), lines and planes were determined.

Cephalometric points:

- N (Nasion): The most anterior point of the nasofrontal suture.
- S (Sella): A constructed point as the center of sella turcica.
- A Point (Subspinale): The deepest point on the anterior outer contour of the maxillary alveolar process between the anterior nasal spine and prosthion.
- B Point (Supramentale): The most posterior point in the anterior outer contour of the mandibular alveolar prosess, in the median plane between infradentale and pogonion
- Me (Menton): The most caudal point in the outline of the symphysis.
- Go (Gonion): A constructed point of intersection of the lines tangent to the posterior margin of the ascending ramus and the lower border of the mandible.
- ANS (Anterior nasal spine): It is the tip of the bony anterior nasal spine, in the median plane.
- PNS (Posterior nasal spine): This is a constructed point as the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose.
- CF (Center of the face): A constructed point as the point of a perpendicular line from the margin of the foramen tundum to the Frankfort plane.
- Or (Orbitale): The lowest point on the lower margin of the bony orbit.
- P (porion): The highest point on the upper margin of the external auditory canal or the ear rod.

Measuring procedures:

A horizontal reference plane (RH) was drawn at an angle of 7 degrees from SN plane through sella, and a vertical reference plane (RV) perpendicular to RH was drawn through sella

Cephalometric lines and planes:

A: Angular variables

1. SNA° (the angle between the SN and NA planes)
2. FH-NA° (the angle between the Frankfort horizontal plane and the NA plane)
3. SNB° (the angle between the SN and NB planes)
4. GoMeSN° (mandibular angle: the angle between GoMe and SN)
6. SN-PP° (the angle between SN and palatal planes)
7. SN-OP° (the angle between SN and functional occlusal planes)
8. U1-SN° (the angle between SN and the long axis of the maxillary incisor)
9. U6-RH° (the angle between the line passing through the radio-opaque vertical indicators of the maxillary first molars and RH), for both first molars the radio-opaque indicators in both sides were recorded separately and the mean of the two results were taken.
10. U4-RH° (the angle between RH and the long axis of the maxillary first premolar)
11. IMPA° (the angle between the long axis of the most prominent mandibular incisor and the mandibular plane)

B: Linear variables 129:

1. A ⊥ RV mm (the perpendicular distance from point A to RV)
2. A ⊥ RH mm (the perpendicular distance from point A to RH)
4. U1-RH mm (the perpendicular distance between the maxillary incisor tip and RH)
6. U6-RH mm (the perpendicular distance between RH and mesial cusp tip of the maxillary first molar)
8. U4 ⊥ RH mm (the perpendicular distance between RH and cusp tip of the maxillary second premolar)

Casts analysis:

Cast analysis

The following landmarks were marked on the pre and post-distalization study casts with a sharp HB lead pencil.

- (mb mesiobuccal, mp mesiopalatal, db distobuccal and dp distopalatal) cusp tips of the maxillary first molar.
- (CMR) center of maxillary molar right side: the point that bisects the mb-dp line with mp-db line.
- (CML) center of maxillary molar left side: the point that bisects the mb-dp line with mp-db.
- (bc) buccal and (pc) palatal cusp tip of the maxillary second premolar
- (CPR) center of maxillary premolar right side: the midpoint of (bc-pc) line.
- (CPL) center of maxillary premolar left side: the midpoint of (bc-pc) line.

Photocopies of the casts were then taken on the scanner machine with 1-to-1 duplication. On the photocopies a vertical reference line (MV) maxillary vertical was first drawn through the palatal suture, bisecting the incisive papilla. A horizontal reference line (MH) maxillary horizontal-passing through the third left palatal rugae (which was used as the main reference point [17]) was then drawn.

The following variables were measured:

A: Angular variables:

- MV-RU6 and MV-LU6: the anterior angle formed by mb-dp line of the maxillary first molar and MV line.
- MV-RU5 and MV-LU5: the anterior angle formed by bc-pc line of the maxillary first premolar and MV line.

B: Linear variables:

1- MH$\perp$ CMR of RU6.

2- MH$\perp$ CML of LU6.

3- MH⊥ CPR of RU5.

4- MH⊥ CPL of LU5.

5- Overjet.

6- Overbite.

