A Comparative Evaluation Of Canine Retraction Using Periodontally Accelerated Osteogenic Orthodontics (PAOO) And Conventional Mechanotherapy As Assessed By CBCT

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Abstract:

Aim: To compare rate of canine retraction by using periodontally accelerated osteogenic orthodontics and conventional mechanotherapy using CBCT.

Material & Methods : The present study was conducted on patients who reported for routine orthodontic treatment. A sample of 10 patients who required bilateral maxillary 1st premolar extraction and canine retraction as a part of their orthodontic treatment were included for this study. A split mouth randomised technique was used to assess the retraction of upper canines. In this split-mouth design technique, upper canine of one side (right) was retracted with Periodontally Accelerated Osteogenic Orthodontics (PAOO) and on contralateral side it was done with conventional mechanotherapy.

Results : The rate of canine retraction on right side was 1.94 mm/month whereas on left side it was 1.15 mm/ month. Canines were retracted faster with the PAOO procedure and the difference was of 0.78 mm/month which was highly statistically significant with the p-value <0.001. Also nature of canine retraction was of translation on right side with minimal mesial movement of premolars and molars.

Conclusions: The rate of canine retraction was more on right side (PAOO) than on left (Conventional) side. Periodontally Accelerated Osteogenic Orthodontics (PAOO) helped canine move faster into the extraction space than the conventional mechanothery.Periodontally Accelerated Osteogenic Orthodontics (PAOO) helped to maintain the bone density level during the orthodontic tooth movement which decreased in the conventional orthodontic tooth movement.

Keywords : Accelerated orthodontics, Regional Acceleratory Phenomenon (RAP), PAOO, Decortication, Rate of Canine Retraction.

INTRODUCTION

Orthodontics and dentofacial orthopaedics encompasses modification of the teeth and the supporting bones to attain desirable changes in their relative position so that esthetics, function, and oral health of the patient can be improved.Orthodontic tooth movement is a process in which a mechanical force is applied to induce alveolar bone resorption on the pressure side, and alveolar bone deposition on the tension side. Tooth movement under mechanical force depends on the remodeling of tissues surrounding the roots. Bone modeling is uncoupled process of activation-resorption (catabolic) or activation-formation (anabolic) on bone surfaces, resulting in changes in shape, size, or position of the bone. Bone remodeling is a tightly coupled local process, which starts with bone resorption, followed by bone formation phases, resulting in replacement of old bone with new bone.Malik (2014) stated that both bone modeling and remodeling are determinants for the rate of orthodontic tooth movement.

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The orthodontic diagnosis and treatment plan often requires retraction of upper anterior teeth. In these cases, premolar extractions or molar distalization can provide the required spaces. First bicuspid extraction followed by cuspid retraction is also indicated in cases of dentoalveolar sagittal anomaliessuch as a prognathic maxilla with a molar Class II relationship or a prognathic mandible with a Class III relationship indicating extraction of first premolars followed by retraction of anteriors.

Canine retraction can be done by any of the two methods : Sliding mechanics or Closing loop mechanics. The friction method (sliding mechanics) is based on the cuspid bracket sliding on a sectional wire from cuspid to second molar. The distalizing force comes from an elastic or from a closed coil connecting the cuspid to the first permanent molar.The frictionless method uses for retraction of cuspids uses closing loops that connectcuspid directly with the posterior segment.

