

**How to Cite:**

Salim, M. A. M. A., Ahmed, H. S. H., Dawaba, M. M. M., Elblhasy, A. I., Moussa, S. A., & Said, M. A. (2021). Evaluation of external root resorption concomitant with maxillary canine retraction assisted by micro-osteoperforation using a cone beam computed tomography: Clinical study. *International Journal of Health Sciences*, 5(S1), 917–925. <https://doi.org/10.53730/ijhs.v5nS1.14837>

## **Evaluation of external root resorption concomitant with maxillary canine retraction assisted by micro-osteoperforation using a cone beam computed tomography (clinical study)**

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**Abstract**--Aim: to calculate the impact of external apical root resorption (EARR) assisted by micro-osteoperforations (MOPs) throughout maxillary canine retraction. Patients and Methods: twenty cases; fifteen girls, five males (average age:  $18.66 \pm 3.27$  years) who required as part of their treatment strategy, the extraction of at least one maxillary first premolar. They were received adjunctive therapy with MOPs. EARR was measured from CBCT before and after canine

retraction. All gathered data will be tallied and subjected to statistical analysis. Results: A comparison between pre-treatment and post-retraction canine length with microosteoperforations (MOPs) showed that there was non-significant difference regarding root resorption. Conclusion: There was no remarkable effect on root resorption of the canine as the microosteoperforation facilitate the canine movement and reduced the whole retraction time.

**Keywords**---canine retraction, Accelerated orthodontics.

## Introduction

Longer orthodontic treatments can have a number of unfavorable outcomes, such as worse oral hygiene and patient participation, more dental cavities, gingival recession, and root resorption. As a result, there have been numerous attempts to hasten tooth movement during orthodontic procedures. Therefore, reducing the length of treatment is a desirable objective since it may lower the chance of EARR.<sup>1,2,3</sup>

Resorption activity during orthodontic tooth movement (OTM) is linked to several cytokines and molecular factors, such as nuclear factor kappa-B ligand receptor activator, that are involved in clastic cell fusion and activation pathways linked to interleukin (IL)-1 and osteoprotegerin (OPG)/RANKL/RANK. The magnitude of the compressive force affects the OPG: RANKL ratio in the crevicular fluid. The neighboring cementoblast layer that covers the cementoid is harmed by macrophage-like cells from the periodontal ligament blood supply, which starts root resorption. This results in cementum exposure, which makes the denuded root surface more vulnerable to osteoclasts and scavenger cells resorbing.<sup>4</sup>

According to a number of studies, mechanical stimulants like OTM may cause certain inflammatory reactions in periodontal tissues.<sup>5</sup> Chemical mediators can be released by the cells in sufficient quantities into GCF; hence, during OTM, GCF may include more of these compounds.<sup>6</sup>

Regarding root resorption, Chan et al. found that the maxillary first premolar was subjected to larger volumes of orthodontic root resorption craters during buccal tipping force.<sup>7</sup>In the Dos Santos et al. 2020 systematic review study.They discovered that MOP had no impact on the resorption of roots.<sup>8</sup>

The most popular minimally invasive technique for speeding OTM at the moment is micro-osteoperforations (MOPs); MOPs are more widely accepted by patients and have a more advantageous application in ordinary practice than other invasive supplementary techniques. Because it lasted only one month, the initial study by Alikhani et al.<sup>15</sup> examining the impact of MOPs on the rate of OTM in people did not look into the related root resorption. Dental panoramic tomography (DPT) was used in the investigation, although the results did not conclusively demonstrate root resorption or alveolar bone loss.<sup>10</sup> More research is necessary because this method was thought to be insufficiently accurate for determining the

extent of root resorption.<sup>9</sup> This study evaluates EARR during maxillary canine retraction assisted by MOPs.

### **Patients and Methods**

Participants were chosen from the orthodontic clinic at the Asyut branch of the Faculty of Dentistry at Al-Azhar University. A detailed clinical examination and a complete diagnostic sheet are completed for each patient. Routine records including Orthodontic study models, Panoramic radiographs, Extra- and intra-oral photos, lateral cephalometric radiation are obtained for each patients. Cone Beam Computed Tomographic (CBCT) scans of the entire skull will also be performed prior to treatment and following the conclusion of canine retraction.

The study participants were subjected to extensive prophylactic measures, such as scaling and gingival therapy, in an effort to achieve the highest level of uniformity in their gum health prior to treatment. Every patient also receives a form with instructions for at-home care.

