Corticotomy assisted orthodontic canine retraction

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ABSTRACT

Background: Surgical injury to alveolar bone can temporarily accelerate tooth movement by increasing the remodeling rate of alveolar bone. The purpose of this study was to clinically evaluate maxillary canine retraction acceleration with corticotomy-facilitated orthodontics, and its effect on vitality of pulp and gingival sulcus depth.

Materials and method: The sample consisted of 12 adult patients (4 males, 8 females; mean age, 21.7 years) requiring the therapeutic extraction of the maxillary first premolars, with subsequent retraction of the maxillary canines. Surgical holes were done mesially and distally to the side with more space between canine and second premolar, and the other side served as the control. Canine retraction was done by power chain applying 200 g of force per side. Rate of canine movement and potential molar anchorage loss were measured after one month using study model and acrylic plug. Bleeding on probing, radiographical assessment, gingival sulcus depth, and vitality test have also been investigated throughout the study.

Result: The surgical side showed a statistically higher retraction mean value as compared with the non-surgical side. In other words, the surgical side demonstrated 42.6% greater net canine distalization than the non-surgical side. Anchorage loss showed no significant difference between sides. There was no significant difference between the pre and post-surgery gingival sulcus depth and pulp vitality response values of surgical side.

Conclusion: It has been concluded that surgical holes introduction is effective in accelerating orthodontic tooth movement, and has no harmful effects on surrounding vital structures and/or pulp vitality.

Key words: canine retraction, corticotomy, tooth movement acceleration. (J Bagh Coll Dentistry 2013; 25(Special Issue 1):160-166).

INTRODUCTION

Conventional orthodontic treatment with fixed appliances is likely to last for 20 to 24 months. The duration of orthodontic treatment is one of the major concerns that patients complain about, most-especially the adult patient [(1)]. To shorten the time of orthodontic treatment, various attempts have been made to accelerate orthodontic tooth movement. These attempts mainly direct electrical current [(2)], micro pulsed electricity [(3)], electromagnetic field application [(4,5)], low energy laser [(6,7)], injection of prostaglandin, Sand calcium gluconate [(8,9)], local injection of Vit. D3 (Calcitriol) [(10,11)]. The last is oral surgery, including gingival fiberotomy, alveolar surgery and distraction osteogenesis. The effect of gingival fiberotomy is controversial [(12)]. Distraction osteogenesis should not be routine in orthodontic treatment, and rapid tooth movement into immature bone regenerating after distraction osteogenesis is not recommended to avoid severe root resorption [(13)], individual canine retractors are bulky and unavailable on the market, and their long-term effects are unknown [(14)].

Surgical injury to alveolar bone can temporarily accelerate tooth movement by increasing the remodeling rate of alveolar bone and decreasing its mineral density, thus decreasing the mechanical resistance of dento-alveolar tissues to orthodontic force.

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A corticotomy is the procedure by which a flap is elevated and the cortical bone is cut with a bur or piezosurgical instrument approximately 1 -2 mm in depth [(16)]. Corticotomies have recently become popularized, which were bone healing mechanisms in combination with orthodontic loadings to decrease treatment times. Although this procedure, termed corticotomy-assisted orthodontics (CAO) or accelerated osteogenic orthodontics (AOO) was first described in 1893, it has only recently gained wide usage. Significantly reduced treatment time has been reported using this procedure with reductions of 75% to 80% of routine treatment time [(17)].

No previous Iraqi studies have dealt with this aspect of orthodontics. Furthermore, this study will, for the first time, involve surgical holes technique for canine distalization.

PATIENTS AND METHODS

Twelve orthodontic patients (4 males, 8 females); with an age ranged from 17- 28 years and mean age 21.7 years, requiring the therapeutic extraction of the maxillary first premolars, with subsequent retraction of the maxillary canines. The sample was set up to use each patient as his own control, thereby increasing the power of small sample. After the patients prepared for the fixed orthodontic treatment; the study started at second stage of treatment (stage of canine retraction). In this stage of treatment arch wire 0.016*0.022 S.S was placed with stopper and tip back bend just mesial to maxillary first molar, ligation of maxillary anterior teeth from right lateral incisor to left lateral incisor, ligation of maxillary second premolar and maxillary first molar in each side. Peri-apical radiograph was taken for both maxillary canines by using self-processing x-ray film; Evaluation of periodontium, roots and surrounding bone was done. Vitality test was done for each patient for maxillary lateral incisors, canines and second premolars for each side by using electric pulp tester. The pathway for the electric current is thought to be from the probe tip of the test device to the tooth, along the lines of the enamel prisms and dentinal tubules, and through the pulp tissue (18). The circuit was completed via the operator having one gloveless hand that touches the patients'skin (19,20). Tingling sensation was felt by patient once increasing the voltage reaching the pain threshold and the reading from device for each tooth was recorded. Pocket depth of both canines was measured by inserting graduated probe and identifying the deepest point at each surface of canine (mesial, distal and palatal). The mean of these readings was calculated for each canine (21). Impression for each patient was taken then poured by stone. The anterior palatal vault could be used as a stable reference point (22). An acrylic plug was fabricated from acrylic with stainless steel reference wires (1.0mm) embedded in the acrylic and extended to the cusp tips of canines and to the central fossae of first molars **(23)**.The patient was re-instructed to maintain good oral hygiene, showing them a video about the procedure of brushing with orthodontic appliance, and prescribing a mouth wash (2% chlorhexidine).