With an increasing number of adult patients coming to the orthodontic clinic, the orthodontic professional is cons-tantly looking for ways to accelerate tooth movement.To date, to accelerate tooth movement, surgical approach, physical approaches with low-energy laser irradiation and magnetic fields, as well as pharmacological approaches with the injection of prostaglandin E2 (PGE2) andVit. D3 (1,25-(OH)2D3) during tooth movement, have been investigated. However, many side effects, such as local pain, severe root resorption, and drug-induced side effects have been reported.(Yamasaki *et al.*,1980)

The development of corticotomy-assisted orthodontic treatment (CAOT) opened doors and offered solutions to many limitations in the orthodontic treatment of adults. Heinrich Köle's (1959) publication was the first to describe modern-day corticotomyfacilitated orthodontics. The new technique, the periodontally accelerated osteogenic orthodontics (PAOO) technique,the method of Accelerated Osteogenic Orthodontics, is patented by Wilckodontics. The principal object of the PAOO surgery is the creation of a relatively thin layer of bone (1.5 mm) over the root prominence in the direction of the intended tooth movement.This procedure is theoretically based on the bone healing pattern known as the regional acceleratory phenomenon (RAP). Goldie and King (1984), Mishra and Wizarath (2016) reportedthat PAOO results in an increase in alveolar bone width, shorter treatment time, increased post treatment stability, and decreased amount of apical root resorption.

RAP was first described by Frost (1983), although this phenomenon has been familiar to many histomorphometrists since 1966. Frost noted that the original injury somehow accelerated the normal regional healing processes by regional acceleratory phenomenon.(Wilcko*et al.*,2003)The two main features of RAP in bone healing include decreased regional bone density and accelerated bone turnover, which are believed to facilitate orthodontic tooth movement.(Liou and Huang,1998; Iseri*et al.*,2005)

The degree of tooth movement can be studied with conventionalcephalogrambut there is a major drawback of superimposition of right and left side dental changes separately and accurately which was the prime requirement of this study.With the advantage of 3D CBCT which has greatly affected ortho diagnostic treatment planning.CBCT, specifically dedicated to imaging the maxillofacial region heralds a true paradigm shift from 2D to 3D approach to data acquisition and image reconstruction.The advantages of this scan over others include determination of root positionwithin the alveolar trough in all planes of space.Hence, this clinical study was done to assess the comparative rate of canine retraction with periodontally accelerated osteogenic orthodontics (PAOO) and conventional mechanotherapy using CBCT in a split mouth technique.

MATERIALS AND METHODS

The study was conducted on patients who reported to department of orthodontics for orthodontic treatment. A sample of 10 patients who required bilateral maxillary 1st premolar extraction and canine retraction as a part of their orthodontic treatment were included for this study. The comprehensive medical and dental history of every patient was taken to rule out any systemic illness.Age and sex were not taken into account.The inclusion criterion for the study was atleast 3mm of canine retraction following extraction and no history of previous orthodontic treatment.Patients with chronic debilitating disease, periodontally compromised patients and missing anchor tooth were excluded from study.

All the cases selected underwent fixed orthodontic treatment utilizing .022 slot MBT bracket systems.A split mouth randomised technique was used to assess the retraction of upper canines. In this split-mouth design technique, upper canine of one side (right) was retracted with periodontally accelerated osteogenic orthodontics and on contralateral side it was done with conventional mechanotherapy.

Fig.1a

After initial alignment and leveling, presurgical records; intraoral photographs**(Fig.1a,b)**, CBCT Scans**(Fig.2a,b)** and upper dental casts were taken. Patient consent was taken prior to the surgery and was prepared for surgery by disinfecting the surgical area and face by betadine solution.

Fig.1b

Fig. 1 (a,b) : Intraoral photographs of Right and Left side after leveling and alignment and before surgery.

