A NEW METHOD FOR RAPID CANINE RETRACTION

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Abstract - Distraction osteogenesis method (DO) in bone lengthening and rapid midpalatal expansion have shown the great ability of osteogenic tissues for rapid bone formation under distraction force and special protocol with optimum rate of one millimeter per day. Periodontal membrane of teeth (PDM) is the extension of periostium in the alveolar socket. Orthodontic force distracts PDM fibers in the tension side and then bone formation will begin.

Objects: Rapid retraction of canine tooth into extraction space of first premolar by DO protocol in order to show the ability of the PDM in rapid bone formation. The other objective was reducing total orthodontic treatment time of extraction cases.

Patients and Methods: Tweleve maxillary canines in six patients were retracted rapidly in three weeks by a custom-made tooth-borne appliance. Radiographic records were taken to evaluate the effects of heavy applied force on canine and anchorage teeth.

Results: Average retraction was 7.05 mm in three weeks (2.35 mm/week). Canines rotated distal-in by mean 3.5 degrees. Anchorage loss was from 0 to 0.8 mm with average of 0.3 mm. Root resorption of canines was negligible, and was not significant clinically. Periodontium was normal after rapid retraction. No hazard for pulp vitality was observed.

Discussion: PDM responded well to heavy distraction force by DO protocol. Rapid canine retraction seems to be a safe method and can considerabely reduce orthodontic time.

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INTRODUCTION

Distraction osteogenesis (DO) is a tissue engineering method that promotes bone formation in optimum rate of one millimeter per day (3,14,15). DO is going to be routine for lengthening all types of bones (18,24,29). Rapid maxillary expansion is actually, a DO method that is quite known (5,13,19). Why cant periodontal membrane (PDM) of teeth do the same? PDM, sutures of maxillofacial skeleton and periostium are osteogenic tissues which are basically similar in structure. Collagen fibers, osteoblasts, fibroblasts and multipotential cells are the most important elements of these tissues. PDM is a very active and back to back histogenic tissue. PDM not only has the supporting and shock-absorbing function for teeth but also generates the lining bone of alveolar socket and actively contributes in all types of tooth movement (6). Rapid canine retraction is a good model to show that PDM of teeth can respond well to distraction force by DO protocol, like other osteogenic tissues.

Review of literature

In an animal study it has been shown that after mandibular lengthening by DO method, when the teeth adjacent to distraction site were moved to this newly bone formed area, rate of tooth movement would reach 1.2 mm per week (7).

They also studied 25 rapid canine retraction cases into extraction space of first premolar in 16 patients (8). Canines in both jaws were retracted in three weeks with average of 6.5 mm; anchorage loss in 73% was 0 and in 27% was less than 0.5 mm, evaluation was done by superimposing lateral cephalograms. According to the authors, canines were retracted bodily. They also observed minimal root resorption that was not significant. No sign of pulp damage and no infrabony defect were seen clinically or radiographically. Our object was rapid canine retraction by DO protocol and evaluation of this unusual rapid tooth movement on the teeth and periodontium.

Patients and methods

Patients: Exclusion criteria were: acute systemic disease, hormonal disturbances (diabetes) and bone metabolism disorders. Age and sex were not limiting factors, but it was desired to select younger patients. All patients needed flit premolar extraction to relieve incisor crowding or protrusion.

After selection of 18 patients, only nine of them accepted to be the subjects of a new method. Along the study three of them were excluded, since they were noncooperative. Finally 12 maxillary canines were retracted in six male patients whose mean age was 16.4 years (one adult 21.5 years old and others adolescent).

Clinical procedures

After extraction of first premolar, the interseptal bone distal to canine were undermined by two vertical grooves and a horizontal groove in order to reduce the mechanical resistance against canine retraction A tooth-borne custom-made retraction appliance

immediately was activated in the rate of 0.8 mm per day for three weeks. After retraction was completed, it was removed and the fixed apliances (band and brackets) were placed.

Undermining Grooves

It seems that a major obstacle against rapid retraction is the interseptal bone distal to the canine tooth; so right after extraction of the first premolar, two vertical grooves undermine the interseptal bone distal to canine.Vertical grooves were on the mesial and distal side of the socket but no cuts were performed on the buccal and lingual plates. A horizontal groove connected the vertical grooves in the socket depth (figure 1). Depth of grooves was almost one millimeter, and were made by a round bar. Before and after undermining, periapicals were taken to obsereve its result.