Surgery and retraction

The surgery was done on the side of canine which needed more distalization i.e. the canine in more Class II relation or the side having more space between canine and second premolar.

Local anesthesia infiltration was injected in buccal vestibule from lateral incisor to second premolar at side of surgery and palatally, when the area got anesthetized (examined by probe) incision was made and two sided gingival mucoperiosteal flap was raised to expose cortical bone on the buccal side of the canine (special care was taken not to perforate the flaps, and any interdental papillary tissue that remained inter proximally left in place, the flap retracted beyond the apices of teeth as much as possible).

A series of circular holes (3 to 4 holes, the number of holes was determined according to the length of canine root) were made along the bone mesially and distally adjacent to canine, these holes were made with a 1.5 mm round bur spaced approximately 2mm apart**,** under normal saline solution irrigation and depth of each hole was carefully determined to reach the medullary bone by putting stopper on bur at (3mm), the bleeding through the holes was confirmed by probe, the flap was returned to its position carefully and sutured with 3/0 non absorbable silk braded suture fig.(1), fig.(2).

Antibiotic (Amoxicillin capsules, 500 mg 3 times daily) was prescribed for patients with analgesic (Paracetamol tablet, 500 mg 2 on need). None of the patients was allergic to penicillin excepting one patient who was given Erythromycin (250 mg 4 times daily) instead. Force was applied for both sides by elastomeric chain to retract canine at time of surgery with 200 g (24) measured by force gauge.

Fig.1

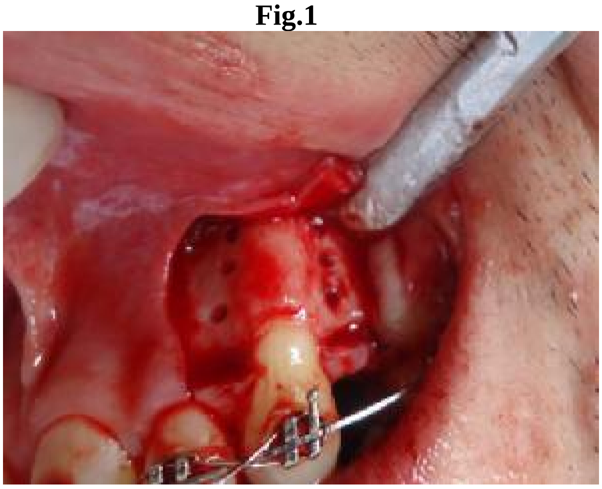

Fig.2

Monitoring Visits

The patients came after one week of surgery date to remove suture and examine the area of surgery for any inflammation or complication. Every patient was instructed to come in regular visits with intervals of one week for: **1**. Checking gingival health by using (Gingival Sulcus Bleeding Index) scoring system (21,25). Bleeding after probing to the base of the probable gingival sulcus has been a common way of assessing presence of sub gingival inflammation [25]. In this system registration, "1" is scored in case bleeding emerges within 15 seconds after probing while absence of bleeding scored (0). **2**. Checking any interference of maxillary canines with opposing teeth in the line of tooth movement. If this interference was present, trimming from palatal surface of maxillary canine was done. **3**. Reloading surgical and non-surgical side with 200g by elastomeric chain, the force was measured by force gauge as mentioned previously.

One month post- surgical

In this visit the following steps were done in the same way mentioned previously: P.a radiograph for maxillary canines, vitality test for lateral incisors, canines and second premolars, gingival sulcus depth measurement for maxillary canines and impression for maxillary arch.

Canine movement and anchorage loss measurements

A reference point was determined on each canine(on cusp tip) of the first model and transmitted on the canines of the final model (fig. 3), the acrylic plug that fabricated on first model then transmitted to the final model to measure the distance between reference wire and the reference point on canine as shown in fig. (4), this distance represented the net canine movement per month**.** The anchorage loss was measured by determining reference point on first molar (usually in the central fossa) of first model and also transmitting it to second model then the acrylic plug that fabricated on first model was transferred to final one with measuring the distance between projecting (reference) wire and reference point which represented the net anchorage loss per month [23,26,27].