Fig.2a

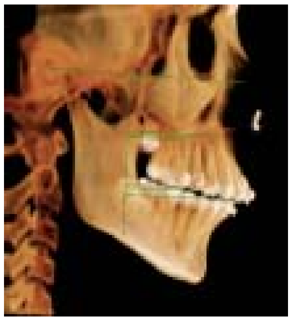


Fig.2b

Fig. 2 (a,b) : CBCT generated 3D view

Periodontally Accelerated Osteogenic Orthodontics

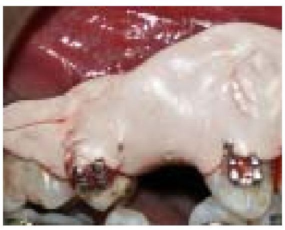


Fig.3a

Fig.3b

Fig.3c

The incisions were given mesial to the canine and distal to second premolar with a BP blade **(Fig. 3a)**. A full thickness flap was raised from mesial to canine to distal of the second premolar on the right side. **(Fig. 3b).**After the full thickness flap was raised, selective alveolar decortications were performed in the form of vertical and round decortication cuts upto 0.5mm in depth, interdentally, distal to the canine **(Fig. 3c).** The decortications were performed with round bone cutting bur.articulate alveolar bone grafting was done in the region of decortication**(Fig. 3d)**. The bone graft was obtained from Tata Memorial Hospital Tissue Bank, Mumbai. The volume of the graft material used was dictated by the direction and amount of tooth movement predicted, the pretreatment thickness of the alveolar bone, and the need for labial support by the alveolar bone.The graft used was a decalcified freeze-dried bone allograft. When grafting was done the flap was sutured in place with 3.0 Vicryl sutures (non-resorbable) and a surgical pack was given over the sutured flap**(Fig 3 e,f).** Patient was adviced to take Cap. Amoxycillin 500mg TDS for three days and Ibubrufen 400mg SOS.

Fig.3d

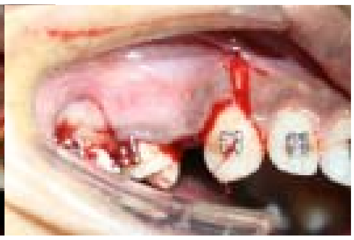


Fig.3e

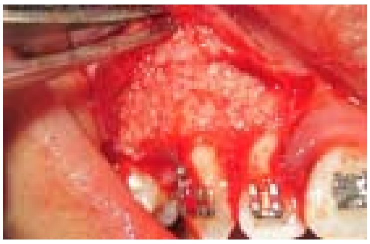


Fig.3f

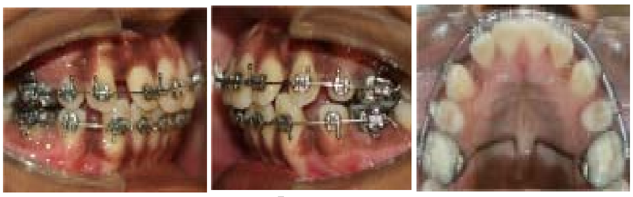
Fig 3.Showing complete surgical procedure. (a) Incisions (b) Full thickness Flap (c) Decortication (d) Bone Grafting (e) Suturing (f) Surgical pack in place

The surgical pack was removed after 1 week and orthodontic tooth movement was started 2 weeks after the surgery. The canine retraction procedure was started on the left side using the conventional molar anchorage and on right side using Periodontally Accelerated Osteogenic Orthodontics (PAOO). Retraction was done using sliding mechanics on 0.017 X 0.025 stainless steel arch wire, using Niti closed coil spring giving a force of 150 grams (Fig 4 a,b).All records were repeated after canine retraction was completed (Fig 5 a,b,c,d,e,)

Fig.4a

Fig.4b

Fig. 4: Equal Force application for Canine Retraction (a)right (PAOO)side and (b) Left (Conventional side)



a b c

Fig.5 Post Canine Retraction recoreds (a,b,c) Intraoral Photographs (d) CBCT generated 3D view of Right (PAOO) side (e) CBCT generated 3D view of Left (Conventional) side

Measurements On Dental Casts (Rotational Changes) :

Canine Rotation

The change in rotation of canine was measured on dental casts , the mesiodistal points of canine were joined with a line and through this mesiodistal line a perpendicular was drawn which extended to form an angle to the line formed by joining the mesiobuccal cusp tips of second molar. This angle measured in the pre treatment and post treatment cast gave the rotational changes in the canine from pre treatment to post treatment (Fig 6a)**.**

Fig.6a: Showing the measurement of canine rotation on dental cast.