The Frog appliance construction:

Bands were fitted to the maxillary first premolars and first molars. Lingual sheath were welded at the center of the lingual side of the first molars bands. An accurate alginate impression was taken with bands in position, and poured in plaster. The appliances kit consisted of a Frog screws, preformed distalizing springs and an activation tool. Palatal retentive arms were adapted of 0.7 mm stainless steel round wire and were soldered to the lingual sides of the first premolar bands. Frog screw was placed parallel to the occlusal plane 10-12 mm apart from the lingual cusp tips of the first molars. Anteroposteriorly the distal of the screw was flush with the mesial aspect of the lingual sheaths. The activation tool was checked for insertion at an angle not greater than 15°. An acrylic Nance button was made. Anchor wires of premolars bands and anterior extensions of the screw were embedded in the acrylic button, locking the appliance securely in place. The distalizing spring was adapted to the palate area of the cast and double back bends were placed bilaterally at the ends for insertion into the lingual sheaths.

Clinical delivery and activation:

The appliance was secured together with an elastic or dental floss, during cementation. The appliance was activated 3 full turns (1.2mm) per month, delivered a force of 225 grams. After overcorrection of every case to "super" Class I, the appliance was removed. An appropriate retention appliance was used

Statistical analysis:

All measurements were calculated and analyzed using the SPSS statistical program. Descriptive statistics including means and standard deviations of the measurements before and after treatment were obtained. Then, t- paired test was done to test the significance difference between the pretreatment and posttreatment measurements (Table I and Table II).

RESULTS

The average period of treatment was 7 months and 9 days. The skeletal measurements changes were not significant for the sample before and after distalization. Except for A point which recorded significant increase by 0.95° in SNAº (p≤ .05), 2.05° in FH-NAº (p≤ .05) and decreased in A-VH mm by 2.05 (p≤ .05).

The upper first molars were significantly distalized 4.85 mm (p ≤ .01) with asymmetrical behavior, were tipped 7.2º (p≤ .02), were intruded 4.51 mm (p≤.01), and were rotated mesiobuccaly 7.98 º (p ≤ .01). The intermolar distance was increased significantly 1.87 mm (p≤ .02).

Table I: The means, standard deviations (SD), and the results of t-test of the pretreatment and posttreatment cephalometric measurements.

	Pretreatment		**Posttreatment**		**Changes**		**t value**	
	Mean	SD	Mean	SD	Mean	SD		
SNAº	81	**± 2.51**	81.95	**± 2.13**	.95	**± 1.09**	2.752	**.022 ***
SNBº	77.1	**± 2.87**	77.5	**± 2.51**	.4	**± .62**	2.058	**.070 NS**
FH-NAº	85.8	**± 3.65**	87.85	**± 3.46**	2.05	**± 2.15**	3.011	**.015 ***
A-RVmm	78.05	**± 6.9**	75.49	**± 4.6**	2.56	**3.81**	2.128	**.062 NS**
A-RH mm	57.88	**± 5.06**	55.83	**± 4.46**	2.05	**± 2.33**	2.788	**.021 ***
GoMe-SN º	35.7	**± 5.95**	36.65	**± 6.43**	.95	**± 2.6**	1.157	**.277 NS**
SN-PP º	10.2	**± 2.62**	9.32	**± 3.19**	.88	**± 1.39**	2.002	**.076 NS**
SN-OP º	17.45	**± 4.49**	18.55	**± 4.37**	1.1	**± 2.59**	1.343	**.212 NS**
U1-SNº	102.1	**± 5.77**	106.1	**± 4.86**	4	**± 2.4**	5.262	**.001 ****
U1-RHº	85.01	**± 5.62**	81.96	**± 547**	3.05	**± 3.05**	3.163	**.011 ***
L1MPº	47.29	**± 3.1**	46.28	**± 3.44**	1.01	**± 1.82**	1.751	**.0114 NS**
U4-RH º	91.15	**± 3.75**	91.95	**± 5.55**	.8	**± 3.33**	.760	**.466 NS**
U4-RH mm	80.41	**± 5.88**	78.95	**± 4.82**	1.46	**± 3.41**	1.354	**.209 NS**
U6-RH º	105.68	**± 5.9**	112.88	**± 6.13**	7.2	**± 7.97**	2.857	**.019 ***
U6-RH mm	76.08	**± 5.45**	71.57	**± 5.33**	4.51	**± 3.8**	3.751	**.005 ****

(*: Significant p≤ .02,**: highly significant p≤ .01, NS: not significant)

Table II: The means, standard deviations (SD), and the results of t-test of the pretreatment and posttreatment measurements of dental casts.