Fig.3

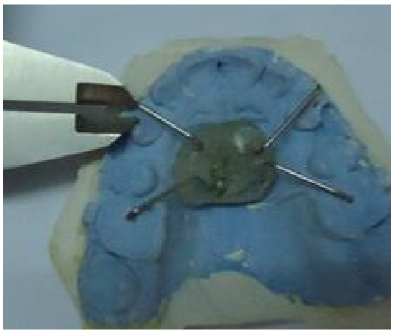

Fig.4

Statistical analysis

All data were statistically evaluated using the Statistical Package for Social Sciences (SPSS) computer program. The statistical analyses included: Descriptive statistics (Means, Standard deviations, Minimum and maximum values, Graphical presentation by bar-charts) and inferential statistics using **(**Wilcoxon Signed-Rank test and Chi square test). Values of $p < 0.05$ evaluated as statistically significant**.**

RESULTS

Canine movement and Anchorage loss

The surgical side showed a higher mean value as compared with the non-surgical side which was statistically highly significant according to the wilcoxon signed rank test. In other words, the surgical side demonstrated 42.6% greater net canine distalization than the non-surgical side as shown in Table (1). Mean of anchorage loss is 0.05mm per month in both sides, i.e. non-significant difference between sides as shown in Table (2).

Radiographic assessment

All the peri-apical radiographs showed almost similar normal sequence of orthodontic tooth movement for both the surgical and non-surgical sides. The periodontal ligament of retracted canines showed compression at the pressure (distalization) site, while widening at the tension (mesial) site. Fig (5) show radiographs patient for both canines pre-surgery and post-surgery. Surgical side cannot be differentiated from non-surgical side in respect of appearance of surgical holes and/or bone destruction.

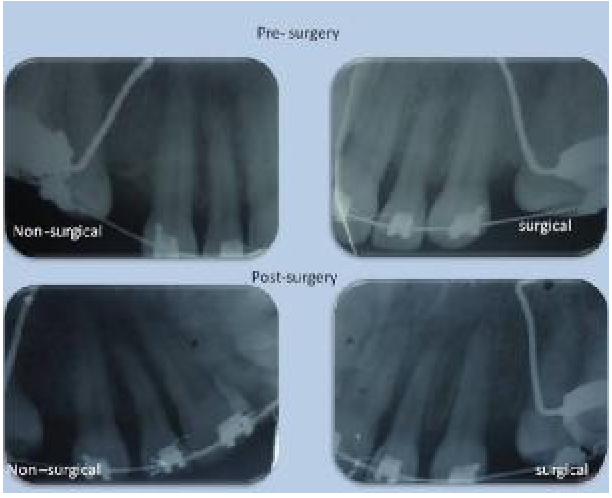

Fig.5

Gingival sulcus depth

A comparison between the pre and post-surgery gingival sulcus depth values of surgical side, the measurements did not exceed 2.5 mm pre and post – surgery. According to Wilcoxon signed rank test there is no significant change in the depth shown in table (3).

Pulp vitality test

In a comparison between pre- and post-surgery pulp vitality test in surgical side and a according to Chi square test there is no significant change in pulp vitality response of the teeth on surgical side between pre- and post-surgery testing as shown in table (4).

Clinical complications and side effects

All patients did not manifest any serious complication after surgery, four patients had post-operative swelling lasted for one to two days after the surgery. There was no sign of gingival inflammation according to bleeding in probing index during the monitoring visits.

DISCUSSION

Corticotomy assisted orthodontics has been reported in few clinical cases [28]. The procedure enhances orthodontic tooth movement by accelerating bone metabolism due to controlled surgical damage. It was initially based more on techniques used ostectomy instead of approaches of corticotomy. It is considered an intermediate therapy between orthognathic surgery and conventional orthodontics [29].

Surgical intervention or osteoporotic situation that is favorable for rapid orthodontic tooth movement can be induced within the alveolar bone without increasing the risk of root resorption [17] and localized osteoporosis [30-33].

Surgery invokes RAP in both hard and soft tissue and reorganization is potentiated, leading to a transient catabolic condition. For bone, this transient osteoporosis means increased mobilization of calcium, decreased bone density, and increased bone turnover, all of which would facilitate more rapid tooth movement. Osteoporosis provided a favorable environment for increasing the rate of tooth movement without increasing the risk of root resorption in rats [34]. Moreover, it has been demonstrated that the residual soft tissue matrix has the ability to induce remineralization after the cessation of tooth movement [35]. All of this suggests that the dynamics of the accelerated tooth movement in this study might be more appropriately described as a demineralization/ remineralization process, rather than bony block movement or resorption/ apposition.