Before commencing orthodontic treatment, the right and left premolar are extracted by a surgeon in Oral Surgery department in accordance with the study requirements (minimal traumatic extraction). Then upper dental arches are leveled and aligned using sequences of wires 0.014",0.016",0.018" 0.016×0.022" and, 0.017×0.025-inch nickel titanium (NiTi) arch wires. After complete alignment and leveling, to make sure the 0.017×0.025" SS arch wires are passive, a final working wire is inserted and left in the bracket slot for a minimum of three weeks.

The four maxillary incisors are ligated together by using figure of eight 0.009-in steel ligature wires. The maxillary 2 nd premolars are colligated to the upper 1st molars with a 0.009-in ligature wire made of steel on each side.

Micro-osteoperforation is performed as follow

Step 1: Rinse

- Rinse with chlorhexidine antiseptic mouthwash for 60 seconds prior to the procedure

Step 2: Administration of local anesthesia

- MOPs are performed under local (normal asepsis and 2% lidocaine with a 1:100,000 epinephrine ratio).

Step 3: Osteoperforations technique:

Flapless MOPs are performed by single investigator Using the subsequent procedures on the left or right maxillary side :

1. Using miniscrews with a 1.6 mm diameter and a 6 mm length, three distinct MOPs were produced directly through the buccal mucosa next to the extraction site. The MOPs were formed in a vertical direction, two mm apart, and three mm deep (as measured with a rubber stopper).
2. The miniscrew inserted 3 mm deep into the bone then removed. The depth of perforation is standardized with the use of a rubber stopper.

As soon as homeostasis is achieved with a cotton pellet and local pressure, paracetamol is advised to be taken as needed. Since anti-inflammatory NSAIDs are known to affect tooth mobility, they are not used. Patients are advised to rinse twice daily with 0.2% chlorhexidine for 5 days to maintain good oral hygiene.

After application of the MOPs, maxillary canine retraction is started. Canines are retracted using elastomeric chain, force 150 gm. As a fixed point of anchorage, the chain is directly attached to the canine bracket anteriorly and the mini-implant posteriorly. Every visit, a force gauge is used to verify the applied force, the appliance is inspected for distortion or positional changes, and the amount of retraction during space closure is measured at each session.

For each patient, CBCT images were obtained both prior to and following canine retraction in order to assess external apical RR. The Sirona Galileos CBCT system was used to acquire CBCT scans. The characteristics of the machine were as follows: voxel size of 0.35 mm amorphous silicon flat panel, scanning time of 2.6 seconds, 82 KV, 32 mA, and 13 cm x 15 cm FOV. After being saved as DICOM 3D multi-files, the scans were loaded into a computer program.

The difference in millimeters between the maxillary canine pre-treatment and post-retraction lengths was used to measure the apical root resorption. For the maxillary canines on both sides, the root length was measured from the most apical point of the root to the cusp tip. Software tools, such as a digital magnification lens and a linear measurement tool, were used to achieve the measurements.

### **Statistical Analysis**

The statistical package for social sciences (SPSS version 23, Chicago, IL, USA) was used for the analysis. The pre and post-retraction were compared using a paired t-test. The significance threshold taken into account was  $p < 0.05$ . After two weeks, interclass correlation (ICC) was conducted on a 20% repeated measurement to assess intra-examiner reliability.

### **Results**

This trial included twenty eligible patients. The average age was  $18.66 \pm 3.27$  years. EARR was measured from CBCT before and after canine retraction. Table 1 compares the length changes of the teeth before and after retraction and finds no statistically significant difference ( $p > 0.05$ ). Additional investigation revealed no discernible variation (table 2). The canine's root resorption was observed to be unaffected, since the micro-osteoperforations allowed for easier canine mobility and reduced the whole retraction time.