	Pretreatment		**Posttreatment**		**Changes**		**T value**	
	Mean	SD	Mean	SD	Mean	SD		
Overjet	3.34	**± .94**	4.24	**± 1.33**	.9	**± .91**	3.128	**.012 ***
Overbite	3.49	**± .87**	2.5	**± 2.16**	.99	**± 1.54**	2.039	**.072** NS
MV-U4 □	76.38	**± 16.74**	80.35	**± 18.61**	3.98	**± 7.04**	3.572	**.006 ** **
MH-U4 □	2.63	**± 3.29**	4.28	**± 4.75**	1.65	**± 2.25**	4.636	**.001 ** **
IPD	33.96	**± 2.05**	34.39	**± 1.99**	.43	**± .32**	4.205	**.002 ** **
MV-U6□	27.73	**± 5.95**	35.7	**± 13.45**	7.98	**± 13.03**	3.870	**.004 ** **
MH-U6 □	14.6	**± 4.18**	19.45	**± 5.16**	4.85	**± 3.87**	7.932	**.000 ** **
IMD	44.98	**± 2.12**	46.85	**± 2.52**	1.87	**± 1.99**	2.968	**.016 ***

(□ Mean of both sides, *: Significant p≤ .02,**: highly significant p≤ .01, NS: not significant)

Figure1: The Frog Appliance. Pretreatment intraoral photograph.

Figure 2: The Frog appliance. Posttreatment intraoral photograph.

The upper incisors and lower incisors showed a significant labial tipping by 4º ($p \leq .01$) and 1.5º ($p \leq .05$) respectively. The linear distance between upper incisors to the horizontal reference line was decreased significantly 3.05 mm ($p \leq .05$). Overjet significantly increased 0.9 mm ($p \leq .05$).

The upper first premolars were significantly protracted 1.65 mm with asymmetrical behavior, and were rotated mesiobuccaly 3.98 º ($p \leq .01$), with asymmetric behavior. The interpremolar distance was increased significantly .043 mm ($p \leq .01$).

The upper first molars were distalized 74.6% of the gained space with an average of 0.7 mm per month (± 0.23), while loss of anchorage represented by mesial movement of the upper first premolars was 25.4% of the gained space.

DISCUSSION

In an attempt to distalize molar with intramaxillary anchorage noncompliant treatment modalities have been introduced and modified to hold certain needs or to improve their efficacy. Despite the effective distalization, these appliances still produce discreet amount side effects. Retention of the gained space and preventing relapse during retraction of anterior teeth are also another challenge.

The present study showed that the Frog appliance was an effective fixed noncompliant appliance to distalize molars. Super Class I molar relationship was established for 10 cases in a period of 7.29 months on average. This finding was in accordance with Keles and Sayinsu 2000 [19]. However, a lot of studies reported shorter period than this study, Ghosh and Nanda 1996[20] Byloff and Darendeliler 1997[21] and Byloff et al 1997[22], Fortini et al 1999[23], Ngantung et al 2001[24], Bolla et al 2002 [25], Nishii et al 2002 [26], and Bayram et al 2010 [18].

Skeletal measurements changes in this study were insignificant except for A point position represented by significant increase in SNAº (0.95 º ±1.09), increase in FH-NH º (2.15º ± 2.15º) and decrease in vertical distance between A point and horizontal reference line A-RH by (2.05 mm ± 2.33 mm). Those findings were in agreement with

Kucukkeles et al 2006 [27]. Keles and Sayinsu 2000 [19] reported significant increase in SNAº and ANBº. Fortini et al 1999 [23] also recorded a significant increase in SNAº. Ghosh and Nanda 1996 [20] and Ngantung et al 2001 [24] evidenced a change in A point position.

Relation of palatal plane, occlusal plane and mandibular plane to the cranial base showed no significant changes. The brief duration of treatment alone would be sufficient reason not to expect such effects on the skeletal skull growth of patients.

