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Clinical Evaluation of the Effect of Piezocision on the Rate of Tooth Movement during Distalization of Maxillary Molars

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Abstract:

Objective :to investigate the effect of piezocision on the rate of tooth movement during distalization of maxillary molars.

Design 2 **:**arms randomized controlled clinical trial with an allocation ratio of.1:1

Setting :The outpatient department of the dental college ,Ain Shams University.

Participants 20 **:**adult patients with Angle class II molar relationship.

Methods :All patients had the distalization appliance cemented and two palatal miniscrews inserted .The experimental group consisted of 10 patients who received 3vertical piezocisions mesial and distal to the first and second maxillary molars .All patients were followed each 2 weeks for appliance activation .These were compared with a control group treated with identical appliace without piezocisions and were assessed for rate of tooth movement)maxillary first molar distalization (using digital models.

Results :A statistically significant increase in rate of tooth movement in the piezocision group) p (0.05>in the first two months of distalization only.

Conclusion : Piezocision has a limited effect on the rate of tooth movement during maxillary molar distalization.

Introduction:

Class II malocclusion is one of the most frequently encountered problems in orthodontic practice .Where there is a mild or moderate Class II malocclusion in an adult or an adolescent who is too old for growth modification ,camouflage treatment

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by tooth movement can be used .Surgical correction is reserved for adults with severe Class II malocclusion and no further growth potential[1].

Maxillary molar distalization is an integral part of most non-extraction treatment philosophies for Class II malocclusion .Various distalization techniques were developed and a vast number of distalization appliances were designed starting with the use of extra-oral traction to distalize maxillary molars to the use of non-compliance dependent skeletally anchored distalization appliances[2–5].

In recent decades major attempts have been made to shorten the length of treatment. Numerous methods have been proposed to accelerate the rate of tooth movement so that faster and better treatment options can be provided to the patients .Prolonged orthodontic treatment also carries the risk of root resorption ,enamel demineralization, caries and gingival recession and leads to decrease in the patient compliance[6–9].

The surgical approach is the most clinically used and most tested with known predictions and stable results .However ,it is invasive, aggressive ,and costly ,and patients are not open to the ideas involving surgery unless it is the only option that is needed to have a proper occlusion .Piezocision is an innovative, minimally invasive surgical technique designed to overcome the drawbacks of the other surgical techniques .It has evolved from being initially a minimally invasive surgical alternative to conventional corticotomies to a more sophisticated philosophy where the orthodontist is given the tools to control the anchorage value of teeth by selectively altering the bone density surrounding them. Piezocision also gives the periodontist and the orthodontist another tool to expand their scope of practice[10–13].

Few studies attempted to utilize some of the acceleration techniques in order to shorten the time needed for maxillary molar distalization and thus shorten the orthodontic treatment period as a whole[14–16].

This study was carried out in order to evaluate the effect of piezocision as a minimally invasive surgical acceleration technique on the rate of tooth movement during distalization of maxillary first molars and-3 dimensional digital records were utilized for evaluation of acquired results.

Materials and Methods:

A total of 20 patients were recruited from the outpatient clinic of the Orthodontic Department at the Faculty of Dentistry Ain Shams University ,they were allocated randomly 1:1 ratio into 2 groups ,control group and piezocision group .Inclusion criteria :Adult patients with age ranging from 18 to 25 years, no previous orthodontic treatment ,presence of all permanent teeth excluding the third molars, Bilateral Class II molar relationship ,increased overjet or upper anterior crowding ,Normal or low mandibular plane angle .Exclusion criteria: Medical problems that affect tooth movement)e.g .osteoporosis ,bisphosphonate therapy, etc ,(...Bad oral hygiene) will be evaluated through plaque index & pocket depth.(

Methods : An informed consent was signed by each patient before their enrollment in the current study in which the aim of the study, the methodology and possible complications will be clearly described .Full orthodontic records were taken for the patients who met the inclusion criteria .These records are :Extra-oral and intra-oral photographs ,orthodontic study casts ,panoramic and cephalometric radiographs.

Maxillary first molars were banded and distalization appliances were fabricated. After distalization appliances cementation, 2miniscrews 8*1.6 mm size were inserted in the palatal inter-radicular area between the first molar and the second premolar .For the piezocision group ,after securing local anesthesia 3 ,buccal vertical gingival incisions were made using a bald parker blade15 mesial and distal to the first molar and distal to the second molar 3 mm apical to the inter-dental papilla .Piezotome was used to perform cortical incisions through the vertical gingival incisions3 mm in depth or till drop in

the cancellous bone is felt .No sutures were needed and patients were given oral hygiene instructions.