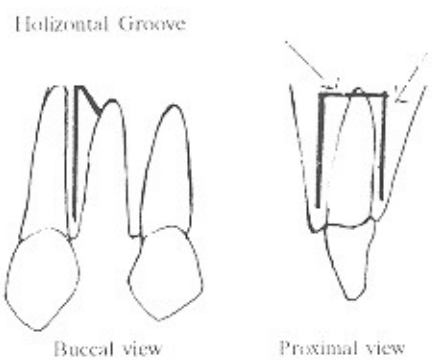


Fig. 1. grooves by round bar weakened the interseptal bone distal to canine- A. periapical after undermining grooves B.

A Rapid retraction appliance

A custom-made tooth-borne device was designed and made for each case. The first design was made of stainless steel wire 1.1 mm diameter and a 1.5 mm diameter screw (figure 2). Important factors in appliance design were:

1: Canine must retract through the midline between buccal and lingual plates, as possible, to facilitate tooth movement. So the screw of the device must be parallel with the connecting line of the canine and first molar crown centers (figure 3).

A

B

Fig. 2. The first design of rapid retraction appliance A: before extraction, B: after retraction was completed.

2: For bodily movement, screw must be at the level of canines center of resistance.

3: Canine and first molar bands must have button so that elastic chain could be used to connect them, in order to prevent rotation of the canine during retraction.

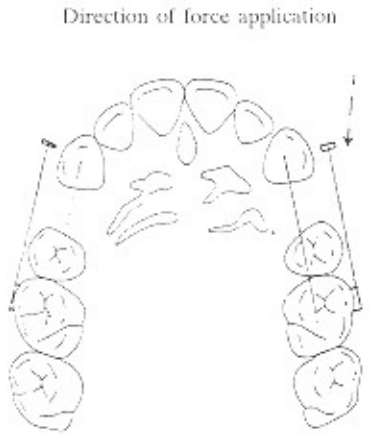


Fig. 3. It is desired to retract the canine along the midline between buccal and lingual plates

4 : Activation range of screw must be at least 15 mm (twice the extraction space), since the ratio between activation and tooth movement was not 1:1.

The most important requirement of the rapid retraction appliance was its rigidity. The first design didn't meet this requirement well. Therefore a more rigid and more simple design was made, with 1.5 mm diameter steel wire and 2mm diameter screw (figure 4). Retraction device could be inserted before or after extraction. Second premolar was in anchor unit but out of rapid retraction appliance.

Fig. 4. Second design, more simple and more rigid than the first appliance.

Protocol of rapid retraction

In the distraction osteogenesis protocol the rate of activation is 0.5 to 1 mm per day. Small and multiple activations results in the best tissue response (14). Our protocol was 0.8 mm in total, 0.4 mm twice daily. The first activation was after undermining grooves were made. Patients and their parents were instructed to activate the appliance at home. Patients were visited weekly to control the appliance and to take the records.

After the rapid retraction was completed in about three weeks, custom-made device was removed and fixed orthodontic appliances including bands and bonds were placed at the same visit. Second premolar was bonded at this stage. Transpalatal bar, head gear or other measures to reinforce the anchorage could be needed depending on the treatment plan. Segmental incisors alignment could be done simultaneously with rapid canine retraction to reduce treatment time. It must be noted that if canine was severely malpositioned, ,a short period of alignment and leveling probably was needed by bands and bonds before canine retraction.

Records

Cast models were taken before and after rapid retraction. The image of cast model was used to evaluate anchorage movements and canine rotation.

Radiographic documents included OPG, lateral cephalogram and periapicals. OPG and lateral cephalograms were taken for treatment plan. They were repeated three and six months after retraction was completed.

Periapicals from canine to first molar were taken before extraction of first premolar and then weekly until the fourth week of rapid retraction. After that, periapicals were taken monthly until the third month. The periapicals were used to evaluate PDM fibers, osteogenesis process, root resorption and periodontal response during and after rapid retraction.