Table 1

Teeth length	Before (Mean±SD)	After (Mean±SD)	(P-Value)
Maxillary right canine	26.11±0.53 mm	26.83±.094mm	>0.05 NS
Upper right second premolar (palatal root)	19.25±0.45 mm	18.8±0.51 mm	>0.05 NS
Upper right first molar (palatal root)	22.57±0.36 mm	22.51±0.33 mm	>0.05 NS
Upper left canine	24.5±0.2 mm	24.44±0.19 mm	>0.05 NS
Upper left second premolar (palatal root)	19.15±0.43 mm	18.88±0.53 mm	>0.05 NS
Upper left first molar (palatal root)	21.75±0.19 mm	21.76±0.19 mm	>0.05 NS

Paired sample t-test was used, NS: No discernible statistical difference P>0.05

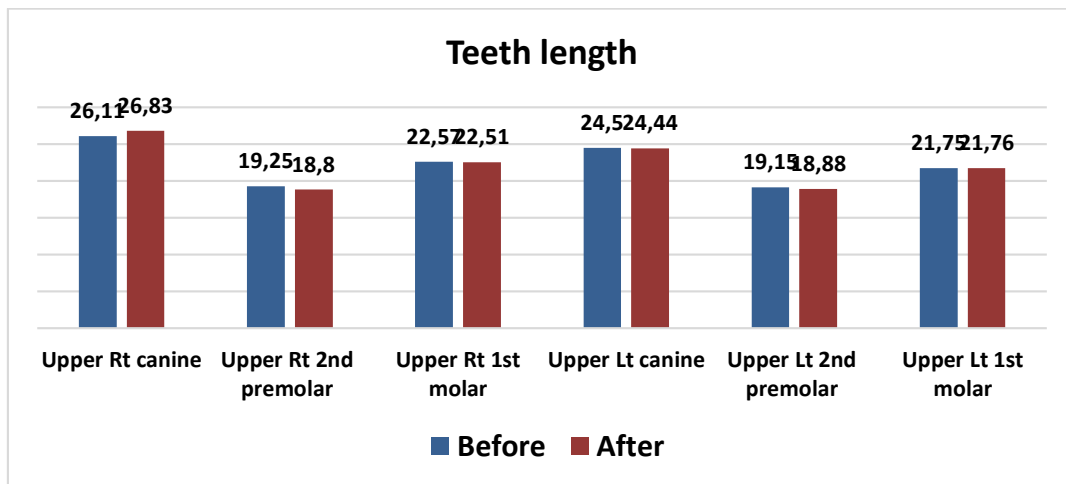
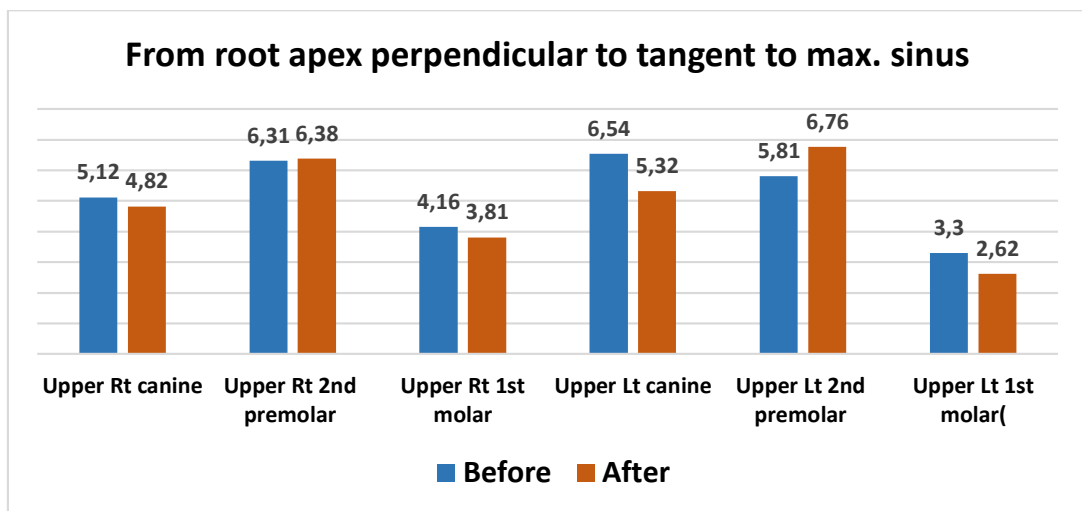


Table 2

From root apex perpendicular to tangent to max. sinus	Before (Mean±SD)	After (Mean±SD)	(P-Value)
Maxillary right canine	5.12±0.13 mm	4.82±0.56 mm	>0.05 NS
Upper right second premolar (palatal root)	6.31±0.1 mm	6.38±0.06 mm	>0.05 NS
Upper right first molar (palatal root)	4.16±0.08 mm	3.81±0.056 mm	>0.05 NS
Upper left canine	6.54±0.53 mm	5.32±0.16 mm	>0.05 NS
Upper left second premolar (palatal root)	5.81±0.028 mm	6.76±0.18 mm	>0.05 NS
Upper left first molar (palatal root)	3.3±0.28 mm	2.62±0.35 mm	>0.05 NS