Appliances were activated using NiTi closed coil springs 300) gm .(Patients were followed up every 2 weeks for appliance re-activation and study models were taken every 4 weeks till the end of distalization .Digital models obtained from study models scanning were analyzed using computer software to compare the rate of molar movement between the2 groups.

Error of measurement: The error of measurement in this study was assessed through assessing the intra-operator and inter-operator reliability.

Statistical Analysis : Numerical data were explored for normality by checking the data distribution and using Shapiro-Wilk tests .All data showed normal) parametric (distribution. Student's t-test was used to compare between the two groups .Intra –and inter-observer reliability were assessed using Cronbach's alpha reliability coefficient and Intra-Class Correlation Coefficient) ICC .(The significance level was set at P .0.05 ≥ Statistical analysis was performed with IBM SPSS Statistics for Windows ,Version .22.0 Armonk ,NY :IBM Corp.

Results : Figure(1)illustrates the subject flow through the trial using a CONSORT diagram ,Out of the 20 subjects enrolled in the study 1 ,patient from piezocision group was lost to follow up leaving a total of19 subjects completing the study and analyzed9) experimental and 10 control.(

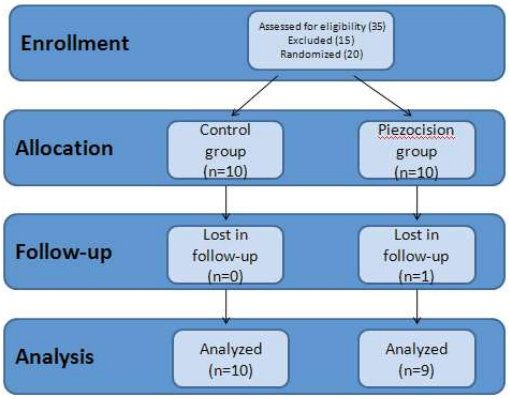

Figure 1 CONSORT Flow Chart

Paired t-test was used to compare the mean and standard deviation) SD (values for the change in maxillary first molar rate of tooth movement in the experimental group .Highly statistically significant changes were found for every two consecutive month readings in the experimental group **Table (1) and figure .(2)**The maximum mean rate of maxillary first molar movement was 0.65 mm/month between the third and forth months.

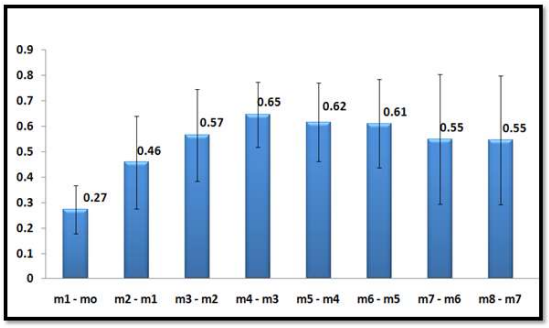

Figure 2 Rate of maxillary first molar movement) mm/month (for experimental group.

Table 1 ***Comparison of the rate of maxillary first molar rate of movement between every two consecutive months in the experimental group.***

	N	Mean	SD	SEM	Paired Differences			95% Confidence Interval of the Difference		t	df	P value
					Mean	SD	SEM	Lower	Upper			
m1	18	12.11	2.76	0.65	0.27	0.10	0.02	0.23	0.32	12.15	17	8.2877E-10
Mo	18	11.83	2.71	0.64								
m2	18	12.56	2.84	0.67	0.46	0.18	0.04	0.37	0.55	10.61	17	6.4749E-09
m1	18	12.11	2.76	0.65								
m3	18	13.13	2.84	0.67	0.57	0.18	0.04	0.48	0.66	13.32	17	2.0180E-10
m2	18	12.56	2.84	0.67								
m4	18	13.78	2.851	0.67	0.65	0.13	0.03	0.58	0.71	21.34	17	1.0345E-13
m3	18	13.13	2.84	0.67								
m5	16	14.36	3.06	0.77	0.62	0.15	0.04	0.53	0.70	15.91	15	8.4135E-11
m4	16	13.74	3.03	0.76								
m6	16	14.97	3.09	0.77	0.61	0.17	0.04	0.52	0.70	14.03	15	4.9905E-10
m5	16	14.36	3.06	0.77								
m7	9	13.67	2.09	0.70	0.55	0.25	0.08	0.35	0.75	6.48	8	0.00019
m6	9	13.12	2.09	0.70								
m8	7	14.38	2.36	0.89	0.55	0.25	0.10	0.31	0.78	5.71	6	0.00124
m7	7	13.83	2.38	0.90								

