Original Article

EFFECT OF MINISCREWS PERFORATION ON MAXILLARY CANINE RETRACTION RATE

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ABSTRACT

The aim of this study was to evaluate the rate of canine retraction in maxillary first premolar extraction patients with or without flapless cortical perforations (FCPs) made with the help of a miniscrew. 30 adult patients with class II div I malocclusion were randomly allocated with the help of SPSS software to either perforation or conventional group for carrying out this randomized parallel group controlled trial in 1:1 ratio. Maxillary first premolars were extracted and canine retractions were commenced in both groups. Three bilateral cortical FCP were made in the perforation group with a self-tapping miniscrew of 1.5mm diameter. The patients were evaluated at 28 days after start of canine retraction. Data were analyzed with the help of SPSS software with an intention-to-treat approach.

Mean canine retraction in patients with conventional mechanics was 0.49 ± 0.08 mm while patients with FCP had a mean retraction of 1.52±0.11 mm measured at the tips of the canine and lateral incisor after 28 days. There were no losses to follow up. FCPs are an effective method of accelerating the rate of canine retractions by 2-3 fold in the first month of tooth movement.

Key Words: *Flapless Cortical perforations, Canine Retraction, Miniscrews.*

INTRODUCTION

One of the primary concerns of orthodontic patients is the duration of the orthodontic treatment.[1-3] In fact, a substantial number of malocclusion patients do not pursue orthodontic treatment because of the long duration it takes.[4] Hence, the idea of accelerated orthodontic treatment has always attracted the attention of orthodontic practitioners and patients alike.

The orthodontic tooth movement (OTM) is a complex process due to the interplay of multiple biologic and biomechanical factors such as periodontal status, duration and type of force application and regional cellular and molecular activity.[5] Although careful diagnosis and a well-planned treatment sequence can reduce treatment duration, the biologic activity remains the main limiting factor of the rate of OTM.[4]

Many attempts of accelerating the OTM have been made in the past. These include increase in force magnitude and type, regional drug applications, vibratory forces, lasers, and light emitting diode light therapy, use of temporary anchorage devices and inciting regional osteopenia to accelerate the remodelling activity.[6-12]

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Regional osteopenia can be induced in the anatomic region of interest in several ways. These can be classified as flap or flapless approaches, corticotomy, medullary osteotomy or both, and cortical incisions with use of burs or piezo instruments.[8, 9, 12, 13] Most of these procedures have produced promising results suggesting increase in rate of OTM from 1.5 to 3 times the normal rate.[14] However, many of these procedures require additional surgeries, substantial increase in costs and increased morbidity.[15]

Recently a more conservative approach has been proposed where a standardized needle gun (Propel) is used to induce micro-osteoperforations in the cortical alveolar bone without elevation of periodontal flap. The animal and human studies suggest that this approach may increase the rate of OTM 2-3 fold in comparison to normal approach.[14] The same flapless perforation or cortical bone may be achieved with the use of an orthodontic miniscrew, which is cheaper and readily available. The aim of this trial was to evaluate the rate of canine retraction in maxillary first premolar extraction patients with or without flapless cortical perforations (FCPs) made with a miniscrew.

Specific objective or hypotheses

The aim of our study was to evaluate the rate of canine retraction in maxillary first premolar extraction patients with or without flapless cortical perforations (FCPs) made with the help of a miniscrew.

MATERIALS AND METHODS

Trial design and any changes after trial commencement

This was a parallel group, randomized controlled trial with a 1:1 allocation ratio. No changes were made after the trial commencement.

Participants, eligibility criteria and setting

This study was carried out at college of Dentistry Jouf University Saudi Arabia. The duration of study was 12 months. The patients included were orthodontic adult patients with age range from 20-40 years, class II div 1 malocclusion, maxillary bilateral premolar extractions indicated and good oral hygiene.

The patients excluded were those who had previous orthodontic treatment, long-time use of drugs and systemic diseases.

Informed consent was taken from the patients included in the study with a thorough explanation of benefits and limitations of the procedures involved.

Interventions

All patients began the treatment with bonding of upper and lower fixed appliances (0.022 inch slot MBT prescription 3M Unitek). The extraction of the first premolars were carried out by a surgeon in Oral Surgery department in accordance with the study requirements (minimal traumatic extraction). Alignment and levelling was carried out by the principal investigator with the help of appropriate sequence of wires. Before starting the retraction of canines, an alginate impression of the dentition was taken for baseline record. For experimental group, local anaesthesia was administered before commencing FCP. 3 FCPs were performed with a self-tapping miniscrew implant of 1.6 mm diameter (Figure 1and 2). The depth of each perforation was 3 mm in the buccal cortical bone between canine and premolar. The canine retraction was commenced in both groups with Nickle Titanium coil springs with a long range and low load-deflection rate with an approximate force of 100g. All patients were recalled on 28th day of retraction and alginate impressions was repeated for data collection.