RESULTS

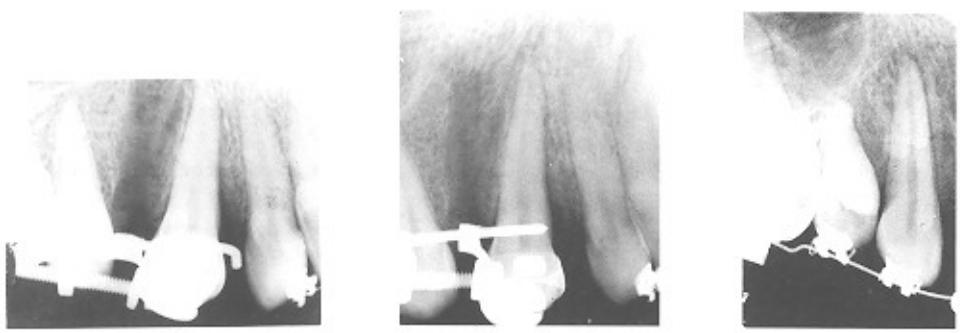
Twelve maxillary canines were retracted rapidly in about three weeks into extraction space of first premolar. Canine movement was not quite bodily and some tipping occured. It was not possible to measure the amount of tipping accurately since there was no way to use a reference pin as other studies did (31).

Pain and discomfort

Right after any activation patients had a feeling of mild to moderate pain. Rarely severe pain was recorded. In all of cases pain was tolerable and

Table 1. Canine retraction, Canine rotation, Anchorage loss.

Case	First week	Second week	Third week	Sum of weeks	Canine Rotation	Anchorage loss
1	2.6	2.4	0.9	5.9	4.3 degrees	4.3
2	2.0	2.0	2.5	6.5	5.2	5.2
3	2.8	2.6	1.8	7.2	3.0	3.0
4	2.3	2.6	2.0	7.4	5.1	5.1
5	3.1	3.4	1.8	8.3	2.3	2.3
6	2.7	2.5	2.3	7.5	2.2	2.2
7	1.9	2.7	2.2	6.8	3.4	3.4
8	2.4	2.6	2.1	7.1	1.2	1.2
9	1.7	3.1	1.5	7.3	12.1	12.1
10	2.8	2.6	1.6	7.0	3.0	3.0
11	2.6	2.5	1.5	6.5	2.8	2.8
12	2.8	2.3	2.0	7.1	1.1	1.1
	Mean = 2.475	Mean = 2.608	Mean = 1.858	Mean = 7.05	Mean = 3.51	Mean = 0.300
	SD = 0.406	SD = 0.336	SD = 0.376	SD = 0.575	SD = 0.207	SD = 0.287



A; First week B: Second week C: Third week

Fig. 5. Periapicals at the end of first, second and third week after rapid retraction was completed. Note that right after retraction completed, retraction appliance was removed and fixed orthodontic bands and bonds were placed.

disappeared a few seconds after activation.

Buccal mocusa had mild inflammation after retraction appliance was placed but subsided in a few days. Appliance appearance was not so pleasant for some patients, but it didn't make any problem since wearing time was only three weeks

Canine retraction

Canine retraction was measured by a boley gauge (0.1mm) in the mouth. Gauge was parallel to occlusal plane .Reference points were canine cusp tip and mesiobuccal cusp tip of first molar. One may choose other references points. All measurements were done by two observers. In ten cases rapid retraction ended in three weeks and in two cases it lasted four weeks. The results can be seen in Table 1. Average total retraction was 7.05 m (2.3 mm per week) with the range of 5.9 to 8.3 mm which is comparable with other study (8). Figure 5 shows periapicals during rapid retraction.

Canine rotation: (Table 1)

All canines showed mild distal-in rotation by an average of 3.5 degrees. The range was 1.1 to 12.1 degrees. It seemed that initial canine position was determinant to the amount of rotation. Canine rotation was measured by cast model image (figure-6).

Anchorage loss

Anchor unit was the first molar and the second premolar. According to Vanderlinden, rugae of palate, especially the posteriors, are stable and reliable references to evaluate dental changes during development of occlusion. It is possible to study mesiodistal and buccolingual movements of first molar and rotation of canine tooth by the cast model image

(Figure 6). Measurement was done by a boley gauge(0.1 mm). First molars didn't show buccolingual changes. Average forward movement of first molar was 0.3 mm. In five cases it was zero, in five cases it was near 0.5 mm and in two cases it was 0.8 mm because retraction lasted more than three weeks.