Paired t-test was used to compare the mean and standard deviation) SD (values for the change in maxillary first molar rate of tooth movement in the control group .Highly statistically significant changes were found for every two consecutive month readings in the control group **Table(2) and figure .(3)** The maximum mean rate of maxillary first molar movement was 0.63 mm/month between the fourth and fifth months.

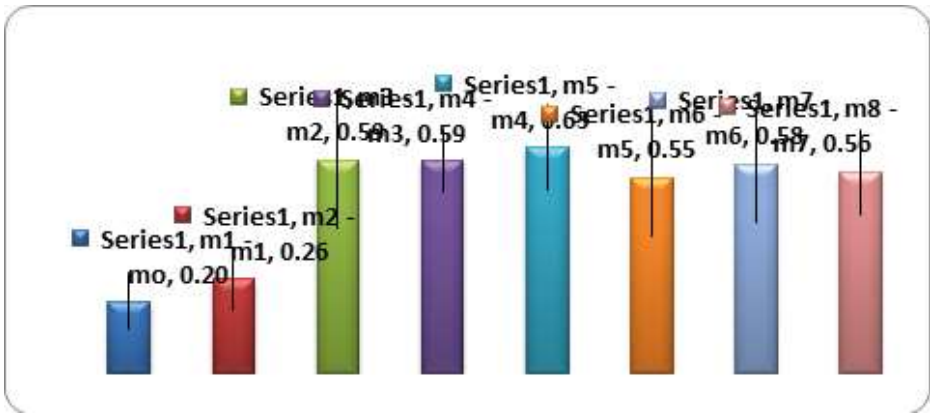

Figure :(3) ***Rate of maxillary first Molar movement) mm/Month (for control group.***

Table :(2) ***Comparison of the rate of maxillary first molar rate of movement between every two consecutive months in the control group.***

	N	Mean	SD	SEM	Paired Differences			95% Confidence Interval of the Difference		t	df	P value
					Mean	SD	SEM	Lower	Upper			
m1	20	12.53	2.42	0.54	0.20	0.08	0.02	0.16	0.24	11.53	19	5.0711E10-
mo	20	12.33	2.42	0.54								
m2	20	12.80	2.43	0.54	0.26	0.08	0.02	0.22	0.30	14.28	19	1.3093E11-
m1	20	12.53	2.42	0.54								
m3	20	13.39	2.45	0.55	0.59	0.19	0.04	0.50	0.68	14.02	19	1.7881E11-
m2	20	12.80	2.43	0.54								
m4	19	14.13	2.40	0.55	0.59	0.09	0.02	0.55	0.63	29.53	18	1.0612E16-
m3	19	13.53	2.43	0.56								
m5	19	14.76	2.45	0.56	0.63	0.12	0.03	0.57	0.69	23.74	18	4.8926E15-
m4	19	14.13	2.40	0.55								
m6	17	15.63	2.37	0.57	0.55	0.16	0.04	0.46	0.63	13.70	16	2.9672E10-
m5	17	15.08	2.38	0.58								
m7	13	16.40	2.56	0.71	0.58	0.16	0.04	0.48	0.68	13.08	12	1.8430E08-
m6	13	15.82	2.46	0.68								
m8	3	15.49	3.89	2.25	0.56	0.12	0.07	0.27	0.85	8.23	2	0.01446
m7	3	14.93	3.78	2.18								

Table :(3) ***Comparison of the rate of maxillary first molar movement between the two groups.***