The molars were distalized in a mean of 4.85 mm ± 3.87 mm. This range of finding was close to those of Keles and Sayinsu 2000 [19] and Keles 2001 [12]. It was greater than those of Ghosh and Nanda 1996[20], Byloff and Darendeliler 1997[21], Byloff et al 1997[22], Fortini et al 1999 [23], Ngantung et al 2001[24], Bolla et al 2002[25], Nishii et al 2002[26], and Kucukkeles et al 2006 [27].

The position of the Frog screw was critical to produce bodily molar distalization to provide bodily tooth movement rather than root or crown tipping [16]. In the present study the significant tipping of the maxillary first molars 7.2º was most probably due to the presence of the second molars at the level of the neck of the first molar[28,29], and the application of heavy force. Similar result has been reported in other studies. It was lesser than that of Ghosh and Nanda 1996 [20], and Byloff and Darendeliler 1997[21]. On the other hand these results were greater than those of Byloff et al 1997[22], Fortini et al 1999[23], Keles and Sayinsu 2000[19], Ngantung et al 2001[24], Bolla et al 2002[25], Nishii et al 2002[26], Kucukkeles et al 2006[27], and Bayram et al 2010[18]. Byloff et al 1997[22] incorporated an uprighting bend of 10-15° into the distalizing spring during the second phase of treatment to avoid excessive distal tipping of the maxillary molars.

A significant mesiobuccal rotation of the first maxillary molar was found in this study. It was an agreement with those of Ghosh and Nanda 1996 [20] and Kucukkeles et al 2006 [27]. Other studies showed insignificant first molar rotation like Keles and Sayinsu 2000[19], this finding was advantageous since mesiopalatal rotation was obvious before treatment.

An important finding in this study was the significant intrusion of the maxillary first molar (4.51 mm ± 3.8 mm) which was attributed to the

vertical position of the Frog screw with distal inclination to allow for the activation tool to be inserted, or it might be a result of intrusive force exerted by the tongue. That was an agreement with Ghosh and Nanda 1996[20,] Byloff and Darendeliler 1997[21], and Kucukkeles et al 2006[27]. However, this was disagreed with Fortini et al 1999 [23].

In the present study the anchorage unit was unable to completely resist the reciprocal mesial force of the activated coil screw. Significant loss of anchorage was represented by protraction of the first premolars (1.65 mm ± 2.25 mm). The maxillary second premolar was excluded from the anchorage unit and was left to be drifted distally under the influence of transseptal fibers. That decreased the treatment time but on the other hand increased the anchorage loss. Anchorage loss was also attributed to the compressibility of the palatal mucosa and sometimes to the shallow palatal vault that allowed for mesial movement of the Nance button. Similar results were explored with Byloff and Darendeliler 1997[21], Fortini et al 1999 [23], Keles 2001, Bolla et al 2002 [25], and Nishii et al 2002 [26]. But anchorage loss was lesser than those of Ghosh and Nanda 1996 [20,] Byloff et al 1997, Keles and Sayinsu 2000[19], and Kucukkeles et al 2006[27].

In this study cast measurements investigation showed that the maxillary first premolars significantly rotated mesiobuccally (3.98º ± 7.04º) and this was attributed to the mesial movement of the Nance button and anchor wires. Insignificant premolar rotation was reported by Kucukkeles et al 2006 [27].

Proclination of the maxillary central incisors, associated with an increase in overjet, was commonly observed as an expression of anterior anchorage loss during molar distalization therapy of the present study. The amounts of incisor flaring (4° ± 2.4°) induced by the Frog appliance were more than those produced by other distalizing appliances reported in studies of, Ghosh and Nanda 1996 [20,] Byloff and Darendeliler 1997[21,] Byloff et al 1997 [22] , Fortini et al 1999 [23], Keles 2001, and Bolla et al 2002[25]. Other investigators reported more incisor tipping than findings reported in this study like, Ngantung et al 2001[24], Keles and Sayinsu 2000[19] and Kucukkeles et al 2006 [27]. On the other hand close results were reported in study of, Nishii et al 2002 [26] and Bayram et al 2010 [18].