Molar Rotation

The change in rotation of molar was evaluated on dental casts; the mesiobuccal and the distobuccal cusp tips were marked and joined them a line perpendicular to the formed line was extended to join the mid palatal raphae, the angle formed by the lines showed the rotational changes seen in the molar in due course of canine retraction (Fig 6b)**.**

Fig. 6 b: Showing the measurement of molar rotation on dental cast.

Premolar Rotation

Premolar rotational changes were measured on dental casts; the line was drawn joining the buccal cusp tip and the palatal cusp tip and was extended to join the mid palatal line. The angles formed showed any rotational changes in premolar in due course of canine retraction(Fig 6c).

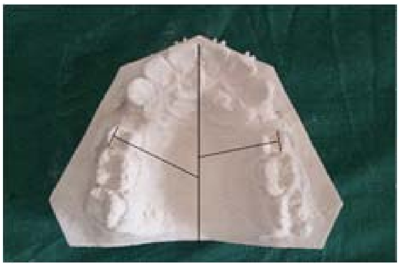


Fig. 6 c : Showing the measurement of premolar rotation on dental cast.

Measurements On CBCT Generated Lateral Cephalogram

CBCT generates 3D cephalometric images of right and left side without superimposition using the IN VIVO DENT 5.0 software for the analysis

Bone Density

The thickness of the alveolar plates were measured for canine on right and left side at the labial surface in three slices separated by 3 mm; at crestal level (S1), mid root level (S2) , 3mm above crestal level, and apical level (S3), 3mm above mid root level{Pre Treatment (T0)}. The same measurements were repeated after canine retraction was completed {Post Treatment (T1)}.Bone density was measured in Hounsfield Units (HU) by the IN VIVO DENT 5.0 software.**(Fig. 7).**

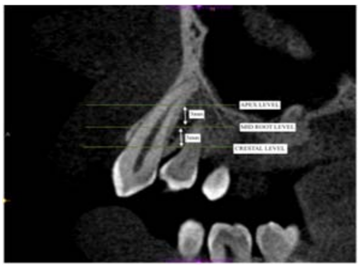


Fig. 7 Showing slices of maxilla to measure bone density at canine at three different levels. S1 at Crestallevel , S2 at mid root level and S3 at apex level

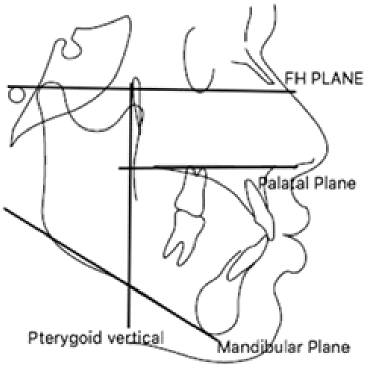
References planes (Fig 8)

1. Frankfort Horizontal (FH)— a line connecting porion to orbitale

2. Pterygoid Vertical (PTV) :The pterygoid vertical (PTV) drawn perpendicular to the Frankfort horizontal (FH) plane passing through posterior superior of Pterygomaxillary Fissure (Ptm).

3.Palatal Plane (PP) - a line connecting anterior nasal spine and posterior nasal spine.

4.Mandibular Plane (MP)— a line connecting gonion to menton



Cephalometric parameters

Skeletal Parametres (Fig 9)

1. Anterior facial height- perpendicular linear distance between nasion and menton

2. Upper Anterior Facial Height (UAFH)— perpendicular linear distance between nasion and anterior nasal spine

3. Lower Anterior Facial Height (LAFH)— perpendicular linear distance between anterior nasal spine and menton.

4. Posterior Facial height- perpendicular linear distance between sella and gonion.

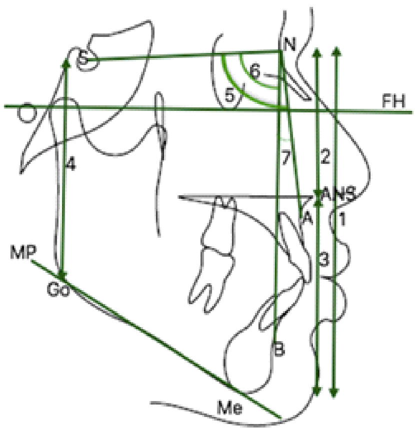
5. SNA –Angle between SN plane and line joining nasion and point A