		N	Mean	SD	SEM Mean	Differences		95% Confidence Interval of the Difference		t	df	P value
						SD	Lower	Upper				
M1-M0	Control	20	0.20	0.08	0.02	0.07-	0.03	0.13-	0.01-	2.53-	36	0.01584
	Experim.	18	0.27	0.10	0.02							
M2-M1	Control	20	0.26	0.08	0.02	0.19-	0.05	0.29-	0.10-	4.30-	36	0.00013
	Experim.	18	0.46	0.18	0.04							
M3-M2	Control	20	0.59	0.19	0.04	0.03	0.06	0.09-	0.15	0.46	36	0.64487
	Experim.	18	0.57	0.18	0.04							
M4-M3	Control	19	0.59	0.09	0.02	0.05-	0.04	0.13-	0.02	1.50-	35	0.14210
	Experim.	18	0.65	0.13	0.03							
M5-M4	Control	19	0.63	0.12	0.03	0.01	0.05	0.08-	0.11	0.30	33	0.76581
	Experim.	16	0.62	0.15	0.04							
M6-M5	Control	17	0.55	0.16	0.04	0.07-	0.06	0.19-	0.05	1.11-	31	0.27580
	Experim.	16	0.61	0.17	0.04							
M7-M6	Control	12	0.57	0.17	0.05	0.02	0.09	0.17-	0.21	0.25	19	0.80157
	Experim.	9	0.55	0.25	0.08							
M8-M7	Control	3	0.56	0.12	0.07	0.01	0.16	0.35-	0.37	0.09	8	0.92945
	Experim.	7	0.55	0.25	0.10							

P 0.05 ≥ significant ,p 0.01 ≥ highly significant

Independent t-test was used for Comparing the rates of maxillary molar movement between the two groups which revealed statistically significant increase in the rate of movement in the experimental group compared to the control group in the first 2 months followed by statistically insignificant difference for the rest of the distalization period as shown in Table (3) and figure.(4)

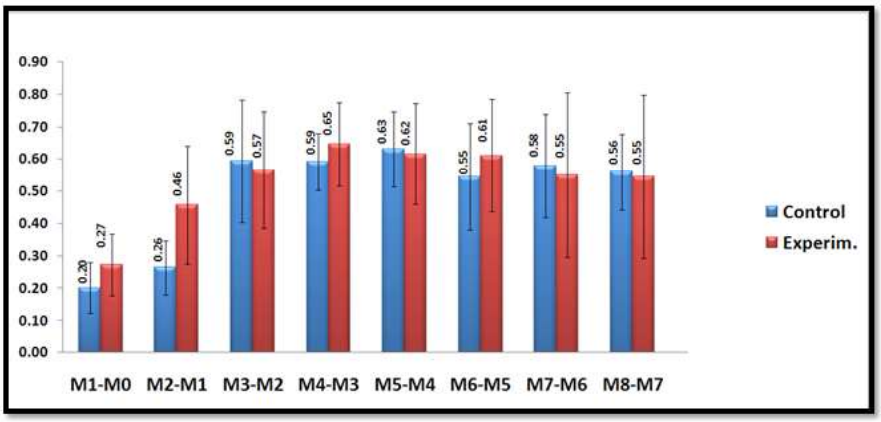

Figure :(4) ***Bar chart comparing the Maxillary first Molar rate of Movement) mm/month(for the experimental and control groups.***

Discussion:

Patients with class II malocclusion represent a large percentage of patients seeking orthodontic treatment .It represents about % 21 among the Egyptian adults orthodontic patients[17] .Treatment modalities of adult patients with mild to moderate class II malocclusion can be a point of controversy .Either extraction or non-extraction treatment can be used as camouflage treatment in such patients .Molar distalization is one of the most interest-attracting non-extraction treatment modalities in patients with class II malocclusion not requiring premolar extraction.

Techniques for maxillary molar distalization were developed for decades .The use of patient-compliance depending appliances starting with the use of Headgear[18] for distal maxillary molar movement to the use of other intraoral compliance distalization appliances[19,20] showed various drawbacks .The main drawback was the dependence on patient cooperation which impaired treatment efficiency .Non-compliance intraoral distalization appliances were later introduced to overcome the need for patient's cooperation .Pendulum appliance[21] , Distal jet[22] and other non-compliance intra-oral appliances were used to distalize maxillary molars but the challenge of maintaining anterior unit anchorage evolved .The introduction of skeletal anchorage in orthodontics addressed the problem of anchorage loss directly and profoundly .Various skeletonized distalization appliances were designed[23–26] and continue to show making use of the advantages of skeletal anchorage .Not only does skeletal anchorage resolve the loss of anterior anchorage problem with the non-compliance distalization appliances but also the ability to approximate the distalization force vector to the molar's center of resistance during distalization yielding a more bodily movement than distal crown tipping.