Measurements were made directly on the unsoaped plaster dental casts. All the measurements were done by the first author under natural light. Distance between the tip of the canine and midpoint of incisal edge of lateral incisor was denoted tip distance, while the distance between the cervical midpoints on the height of contour of respective cinguli was denoted as cervical distance. All dental cast were scanned by Cranex (SOREDEX, Tuusula, Finland) to obtain 3D digital model for the ease of precise measurements. All the measurements were performed by two researchers for reliability of the measurements using dedicated software (NewTom 3G: NNT, QR SRL; Scanora 3D: OnDemand®, Cypermed Inc, Irvine, CA).

Outcomes (primary and secondary) and any changes after trial commencement

Primary outcome was the movement of canine in millimetres measured at tip and cervical landmarks. The data were recorded at 28 days. No changes to methods were done after the start of the trial.

Sample size calculation:

Sample size was calculated with the help of WHO software for Sample based on the following parameters.

Alpha error: 5%

Power of study: 90%

Minimum difference to detect: 50%

Population Standard Deviation: 0.3mm[14]

Randomization (random number generation, allocation concealment, implementation)

In this trial, only the patients who required bilateral maxillary premolar extractions were included. A total of 60 canines in 30 patients were retracted with conventional biomechanics with or without flapless cortical perforations. The patients were randomly allocated by a sequence generated in SPSS with equal number of participants in each group, and the allocation was centrally concealed. Prinicipal investigator assessed the patients for eligibility and discussed the nature of the trial with patients. After obtaining informed consent the patient started with the fixed appliances treatment. The allocation to experimental or control group was carried out when canine retraction was ready to be started.(Fig 3)

Blinding

Blinding was carried out at the analysis stage as patient and operator blinding was not possible due to the nature of the procedure of perforation.

Statistical analysis (primary and secondary outcomes, subgroup analyses)

Statistical analyses were performed using SPSS for Windows (version 20; IBM). Differences between the groups were assessed using the independent sample t-test. Paired t-test was used for differences between right and left sides. The level of significance was set at p=0.05 or less.

RESULTS

60 canines in 30 patients of mean age 27.9 ± 4.5

TABLE 1: BASELINE CHARACTERISTICS AT THE COMMENCEMENT OF TRIAL

Age (years)	**Perforation**	**27.5 ± 4.4**
	Conventional	28.4 ± 4.5
Gender	Females	18
	Males	12
Sample size (Canines)	Perforation	30
	Conventional	30

TABLE 2: CANINE MOVEMENT AT TIP AND CERVICAL LANDMARKS.

Group	**N**	**Distances (mm)**	**Mean**	**S.D.**	**95% CI**		**p value**
					Lower	Upper	
Perforation	30	Tip	1.36	0.12	0.98	1.09	0.001*
		Cervical	1.31	0.13			
Conventional	30	Tip	0.49	0.08	0.30	0.94	0.001*
		Cervical	0.44	0.08			

SD: standard deviation
Test of significance: Paired sample t Test
Level of significance: $P < 0.01$
*Significant Value $P < 0.05$