6. SNB- Angle between SN plane and line joining nasion and point B

7. ANB –angle between SNA and SNB.

8. MP-FH –Angle between mandibular plane (MP) and Frankfort horizontal (FH) plane

9. MP-SN- Angle between mandibular plane (MP) and the sellanasion (SN) plane



Anterior facial height 2)Upper Anterior Facial Height (UAFH) 3) Lower Anterior Facial Height (LAFH) 4) Posterior Facial height. 5) SNA 6) SNB 7) ANB

Dental Parameters (Fig 10 a,b)

1. U3-PTV- linear distance between cusp tip of maxillary canine and pterygoid vertical reference plane (PTV).
2. U5- PTV- linear distance between cusp tip of maxillary second premolar and vertical reference plane (PTV).
3. U6-PTV- linear distance between mesiobuccal cusp of first maxillary molar and vertical reference plane
4. U3-PTV- linear distance between Apex tip of maxillary canine and pterygoid vertical reference plane (PTV).
5. U5- PTV- linear distance between apex tip of maxillary second premolar and vertical reference plane (PTV).
6. U6-PTV- linear distance between mesiobuccal apex tip of first maxillary molar and vertical reference plane
7. U3-PP(deg) – angle formed between long axis of maxillary canine and palatal plane.
8. U5-PP(deg) – angle formed between long axis of maxillary second premolar and palatal plane.
9. U6-PP(deg) – angle formed between long axis of maxillary first molar and palatal plane.

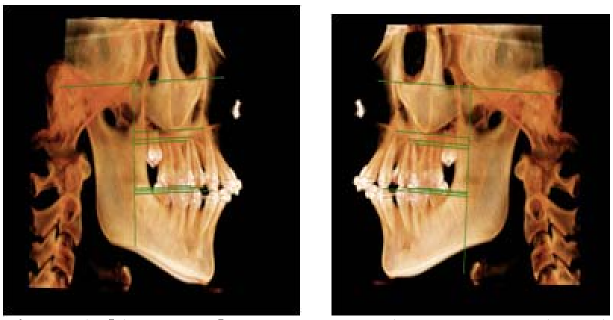


Fig 10 (a,b): Dental Parameters. 1) U3 to PTV (cusp) 2) U5 to PTV (cusp) 3) U6 to PTV (cusp) 4)U3 to PTV (apex) 5) U3 to PTV (apex) 6) U6 to PTV (apex) 7) U3 to PP 8) U5 to PP 9) U6 to PP

RATE OF CANINE RETRACTION

The initial (T0) and final (T1) measurements of canine were measured by taking the linear distance between cusp tip of maxillary canine and pterygoid vertical reference plane (PTV). The mean monthly movement was obtained by dividing the total amount of movement by the number of months for each patient.

RESULTS

The results showed the changes in the amount and rate of retraction of canine, amount of anchorage loss in the molar and premolars. Angular changes in the canine, premolar and molar before and after the retraction of canine were compared using the 3D view generated using CBCT and the rotational changes were assessed by using dental cast. The study was conducted for either a duration of 4 months or the complete retraction of canine of any the side, which ever was earlier.

Table 1 shows the comparison of mean maxillary canine cusp & root tip, mean maxillary molar cusp & root tip, and maxillary premolar cusp & root tip of right and left side respectively. Statistically significant difference in increased distal movement of canine cusp tip (P=0.042) and root tip (p=0.000) was observed on right side (PAOO) as compared to left side (conventional side). There was significant mesial movement of maxillary premolar and molar on left side **(p-value=0.000)**indicating anchorage loss on left side.