Since molar distalization became a big part of orthodontic practice mainly in adult patients who seek short-termed esthetic treatment ,the search for means to accelerate this phase of orthodontic treatment drew attention ,in addition to the use of inconspicuous appliances .According to a recent meta-analysis,Correction of a half-to-full cusp Class II molar relationship with intraoral distalizers can be achieved in 8.34 months ,and this distalization time may not be affected by the kind of anchorage used[27].

A small number of studies[14,15]and case reports[28,29] investigated the effect of different acceleration techniques whether surgical or non-surgical on the rate of maxillary molar movement during distalization.

The aim of this study was to evaluate the effect of piezocision a minimally invasive surgical technique for acceleration of orthodontic tooth movement on the rate of maxillary molar distalization using a mini-screw implant-supported modified transpalatal bar appliance.

Piezocision ability to accelerate tooth movement arises from stimulating the alveolar bone turnover through increased osteoclastic activity leading to RAP ,which forms the basis of rapid tooth movement compared to the conventional orthodontic treatment. Piezocision-assisted tooth movement also allows to' bypass 'the lag phase following the displacement phase that is characteristic of the tooth movement subjected to conventional orthodontics .Unlike conventional orthodontics and during the course of treatment in the adult patient ,a sharp increase in tooth mobility is observed resulting from the transient osteopenia induced by the surgery .This was confirmed and explained by the amount of demineralization following Piezocision that was seen histologically in animal experiments[13] .Piezocision was proved to be effective in alleviating dental crowding and canine retraction in extraction cases in previous studies[10,30–33].

Results of this study revealed that the acceleration effect of piezocision was confined to the first 2 months of distalization resulting in a slightly higher rate of distal molar movement in the piezocision group than the control group. The rate of tooth movement in the following distalization period was almost comparable in both groups .The short acceleration period may be the result of a milder injury than needed for this type of tooth movement to produce the sufficient RAP .Other reasons may be the direction of the distalization force, passing through the furcation area of the maxillary first molar) center of resistance (in an apical direction[34] .This force direction aimed to produce bodily molar movement which is more difficult to achieve than distal tipping movement .Also the vertical component of force causing molar intrusion might have dragged the distalization rate back .One more explanation of the slower than expected rate of molar distalization is 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 place added resistance to distal molar movement and posterior occlusion movement in general[35–37].

The total distalization period in this study was 7±2.75 moths .According to a recent meta-analysis[27] this period is comparable to other non-compliance intra-oral distalizing appliances.

A previous pilot study in which molar distalization was assisted by piezoincisions was carried out in .2014[15] Results of this study revealed that the mean total distal movement of the maxillary first molar was 4.98 mm ,the average molar movement rate was 1.09 mm/ month .Authers attributed the high rate of maxillary molar movement to the accelatory effect of piezocision which enhances the production of inflammatory markers at the site of injury increasing the rate of bone resorption and turn-over.

Comparing the results of our study to those of the mentioned study ,the rate of distal molar movement in the piezocision group of our study was slower 0.65) mm/month in the current study compared to 1.09 mm in the previous study .(This difference may be attributed to the following reasons :First ,the subjects recruited for the current study were all adults of age ranging from 18 to 30 years while those of the previous study were at mean age 2.19 ± 12.96years .Age affects the response of alveolar bone to orthodontic force and the rate of tooth movement .The rate of tooth movement in adult patients is slower than that in younger patients[38,39] .The piezoincisions in the current study were confined to the first and second molars area while in the previous study

piezoinsicions started from the first premolar area to the first molar area .The difference in the surgical technique might affect the inflammatory response and the rate of tooth movement although the effect of surgical injury is supposed to be in the nearby area. Finally ,the difference in the appliances used for maxillary first molar distalization and the mechanism of force delivery might affect the rate of tooth movement.

Conclusion:

Piezocision has a limited effect on the rate of tooth movement during distalization of maxillary molars .The acceleratory effect of piezocision was confined to the first two months of the distalization phase.