Fig 1: Miniscrew driver

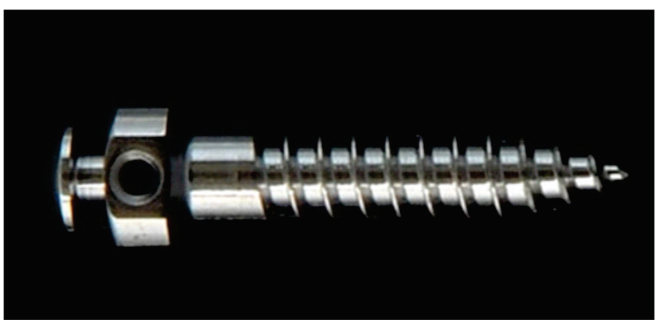

Fig 2: Miniscrew implant

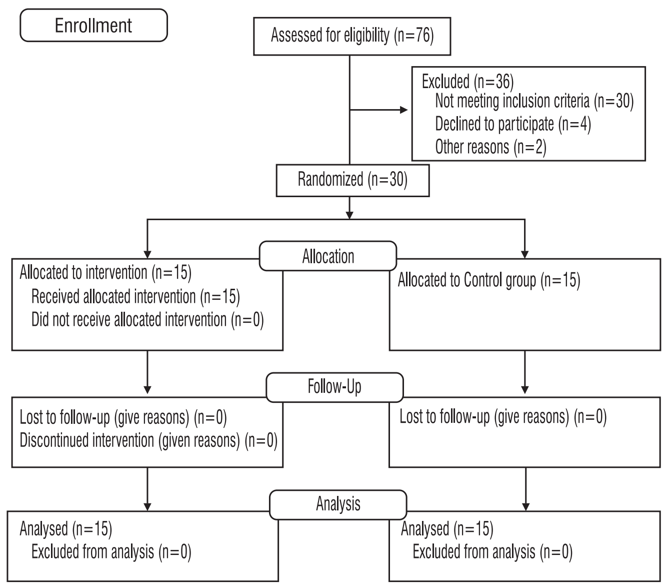

Fig 3: Consort flow chart

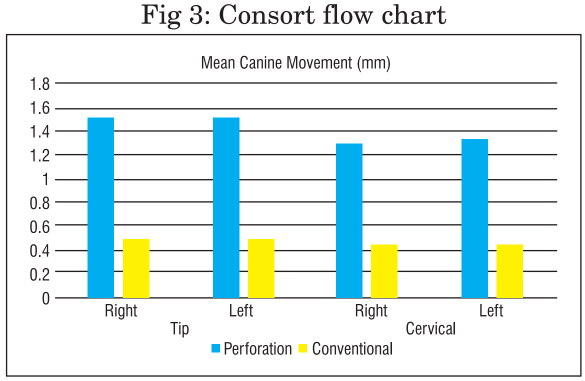

Fig 4: Right and left side canine movement comparison

years (age range 20-36 years) were followed for 28 days. There were no losses to follow up. Baseline characteristics are given in Table 1. In MOP group, there were 8 males and 7 females while conventional group comprised of 4 males and 11 females.

Canine retraction was measured at the tip of the incisal edges and cervical height of contour in the middle third of the same quadrant lateral incisor and the canine. The average canine retraction in patients with conventional mechanics was 0.49 ± 0.08 mm and 0.44 ± 0.08 mm at the canine tip and cervical point respectively. In contrast, canines in patients with osteo-perforation had a mean retraction of 1.52±0.11 mm at the tip and 1.33±0.12 mm at the cervical point showing some degree of tipping (Table 2).

Independent sample T-test demonstrated highly significant difference between the two groups ($p<0.000$) at 28 days. There were no significant differences between right and left sides in both groups. (Figure 4)

Harms

No serious harm except pain and minor bleeding in the perforation area. No medications for the pain were necessary.

DISCUSSION

Main finding in the context of the existing evidence, interpretation.

Acceleration of orthodontic tooth movement is of interest to clinicians as it has the potential to reduce the orthodontic treatment duration. Although there are several factors which affect this duration, the biologic process of tooth movements is a major factor which has captured attention in the recent past.

Transient localized osteopenia has shown to be effective in increasing the bone turnover which can in turn increase the rate of orthodontic tooth movement. Several methods of inducing such osteopenia have been advocated and range from osteotomies to small flapless alveolar perforations. This indicates the underlying desire to identify methods of reducing trauma to the patient during this procedure. Micro-osteo-perforation has the advantage of being minimally invasive, easy to perform and relatively comfortable for the patient. This trial compared the effect of micro-osteo perforations on the rate of the canine movement in the first month.

We found significantly higher rate of canine retraction in the perforation group, highlighting the effectiveness of the procedure, at least in short term. This is in agreement with the only available human trial conducted with this technique by Alikhani et al[14] who found 2-3-fold increase in the rate of tooth movement with MOPs in their split mouth design trial. The same group initially experimented this technique in rats, and found it effective in enhancing the rate of tooth movement.[16] Recently, Tsai et al also reported increased rate of tooth movement with MOPs in rats.[17]

The increase in the rate of tooth movement can be explained by the process of regional acceleratory phenomenon (RAP), originally described by Frost.[18] The osteopenia induced by perforations leads to a zone of increased remodelling activity, which essentially leads to faster tooth movement than normal.[19,20]

While several factors affect the rate of tooth movement,[21-27] it is reasonable to assume that the effect of occlusal interferences was minimal in this study as only class II div I malocclusion cases were included. Similarly, the use of rectangular wires with steel ligatures ensured primarily bodily movement, evident by minimal tipping during the retraction. Age of the patients was well balanced in both groups. Hence age and type to tooth movement are also unlikely to have confounded the results. We found no differences in the rate of retraction on right and left sides, or between males or females. This is also in agreement with previous studies.[22]

In comparison to Alikhani et al[14], there were some notable differences in the study design in our trial. They used miniscrew anchorage for the retraction of canine, while we used compound anchorage, which involved inclusion of second molar in the anchorage segment. However, this is unlikely to be of significance. The perforations were made with a miniscrew in our study which is a cheap and easily available. Also, we performed canine retraction with bilateral FCPs, as it was shown by Alikhani et al[14] that the localized regional acceleratory phenomenon (RAP) did not carry across to the contra-lateral side.

Limitations

Our study was a short term, 1 month follow up study. Blinding of the patient and operator was not feasible and blinding was confined to analysis stage only. Future studies with longer observation time, number of perforations and inclusion of variables such as pulp vitality and root resorption are recommended.

Generalizability

The generalizability of these results can be considered good, as all the procedures were performed in a hospital based orthodontic setting and all the patients were adults.

CONCLUSION

Flapless Cortical Perforations with orthodontic miniscrew is an easy, safe and effective method of accelerating orthodontic tooth movement by 2-3 times.

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CONTRIBUTIONS BY AUTHORS

Both authors contribted substantially