Table 1 : Comparison of maxillary canine cusp tip and root tip changes of right side (PAOO) and left side (Conventional)

S.No.	Parameter	Right side		Left side		t-value	Significance (p value)
		Mean	SD	Mean	SD		
1	U3(A)-PTV Root tip	3.579	1.368	1.574	.987	2.371	.042*
	U3©-PTV Cusp tip	6.468	.984	3.874	.857	5.558	.000***
	U6APTV	-0.009	.497	-1.897	.895	5.583	.000***
	U6CPTV	-.383	.266	-1.190	.363	6.439	.000***
	U5APTV	-0.352	0.805	-1.428	1.169	2.311	.046*
	U5CPTV	-.441	.226	-1.208	.267	5.597	.000***

p< 0.001***; p<0.01** and p<0.05* : significant and p>=0.05 : non significant (N.S.)

Table 2 shows the comparison of angular changes in canine, molar and premolar during canine retraction on right and left side respectively. Angular changes were measured from long axis of canine, mesiobuccal cusp tip of molar and long axis of premolar to palatal plane respectively.There was more of tipping of canine on left side whereas on the right side, canine moved bodily with the help of PAOO which was highly statistically significant **(p-value=0.000**).Whereas on left side, statistically significant mesial tipping of molar and second premolar was observed on left side when compared with right (PAOO) side**(p-value=0.000**)

Table 2 : Comparison of maxillary canine angulation changes of Right side (PAOO) and Left side (conventional)

S.No.	Parameter	Right side		Left side		t-value	Significance
		Mean	SD	Mean	SD		
1.	U3PP	3.480	1.550	7.840	1.906	-7.129	.000***
2.	U6PP	-1.660	1.093	-5.040	2.143	5.370	.000***
3.	U5PP	-1.890	.889	-4.880	1.370	6.680	.000***

p< 0.001***; p<0.01** and p<0.05* : significant and p>=0.05: non significant (N.S.)

Table 3 shows the mean rotational changes, seen on cast, in maxillary canine on right side by 7.8^0 and on left side by 11.9^{0}which was statistically insignificant **(p-value=0.503)**.This large difference in canine angulation from pre to post is because canine moved distally along the arch wire. Whereas molar mean rotational changeswere statistically significant **(p-value=0.017**) and maxillary second premolar rotation was statistically insignificant (p-value=0.913)**.**

Table 3 : Comparison of maxillary canine rotational changes of Right side (PAOO) and Left side (Conventional)

S. No.	Para meter	Right side		Left side			
		Mean	SD	Mean	SD	t-value	Significance
1.	C	-7.848	17.178	-11.97	9.186	.698	.503
2.	M	-2.944	8.727	8.885	7.593	-2.917	.017*
3.	PM	-1.147	5.752	-.815	6.322	-.112	.913

p< 0.001***; p<0.01** and p<0.05* : significant and p>=0.05 : non significant (N.S.)

Table 4 shows the mean rate of canine retraction in maxilla on right side by 1.936 mm/month and on left side by 1.159 mm/month, dipicting a faster canine retraction rate on right side (PAOO).The mean value in the maxillary difference was0.777 mm/monthwith a p value of **0.000**which was highly statistically significant.

Table 4 : Comparison of maxillary canine retraction rate of Right side (PAOO) and Left side (Conventional).

S. No.	Parameter	Right side		Left side			
		Mean	SD	Mean	SD	t-value	Significance
1.	Canine Retraction Rate	1.936	.295	1.159	.257	-5.555	.000***

p< 0.001***; p<0.01** and p<0.05*: significant and p>=0.05 :non significant (N.S.)

Table 5 shows the bone density changes on maxillary canine at crestal, mid root and apex level. The bone density changes were highly statistically significant at all the three levels; S1 , S2 and S3 with the **p-values 0.002, 0.000 and 0.002** respectively.