In the present work the overbite decreased insignificantly (- 0.99 mm ± 1.54) according the dental cast measurements as a result of treatment. This was attributed to the intrusion and labial flaring of upper incisors. Significant decrease in overbite was reported in studies of Ghosh and Nanda 1996 [20], Keles 2001, and Bayram et al 2010 [18], Other studies showed insignificant decrease in overbite like that of Bolla et al 2002 [25] .

The Frog appliance of the present work induced an average of (0.7 mm ± 0.23 mm per month) distal movement of the crowns of the maxillary first molars in relation to the third left palatal rugae during a period of 7.29 months. Since the activation of the screw produced 0.4 mm per full turn which equaled to 1.2 mm of distal movement per month but not all this space was transmitted to the molars crowns. A high percentage of this distance faded away in loss of anchorage. Close result were reported by Byloff and Darendeliler 1997 [21] and Keles and Sayinsu 2000[19]. However, distalization rates less than the findings of this study were reported by Ghosh and Nanda 1996[20], Byloff et al 1997 [22], Ngantung et al 2001[24], Bolla et al 2002 [25] and Nishii et al 2002[26].

In the present study; molar distalization accounted for 74.61 % of the change in sagittal position between the first molar and the first premolar. Similar results were reported by Byloff and Darendeliler 1997 [21], Fortini et al 1999 [23], and Bolla et al 2002 [25]. The amount of average distalization of the first molar in this study was greater than that reported by Ghosh and Nanda 1996[20], Byloff et al 1997[22], Keles and Sayinsu 2000[19], Ngantung et al 2001 [24], and Nishii et al 2002 [26].

Molar distalization cost some anchorage loss. However, the lost anchorage was regained by distal relapse of premolars during the stabilization of maxillary molars with Nance button for 2-3 months, or by second phase of full fixed orthodontic treatment.

The activation screw was temporarily removed from the Nance button to allow for easy polishing during activation. One of patients in this study had broken the lingual sheaths of upper molars and had the distalizing spring removed. The patient ingested the Frog screw with food. An abdomen radiograph was taken 3 days later the film was clear and the appliance was assumed to pass through faeces.

The stability of distally tipped molars was suspect, and their use as anchorage to retract the anterior teeth was questionable. Angelieri et al 2006 [30] recommended retracting the molars to super Class I position and retention for 2-3 months. Retention was done for the cases of the present study by Nance appliance. The premolars were allowed to drift distally under the influence of the transseptal fibers.

CONCLUSION

From this study the followings were concluded:

The Frog appliance was an effective noncompliance distalizer, easily assembling device with easy activation. The first maxillary molars have been distalized by the Frog appliance with significant distal tipping, intrusion and mesiobuccal rotation. Unfortunately the Frog appliance produced reciprocal anchorage loss in the first maxillary premolars and incisors teeth, and the overjet slightly increased.

Further studies are needed to determine the effects of bone supported Frog appliance. Some modification may be needed in the Frog appliance to prevent ingestion or aspiration of separated assembly.

REFERENCES

1. El-Mangoury NH and Mostafa YA: Epidemiologic panorama of dental occlusion. Angle Orthod. 60 (3): 207-14. 1987.
2. Proffit WR and Fields HW Jr. Orthodontic treatment Planning: from problem list to specific plan. 4th ed. St. Louis: Mosby. Chap 7. page. 251-76. 2007.
3. Joseph AA and Butchart CJ. An evaluation of the Pendulum distalizing appliance.Semin Orthod. 6: 129-135. 2000.
4. Fortini A, Lupoli M, Giuntoli F and Franchi L: Dentoskeletal effects induced by rapid molar distalization with the first class appliance. Am J Orthod Dentofacial Orthop. 125(6):697-705. 2004.
5. Wilson WL: Modular orthodontic systems. Part 2. J Clin Orthod. 12(5): 358-75.1978.