Paired sample t-test was used, NS: No discernible statistical difference P>0.05



## Discussion

Typically, orthodontic therapy does not result in clinically significant root resorption; rather, the teeth's roots undergo microscopic alterations that are hard to see on radiological scans. For orthodontic treatment to be successful, root resorption must be prevented since it shortens the teeth's roots and weakens the tooth arch. When 1-2 mm (1/4) of the root length is lost, root resorption is regarded as clinically significant.<sup>10</sup>

The diagnostic performance of CBCT shown good specificity and high sensitivity. In 2010, John et al. came to the conclusion that CBCT, as opposed to periapical radiographs, which have errors in magnification and imprecise landmark identification, is the most dependable technique for measuring and assessing external apical RR.<sup>11</sup>

According to Alikhani et al., patients and orthodontists can benefit greatly from shorter orthodontic treatment times. With fixed orthodontics, the risk of external apical RR is decreased with shorter treatment times.<sup>12</sup> Several surgical methods, with varying degrees of invasiveness, have been documented to expedite OTM, including flapless partial corticotomies and total block osteotomies.<sup>13</sup> An increase in inflammatory mediators during surgery may momentarily accelerate bone resorption and metabolism. In order to solve these issues, less invasive surgical techniques such as corticision, PZC, piezopuncture, and MOP have been developed.<sup>14</sup>

An orthodontist can execute MOP, a minimally invasive procedure, with the use of mini-screws and other appliances. Therefore, in comparison to other treatment modalities, it may be more beneficial and less intrusive for root resorption.<sup>15</sup> MOPs were used as a minimally invasive accelerated TM approach, Alikhani et al. discovered that there is no rise in external apical RR after MOP therapy. Between pre-treatment and post-retraction canine length with MOPs, we found no discernible difference.<sup>12</sup>

The difference in the rate of canine retraction following the MOP was shown to be statistically significant but not very important clinically in a systematic review and meta-analysis research by Shahabee et al. A study regarding the negative consequences of MOP found that individuals undergoing MOP had increased levels of root resorption. Similar findings and detrimental effects for MOP were not found in any other research. After evaluating the benefits and drawbacks of MOP for each patient individually, a recommendation can be made.<sup>16</sup>

In terms of the buccal bone thickness before and after canine retraction, Agrawal et al. compared corticotomy with a mucoperiosteal flap to MOP in a case series research. The buccal bone exhibited a notable increase in thickness in both procedures, particularly in the vicinity of the mid-root and coronal portions of the root. The majority of publications, according to this systematic review, did not discover a meaningful correlation between MOP and root resorption during tooth movement.<sup>17</sup>

Following canine retraction, Khursheed et al. observed significant root resorption on the experimental PZC side as opposed to the MOP side postoperatively.<sup>18</sup> Additionally, Chan et al. showed that when buccal tipping force is applied to the maxillary first premolars, MOP results in increased levels of orthodontic root resorption. It was demonstrated that, in contrast to MOP, periapical radiographs, which were utilized to assess root lengths, were substantially less reliable in identifying root resorption.<sup>7</sup> The study discovered that MOPs had no discernible impact on the resorption of apical roots following canine retraction.

## **Conclusions**

There was no noteworthy outcome on resorption of root for the canine as the microsteoperforation facilitates the canine movement and reduced the whole retraction time.

### **Conflict of Interest Disclosure**

There are no possible conflicts of interest that the authors have disclosed about the research, writing, or publication of this article.

### **Approval from an Ethical Perspective**

The Institutional ethical Committee (IEC) of Dental Medicine, Al-Azhar University, Assuit, Egypt, obtained the ethical approval by Communication of Decision; the form for this purpose is included below.

### **Knowledgeable Consent**

At the beginning of his care, a generic patient consent form was completed, stating that the patient's records and pictures might be utilized in upcoming clinical research projects. As a record-based retrospective study, no specific consent was obtained for this investigation.

### **Finance**

The research, writing, and/or publication of this paper were all done without financial assistance from the authors.

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