Table 5 : Comparison of bone density changes in canine region at three different levels of right (PAOO) and left (Conventional) side.

S. No.	Parameter	Right side (PAOO)		Left side (Conventional)			
		Mean	SD	Mean	SD	t-value	Significance
1	S1 (Crestal level)	-3.600	38.205	77.100	44.759	-4.287	.002**
2	S2 (MidRoot level)	-12.30	15.026	68.300	31.423	-7.567	.000***
3	S3 (Apex level)	-2.100	12.414	33.200	23.574	-4.478	.002**

p< 0.001***; p<0.01** and p<0.05* : significant and p>=0.05 : non significant (N.S.)

Hence there was bodily movement of canine at a faster rate on right side where PAOO was used and more tipping and anchorage loss was observed in molar and second premolar on left side where canine retraction was done using conventional method.

DISCUSSION

Biologically, canine retraction ,with optimum mechanical force is achieved with the rate of approximately 1 mm in 4 to 5 weeks. Therefore, in maximum anchorage, premolar extraction cases, canine distalization usually takes 6 to 9 months, contributing to an overall treatment time of 2 to 2.5 years . Orthodontic tooth movement is produced by "periodontal phenomenon." The constant demand for shorter treatment time, led orthodontists to find ways to improve orthodontic treatment efficiency.The Wilckodontics™ Accelerated Osteogenic Orthodontics (AOO®) procedure; as patented by Wilcko and Wilcko; gave a powerful orthodontic technique that can make the treatment of very complicated scenarios more routine, make the treatment of routine cases extremely fast and predictable and provide a new "orthodontic patient population". (Murphy*et al*.,2009)The principal object of the AOO surgery was the creation of a relatively thin layer of bone (not more than 1.5 mm) over the root prominence in the direction of the intended tooth movement.

The subjects selected for this study were of arch length discrepancy of more than 9mm. The treatment plan required the extraction of the maxillary first premolars and the subsequent retraction of the canines. A total of 10 patients were included in this study and all of them were informed about the procedure. In this present study, a split mouth randomised technique was used to assess the retraction of upper canines.The right side was prepared for the PAOO procedure.Roth*et al*. (2006) have reported that patients with thinner mandibular cortices are at increased risk for dental relapse. The bone grafting procedure or alveolar augmentation was performed in conjunction with the bone activation at the time of PAOO surgery.

A force of 150 g was applied with nickel-titanium closed-coil springs in this study for retraction of the canines into the premolar extraction spaces for optimum tooth movement.Although various studies deal with the relationship between optimum force magnitude and rate of canine retraction, few human studies have been reported. The first such study for comparing this relationship was by Story and Smith (1952), who reported an optimum force of 150 to 200 g for retraction of the mandibular canines. Alikhani*et al*.(2013) recommended 150 to 200 g as the optimum pressure value for canine retraction. Huffman and Way (1983) advocated 200 g as the optimum force.

The movement of the canine with corticotomy (PAOO) was compared with conventional mechanotherapy. The rate of canine retraction on right side was 1.93mm/month whereas on left side it was 1.15 mm/month. Canines were retracted faster with the PAOO procedure and the difference was of 0.78 mm/month. The reported rates of canine retraction have varied from 0.35 to 1.55 mm per month. Paulsen et al showed an average canine retraction rate of 1 mm per month. In the study of Sonis*et al*., (1986), the rates of canine retraction were 0.99 to 1.51 mm in 3 weeks. The differences in their retraction rates were probably due to the high force levels used in their study.Wilcko*et al*., (2001) presented two case reports of decrowding by PAOO. They were able to complete the orthodontic treatment of both the cases in 6 months and 2 weeks with no loss of tooth vitality, no significant apical root resorption, and no periodontal pocketing.The results of this study suggested an increase rate of canine retraction with PAOO procedure.