Root resorption

Periapical radiograms of the canines which were magnified by 10 were evaluated for root resorption. Subtelney and Sharpe scoring was used for apical and lateral root surface resorption. For apical root resorption scores were:

0 = no apical root resorption

1 = slight blunting of canine root apex

2= moderate resorption of the root apex beyond blunting and up to one fourth of the root length.

3 = excessive resorption of the root apex beyond one fourth of the root length. For lateral surface root resorption the scores were:

0 = smooth lateral root surface.

1=slightely irregular lateral root surface, not beyond one third of the dentine width between the distal side of PDM and pulp chamber.

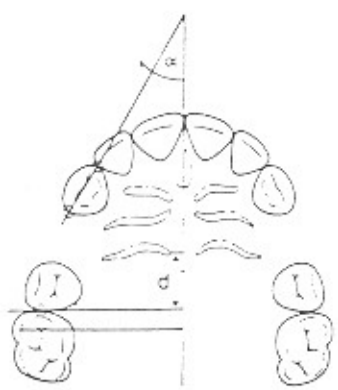


Fig. 6. Mesiodistal and buccolingual movements of first molar and rotation of canine can be measure by the image of the cast model.

2=moderate irregular lateral root surface beyond one third and up to two thirds of the dentine width between the distal side of PDM and pulp chamber.

3=excessive irregularitiy of the lateral root surface beyond two thirds of the dentine width between the distal side of PDM and pulp chamber.

Apical root resorption in nine cases (75%) had zero score and three cases (25%) had score one. Lateral root surface resorption of the distal side of canine root in eight cases (66.6%) had zero score and four cases (33.3%) had score one. Figure 7 shows canine root, one month and three months after rapid retraction. Note maturation of bone distal to the canine third month after retraction.

A B

Fig. 7. Periapicals one month A and three months B. after retraction completed. Note the normal bone pattern at this time.

Periodontal condition and pulp vitality

Rapid retraction appliance generates heavy force but pulp reaction to heat and cold tests were normal and no sign of pulp necrosis was seen. Note that DO method for bone lengthening has shown excellent adaptation of nerves and blood supply (2,18). Radiographic and clinical surveys showed normal periodontium around the canine at the end of retraction.

DISCUSSION

Twelve maxillary canines were retracted successfully into extraction space of first premolar with protocol of DO in three weeks. It could be concluded that periodontal membrane of teeth was stimulated to rapid bone formation like sutures and other osteogenic tissues but at a lower rate. Retracton appliance was activated about 0.8 mm daily. Total activation was 15 mm in three weeks. There was not 1:1 ratio between appliance activation and canine movement; it seemed that bone flexibility, bone bending and creep with the possibility of appliance distortion were the contributing factors (11). The interseptal bone distal to the canine seemed to be the only significant obstacle against rapid canine retraction. Grooving the interseptal bone weakened this mechanical resistance but a heavy force was needed to keep interseptal bone bending and carrying it with canine. Conventional orthodontic appliance not only can not generate such a heavy force but also can not be activated with DO protocol. Average anchorage loss was 0.3 mm that is not significant clinically. Bone response to the heavy force is hyalinization and removing this tissue takes 2 to 3 weeks, which is called lag phase. After lag phase,

anchorage teeth move foreward. The best way to avoid anchorage loss is to finish canine retraction before the end of lag phase. When retraction lasted more than three weeks, not only the lag period was passed but also bone trabeculae in the extraction site became more solid. The beginning of external root resorption is 2 to 3 weeks after orthodontic force is applied (12,16). Root resorption is a biochemical process that needs enough time to occur. The duration of the applied force is an aggravating factor for the root resorption and is more critical than the magnitude of the force (25,30). This study showed that root resorption was quite negligible. Although heavy force was applied for rapid canine retraction, but when the retraction had been completed, root resorption had started begining. Another important factor for root resorption is the type of tooth movement and intrusion is the most critical factor for root resorption. Radiographic documents showed that bone mineralization mesial to canine became obvious in the second week of retraction and increased till the fourth week. Bone maturation lasted until the third month and bone pattern was quite normal at that time. It seems that rapid canine retraction is a safe method. Conventional methods of canine retraction takes 4 to 6 months depending on the anchorage needs. The new rapid method significantly reduces treatment time of extraction cases.

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