References:

1. Papadopoulos ,M .A .*Skeletal Anchorage in Orthodontic Treatment of Class II Malocclusion*.(2015) .

2. Papadopoulos ,M .A .Orthodontic treatment of Class II malocclusion with miniscrew implants .*Am .J .Orthod .Dentofac. Orthop*.604 ,**134** .e1-604.e16.(2008)

3. Da Costa Grec ,R .H .*et al* .Intraoral distalizer effects with conventional and skeletal anchorage :A meta-analysis .*Am .J .Orthod. Dentofac .Orthop*.(2013) 615–602 ,**143** .

4. Fudalej ,P & .Antoszewska ,J .Are orthodontic distalizers reinforced with the temporary skeletal anchorage devices effective ?*Am .J .Orthod .Dentofac .Orthop*. .(2011) 729–722 ,**139**

5. Antonarakis ,G .S & .Kiliaridis, S .Maxillary molar distalization with noncompliance intramaxillary appliances in class II malocclusion :A systematic review. *Angle Orthod*.(2008) 1140–1133 ,**78** .

6. Kalemaj ,Z ,.DebernardI ,C .L& . Buti ,J .Efficacy of surgical and non-surgical interventions on accelerating orthodontic tooth movement :a systematic review .*Eur .J. Oral Implantol*.(2015) 24–9 ,**8** .

7. M.L ,.G & .K ,.S .P .Acceleration of tooth movement during orthodontic treatment-A frontier in orthodontics .*J .Pharm .Sci .Res*,**9** . .(2017) 744–741

8. Spielmann ,T ,.Wieslander ,L & .Hefti, A .F] .Acceleration of orthodontically induced tooth movement through the local application of prostaglandin) PGE1 .[(*Schweizer Monatsschrift fur Zahnmedizin = Rev .Mens. suisse d'odonto-stomatologie = Riv .Mens. Svizz .di Odontol .e Stomatol*.(1989) .

9. Alfawal ,A .M .H ,.Hajeer ,M .Y ,.Ajaj, M .A ,.Hamadah ,O & .Brad ,B .Effectiveness of minimally invasive surgical procedures in the acceleration of tooth movement :a systematic review and meta-analysis .*Prog .Orthod*,**17** . .(2016)

10. Abbas ,N .H ,.Sabet ,N .E & .Hassan, I .T .Evaluation of corticotomy-facilitated orthodontics and piezocision in rapid canine retraction .*Am .J .Orthod .Dentofac .Orthop*. .(2016) 480–473 ,**149**

11. Sebaoun ,J .D .M ,.Surmenian ,J& . Dibart ,S] .Accelerated orthodontic treatment with piezocision :a mini-invasive alternative to conventional corticotomies .[*Orthod .Fr*,**82** . .(2011) 319–311

12. Dibart ,S ,.Keser ,E & .Nelson ,D. Piezocision™-assisted orthodontics :Past, present ,and future .*Semin .Orthod*–170 ,**21** . .(2015) 175

13. Dibart ,S .*et al* .Tissue response during Piezocision-assisted tooth movement :A histological study in rats .*Eur .J .Orthod*,**36** . .(2014) 464–457

14. Bowman ,S .J .The Effect of Vibration on Molar Distalization .*J .Clin .Orthod*,**50** . .(2016) 693–683

15. Çörekçi ,B .*et al* .Periodontally Accelerated Molar Distalization With Miniscrew Assisted Memory Screw :A Pilot Study .*Turkish J .Orthod*.(2013) 168–162 ,**26** .

16. Spena ,R ,.Caiazzo ,A ,.Gracco ,A& . Siciliani ,G .The use of segmental corticotomy to enhance molar distalization .*J .Clin .Orthod*. .(2007) 699–693 ,**41**

17. El-Mangoury N.H .and Mostafn Y.A. Epidemiologic panorama of dental occlusion. *Angle Orthod*.(1990) 214–207 ,**60** .

18. Kingsley ,N .W .*A treatise on oral deformities as a branch of mechanical surgery*. *A treatise on oral deformities as a branch of mechanical surgery*) New York :D .Appleton, .(1880

19. Ritto ,A .k .Removable molar distalization splint .*J .Clin .Orthod*–396 ,**29** . .(1995) 397

20. Mordecai ,R .M .Distal movement without headgear :the use of an upper removable appliance for the retraction of upper first molars .*Br .J .Orthod*344–343 ,**24** . .(2014)

21. Hilgers ,J .j .The Pendulum appliance for Class II non-compliance therapy .*J .Clin. Orthod*.(1992) 714–706 ,**26** .