This accelerated tooth movement by PAOO procedure is theoretically based on bone healing pattern known as the Regional Acceleratory Phenomenon (RAP). The RAP begins within a few days of injury, typically peaks at 1-2 months, usually lasts 4 months in bone and may take 6 to more than 24 months to subside. The onset of RAP in alveolar bone is accompanied by a burst of osteoclastic activity resulting in lower bone density and augmented osteoblastic activity. Tooth movement is affected by alveolar mineralization, greater the mineralization of the alveolar bone the more difficult teeth are to move. (Ferguson and Wilcko, 2006)

This study is one of the few studies in orthodontics that is assessed by CBCT.. Chaudhary*et al*.(2014) evaluated left and right canine retraction rate through CBCT generated lateral cephalograms using implants and conventional method for anchorage in a split mouth design. It is difficult to evaluate right and left side in a lateral cephalogram as there are superimpositions of right side on left.

Individual canine retraction often results in rotations and mesiodistal tipping of the canine. However, with en-masse retraction, no such problems were encountered.Ziegler and Ingeryall (1989) andSadowsky*et al*. (1997) observed distopalatal rotation of the canine 24^0 and 15.3^0 respectively during retraction. A similar distopalatal rotation of right and left canine were seen in this present study.In both groups the line of action of force passed buccally and distally to the center of rotation. However, distopalatalrotation observed may be explained by force duration and by arch wire control and the way the teeth has been ligated .Anchorage loss was seen on both the sides, but on the right (PAOO) side it was as less as 0.38mm whereas on the left side (Conventional) , the molar moved mesially by 1.2 mm. This difference in anchorage loss of right and left side was highly statistically significant with the p-value <0.001.Anchorage loss of 0.44mm and 1.2 mm was evaluated for the maxillary right and left second pre molar respectively.In previous reports of Guray and Orhar (1997), 1.6 to 4 mm of mesial molar movement was reported while retracting canines with traditional mechanics. Similarly, in this study , on the left side, the canine was retracted with conventional method and anchorage loss of 1.2 mm was seen.

In this present study the bone density was increased on the right side (PAOO) at all the three levels; S1(crestal level), S2(mid root level, 3mm above crestal level) and S3(apex level, 3mm above mid root level) by 3.6HU, 12.3 HU and 2.1 HU respectively. Whereas on the left side (Conventional) there was decrease in bone density at all the three levels.Chang *et al*. (2012) in their study showed that the bone density was reduced by 24.3 % by the orthodontic tooth movement.The bone density was measured at the mesial, distal , labial and lingual surface of each tooth before and after retraction.Wheras in this present study, the bone density was measured only at the labial surface of the canine as the PAOO procedure was performed only at the labial surface. . The decrease in the bone density of left side was due to the conventional orthodontic tooth movement as concluded in the above mentioned study by Chang *et al*. (2012) andSarikaya S *et al*. (2002)also concluded that there is decrease in bone thickness after the orthodontic treatment.

PAOO can play an important role in the comprehensive treatment of a patient's occlusal and esthetic needs. This technique has been shown to increase alveolar bone thickness, decrease treatment time, and enhance post-treatment orthodontic stability.It is this additional step that is believed to be responsible for the increased post-treatment alveolar bone width. Likewise, the additional alveolar bone width may be responsible for enhanced long-term orthodontic stability.Further studies with more number of subjects should be done to evaluate better results.

CONCLUSIONS:

1. The rate of canine retraction was more on right side (PAOO, 1.94 mm/month) than on left (Conventional, 1.15 mm/month) side.
2. The nature of canine retraction on right (PAOO) side was more of translation than tipping because of PAOO which helped in translatory movement of the canine in addition to the faster tooth movement.
3. Anchorage was preserved on right side by PAOO with minimal mesial movement of molars of as compared to the left (Conventional) side .
4.Periodontally Accelerated Osteogenic Orthodontics (PAOO) helped to maintain the bone density level during the orthodontic tooth movement which decreased in the conventional orthodontic tooth movement.

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