6. Blechman AM: Magnetic force systems in orthodontics. Clinical results of a pilot study. Am J Orthod. 87(3): 201-10. 1985.
7. Hilgers JJ. The Pendulum Appliance for Class II non-compliance therapy. J Clin Orthod. 26(11):706-14.1992.
8. Jones RD and White JM: Rapid Class II molar correction with an open-coil jig. J Clin Orthod. 26(10): 661-4. 1992.
9. Kalra V.The K-loop molar distalizing appliance. J Clin Orthod. 29(5): 298-301. 1995.
10. Greenfield RL: Fixed piston appliance for rapid Class II correction. J Clin Orthod. 29(3): 174-83. 1995.
11. Carano A, Testa M: The distal jet for upper molar distalization. J Clin Orthod. 30(7): 374-80. 1996.
12. Keles A, Pamukcu B and Tokmak EC: Bilateral Maxillary Molar Distalization with Sliding Mechanics: Keles Slider. World J Orthod. 3(1):57-66. 2002.
13. Lanteri C, Francolini F and Lanteri V: Distalization Using the FAST BACK Expansor,Requirements, Ideas, Comparisons and Applications. Ortho News. 1(25): 2-3. 2003. Available on line at http://www.americantooth.com/downloads/orthonews/FASTBACK.pdf
14. Baccetti T and Franchi L: A New Appliance for Molar Distalization. Leon Boll Int. 2: 3-7. 2001. Available on line at http://www.americantooth.com/downloads/orthonews/MOLARDIST.pdf
15. Jena AK and Panda S: Distal Propeller: An appliance with new concepts in the innovation of molar distalization appliance design: Orthod Cyber J. Available on line at www.oc-j.com/june09/Distalizer.pdf
16. Walde KC: The simplified molar distalizer. J Clin Orthod. 37(11): 616-9. 2003.
17. Abdel-Aziz HM and Sabet NE: Palatal rugae area: a landmark for analysis of pre- and post-orthodontically treated adult Egyptian patients. East Mediterr Health J. 7(1-2): 60-6. 2001.
18. Bayram M, Nur M and Kilkis D: The frog appliance for upper molar distalization: a case report. Korean J Orthod. 40(1): 50-60. 2010.

19. Keles A and Sayinsu K: A new approach in maxillary molar distalization: intraoral bodily molar distalizer. Am J Orthod Dentofacial Orthop. 117(1): 39-48. 2000.
20. Ghosh J and Nanda RS: Evaluation of an intraoral maxillary molar distalization technique. Am J Orthod Dentofacial Orthop. 110(6): 639-46. 1996.
21. Byloff FK, Darendeliler MA: Distal molar movement using the pendulum appliance. Part 1: Clinical and radiological evaluation. Angle Orthod. 67(4): 249-60. 1997.
22. Byloff FK, Darendeliler MA, Clar E and Darendeliler A: Distal molar movement using the pendulum appliance. Part 2: The effects of maxillary molar root uprighting bends. Angle Orthod. 67(4): 261-70. 1997.
23. Fortini A, Lupoli M and Parri M: The First Class Appliance for rapid molar distalization. J Clin Orthod. 1999 Jun;33(6):322-8.
24. Ngantung V, Nanda RS and Bowman SJ: Posttreatment evaluation of the distal jet appliance. Am J Orthod Dentofacial Orthop. 120(2):178-85. 2001.
25. Bolla E, Muratore F, Carano A and Bowman SJ: Evaluation of maxillary molar distalization with the distal jet: a comparison with other contemporary methods. Angle Orthod. 72(5): 481-94. 2002.
26. Nishii Y, Katada H and Yamaguchi H: Three-Dimensional Evaluation of the Distal Jet Appliance. World J Orthod. 3: 321–327. 2002.
27. Kucukkeles N, Cakirer B and Mowafi M: Cephalometric evaluation of molar distalization by hyrax screw used in conjunction with a lip bumper. World J Orthod. 7(3): 261-8. 2006.
28. Gianelly AA, Vaitas AS and Thomas WM: The use of magnets to move molars distally. Am J Orthod Dentofacial Orthop. 96(2):161-7. 1989.
29. Erverdi N, Koyutürk O and Küçükkeles N: Nickel-titanium coil springs and repelling magnets: a comparison of two different intra-oral molar distalization techniques. Br J Orthod. 24(1): 47-53.1997.
30. Angelieri F, Almeida RR, Almeida MR and Fuziy A: Dentoalveolar and skeletal changes associated with the pendulum appliance followed by fixed orthodontic treatment. Am J Orthod Dentofacial Orthop. 129(4): 520-7. 2006.