22. Carano ,A & .Testa ,M .The Distal Jet for upper molar distalization .*J .Clin .Orthod*,**30** . .(1996) 380–374

23. Keles ,A ,.Erverdi ,N & .Sezen ,S .Bodily distalization of molars with absolute anchorage. *Angle Orthod*.(2003) 482–471 ,**73** .

24. Papadopoulos ,M .A ,.Melkos ,A .B& . Athanasiou ,A .E .Noncompliance maxillary molar distalization with the First Class Appliance :A randomized controlled trial .*Am. J .Orthod .Dentofac .Orthop*.586 ,**137** .e1-586.e13.(2010)

25. Papadopoulos ,M .The" Advanced Molar Distalization Appliance :"A Novel Approach to Correct Class II Malocclusion. *Recent Patents Biomed .Eng*.(2010) 15–6 ,**3** .

26. Kinzinger ,G .S .M ,.Gülden ,N,. Yildizhan ,F & .Diedrich ,P .R .Efficiency of a skeletonized distal jet appliance supported by miniscrew anchorage for noncompliance maxillary molar distalization .*Am .J .Orthod. Dentofac .Orthop* .(2009) .doi/10.1016:j. ajodo2007.10.049.

27. Bellini-Pereira ,S .A ,.Pupulim ,D .C,. Aliaga-Del Castillo ,A ,.Henriques ,J .F .C& . Janson ,G .Time of maxillary molar distalization with non-compliance intraoral distalizing appliances :a meta-analysis .*Eur .J .Orthod*,**41** . .(2019) 660–652

28. Fontana ,M ,.Cozzani ,M ,.Mutinelli, S ,.Spena ,R & .Caprioglio ,A .Maxillary molar distalization therapy in adult patients :A multicentre study .*Orthod .Craniofacial Res*. .(2015) 231–221 ,**18**

29. Ojima ,K ,.Dan ,C ,.Watanabe ,H. &Kumagai ,Y .Jco Distalizacao Molat E Invidaalign .**LII**.(2018) 683–675 ,

30. Charavet,C.*etal*.Localized Piezoelectric Alveolar Decortication for Orthodontic Treatment in Adults :A Randomized Controlled Trial .*J .Dent .Res*.(2016) 1009–1003 ,**95** .

31. Gibreal ,O ,.Hajeer ,M .Y & .Brad, B .Efficacy of piezocision-based flapless corticotomy in the orthodontic correction of severely crowded lower anterior teeth :a randomized controlled trial .*Eur .J .Orthod*,**41** . .(2018) 195–188

32. Aksakalli ,S ,.Calik ,B ,.Kara ,B& . Ezirganli ,S .Accelerated tooth movement with piezocision and its periodontaltransversal effects in patients with Class II malocclusion. *Angle Orthod*.(2016) 65–59 ,**86** .

33. Alfawal ,A .M .H ,.Hajeer ,M .Y ,.Ajaj, M .A ,.Hamadah ,O & .Brad ,B .Evaluation of piezocision and laser-assisted flapless corticotomy in the acceleration of canine retraction :A randomized controlled trial. *Head Face Med*.(2018) 12–1 ,**14** .

34. Sajedi ,A .Three-dimensional analysis o f the distal movement o f maxillary1 st molars in patients fitted with mini-implant-aided trans-palatal arches.(2015) 245–236 .

35. van Spronsen ,P .H .Long-Face Craniofacial Morphology :Cause or Effect of Weak Masticatory Musculature ?*Semin. Orthod*.(2010) 117–99 ,**16** .

36. Proffit ,W .R ,.Fields ,H .W & .Nixon, W .L .Occlusal Forces in Normal -and Long-face Adults .*J .Dent .Res*.(1983) 570–566 ,**62** .

37. Ingervall ,B & .Helkimo ,E .Masticatory muscle force and facial morphology in man. *Arch .Oral Biol*.(1978) 206–203 ,**23** .

38. Alikhani ,M .*et al* .Age-dependent biologic response to orthodontic forces .*Am. J .Orthod .Dentofac .Orthop*644–632 ,**153** . .(2018)

39. Bridges ,T ,.King ,G & .Mohammed, A .The effect of age on tooth movement and mineraldensity in the alveolar tissues of the rat. *Am .J .Orthod .Dentofac .Orthop*–245 ,**93** . .(1988) 250