This perspective is substantiated by the fact that there is a growth protein component in the soft tissue matrix of bone [36-38]. Following cessation of the active tooth movement, this growth protein component may assist in stimulating an increase in osteoblastic activity, resulting in remineralization of the soft tissue matrix [17].

Gingival bleeding on probing index was used in this study. This index, unlike other indices which give an assessment for a quadrant or the whole dentition, can assess the gingival inflammation for a specific tooth or a specific site. When assessing gingival health of canines in both sides, all involved teeth scored (0), indicating successful prevention of maxillary canine's gingival inflammation throughout the study period due to the firm instructions about the proper oral hygiene maintenance methods given to the patients throughout the study, in addition to the use of mouth rinses and special orthodontic brushes.

In this study, the response of teeth was increased gradually from lateral incisor, canine to second premolars. Key variables known to affect the response to pulp testing are the thickness of the enamel and dentine, the number of nerve fibers in the underlying pulp, and the direction of the dentinal tubules is also important in establishing pulp test responses in various parts of the tooth crown. The dentinal tubules run an almost straight course from the incisal edge of anterior teeth to the pulp horn. In multi-cuspal teeth, the course of tubules is somewhat curved and resembles an ‘S’ shape [55]**.** Because it is principally the fluid in the tubules that conducts electrical impulses from the pulp tester electrode to the pulp, the shorter the distance between the electrode and the pulp, responds faster and records lower score.

Furthermore, orthodontic force increases the response threshold to electric pulp test. The effect is almost instantaneous and could persist for up to 9month after treatment [39,40], this may give another explanation for the result of teeth responding at different levels of current intensity in this study, and this is in agreement with [41-44].

Statistically, EPT readings regarding the three teeth did not differ significantly between the two sides both pre and post-surgery and between per and post-surgery for surgical side. This is attributed to the safe, non- traumatic surgical intervention for the canine and surrounding area, and the use of optimal physiologic force that did not endanger pulp vitality.

As a conclusion; the introduction of surgical holes is effective in accelerating OTM and shortening orthodontic treatment time, Enhancement of bone turnover through demineralization/remineralization concept can serve as a successful clinical adjunct to the bone resorption /deposition concept and when done properly, surgical holes introduction produce no iatrogenic insult on periodontium and/or pulp vitality.

Table 1: Descriptive and inferential statistics of net canines' movement

Side	Descriptive Statistics					Side difference		
	N	Mean	S.D.	Min.	Max.	Wilcoxon Signed Ranks Test	p-value	Sig.
Non-surgical side	12	1.22	0.40	0.55	1.82	-3.06	0.002	HS
Surgical side	12	1.74	0.47	1	2.34			

Table 2: Descriptive and inferential statistics of anchorage loss

Side	Descriptive Statistics					Side difference		
	N	Mean	S.D.	Min.	Max.	Wilcoxon Signed Ranks Test	p-value	Sig.
Non-surgical side	12	0.05	0.12	0	0.3	0	1	NS
Surgical side	12	0.05	0.12	0	0.3			

Table 3: Comparison the pre- and post- gingival sulcus depth in the surgical side

Sulcus depth	Descriptive Statistics					Sulcus depth difference		
	N	Mean	S.D.	Min.	Max.	Wilcoxon Signed Ranks Test	p-value	Sig.
Pre-gingival sulcus depth	12	1.98	0.22	1.5	2.5	-1.34	0.18	NS
Post-gingival sulcus depth	12	1.94	0.26	1.5	2.5			

Table 4: Comparison pre-surgery and post-surgery vitality test in surgical side

Scores	Lateral incisor		Canine		2nd premolar	
	Pre-vitality	Post-vitality	Pre-vitality	Post-vitality	Pre-vitality	Post-vitality
1	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
2	3 (12.5%)	4 (16.7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
3	3 (12.5%)	2 (8.3%)	2 (8.3%)	2 (8.3%)	0 (0%)	0 (0%)
4	4 (16.7%)	4 (16.7%)	1 (4.2%)	1 (4.2%)	0 (0%)	0 (0%)
5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
6	2 (8.3%)	2 (8.3%)	5 (20.8%)	6 (25%)	4 (28.6%)	4 (28.6%)
7	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8	0 (0%)	0 (0%)	4 (16.7%)	3 (12.5%)	2 (14.3%)	2 (14.3%)
9	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
10	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (7.1%)	1 (7.1%)
X^2	0.34		0.23		0	
Likelihood ratio	0.35		0.23		0	
p-value	0.95		0.97		1	
Sig.	NS		NS		NS	

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