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Assessment of association between pain and root resorption during canine retraction: An exploratory study

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ABSTRACT

Background: Pain and root resorption are common adverse events reported in the orthodontic literature. Both are side effects of the sterile inflammatory tissue reaction related to the application of orthodontic force.

Aim: The aim of this exploratory study was to assess the association between pain and root resorption during canine retraction.

Materials and Methods: Twenty-four patients indicated for first premolar extraction and canine retraction were recruited. All patients were treated with 0.022" X 0.028" Roth prescription brackets. After leveling and alignment, canines were retracted over 0.017" X 0.025" stainless steel arch wires. Canines were retracted with elastomeric chains applying 150g of force. Root length was measured and resorption was calculated. Measurements were made on the cone beam computer tomograms taken before canine retraction and after 6 months of retraction. The patients were asked to record their pain intensity 24 hours after the replacement of the elastomeric chain. Spearman's correlation coefficient was calculated for the pain scores and root resorption.

Results: The correlation coefficient was very weak (ρ: 0.137, p-value 0.425).

Conclusion: Within the limitation of this study, the correlation between pain scores and root resorption was insignificant.

1. Introduction

Pain is one of the most common complaints of orthodontic patients. Most procedures in orthodontics are associated with pain including teeth separation, banding, archwire placement and activation, debanding and debonding.

The application of orthodontic force stimulates a cascade of biological responses that elicit pain. The pain onset is reported to be immediate or 2-4 hours after insertion of separator or wire activation. It peaks after 24 hours,[1,2] declines by the third day [3] and lasts 5-7 days.[4, 5]

External apical root resorption is also very common with orthodontic tooth movement. The osteoclasts are recruited to the areas of compression to remove the hyalinized bone and start bone remodeling in the periodontal ligament. They also resorb the root cementum and dentin adjacent to areas of hyalinization.[6]

The degree of resorption is unpredictable.[7] It can be classified into 4 stages; Level 1 is seen as irregular root surface, level 2 shows less than 2mm. resorption, level 3 is more than 2mm. and less than 1/3 of the original root size and level 4 is resorption exceeding the apical 1/3.[8] In most patients, orthodontically induced external apical root resorption is minimal (1.4 ±0.45 mm.).[9]

Both pain and root resorption, are associated with the inflammatory process related to the orthodontic force application. They have a high prevalence. They occur more in the anterior than in the posterior region. Both are associated with decreased swallowing and masticatory function to avoid pain exacerbation.[2] These similarities may hint at an association between pain and root resorption.

Unlike root resorption, pain has an early onset. It is recurrent with force reactivation. Root resorption is visible by six months of treatment.[10, 11] If an association exists between pain intensity and/or duration it may give some early indication to the onset and severity of root resorption.

The aim of this study was to explore if an association between pain and root resorption exists during canine retraction.

2. Materials and Methods

This study was approved by the ethical review board at Future University in Egypt (FUE) before the start of treatment and patients and/or guardians signed an informed consent agreeing to participate in this study. Twenty-four patients indicated for first premolar extraction and canine retraction were

recruited from the out-patient clinic of the FUE between 2018-2020. Patients were excluded from the study if they had received previous orthodontic treatment, periodontal disease, missing permanent teeth, or suffered from any craniofacial disorders or bone disease. The patients included sixteen females and eight males with ages ranging between 14 and 22 years.

All patients were bonded with 0.022" X 0.028" Roth prescription brackets. After leveling and alignment were completed, canines were retracted over 0.017" X 0.025" stainless steel arch wires. Elastomeric chains applying 150g of force were used. A digital force gauge was used to check the magnitude at each appointment.

The patients were referred for cone beam computer tomogram (CBCT) imaging before canine retraction and after 6 months of retraction. The DICOM images were imported into the Invivo Dental 5 software (version 5.3.1, Company, Santa Clara, Calif.) and a three dimensional digital image was generated. The canine root apex and cusp tip were localized in the three planes using the slice locator. The pre-retraction and 6-month post-retraction CBCTs were used to calculate the root resorption as the difference in root length, from cusp tip to root apex.

The patients were asked to record their perceived pain intensity, after 24 hours from the replacement of the elastomeric chain for 6 months of activation. However, the 6-month time point was selected for the statistical analysis, to coincide with the time at which the root resorption was measured. The patients marked the pain intensity on a 100-mm visual analogue scale, where the left end represented a score of zero (no pain) and the right end a score of 100 (maximum pain imaginable). The association between the perceived pain and the change in root resorption was investigated.

3. Statistical analysis

Spearman's ranked correlation coefficient was calculated at a 95% confidence level.

4. Results

The pain scores showed a non-normal distribution. The median pain score was 27.5 (range: 4 – 31). The mean root resorption was 0.73±0.47.

There was no statistically significant correlation between pain scores and root resorption 24 hours after the activation of the elastomeric chain. The spearman's correlation coefficient showed a very weak positive correlation (ρ: 0.137, p-value 0.425).

5. Discussion

The two most commonly reported side effects of orthodontic treatment are pain and root resorption. They share epidemiologic and biomechanical aspects as well as risk factors.

The orthodontic force compresses the periodontal ligament producing pulpal ischemia leading to immediate pain. This is followed by the release of neurogenic vasodilators such as Substance P and Calcitonin-related polypeptides which cause vasodilatation, contributing to the pain by stimulating pulpal hyperalgesia. Another inflammatory factor is the metabolism of arachidonic acid into prostaglandins that may metabolize into Prostaglandins E2, which plays a role in pain and inflammation.[12] The periodontal ligaments become sensitive to the released histamine, bradykinin, and serotonin increasing the pain sensation.

Prevalence of pain in orthodontic patients was reported as high as 70-95%.[1,13] It is more frequent in the anterior region.[14]

Pain severity has been affected by some biomechanical parameters such as the magnitude and type of force application. Application of heavy continuous force is accompanied by greater pain intensity during biting compared with light force.[15] The pain intensity was significantly greater with 150 grams than a 50 g force[16].

Surface root resorption was found in people receiving and not receiving orthodontic treatment. Prevalence was 73% and 15%, respectively.[7] The apical region is most affected.[17] The most commonly affected teeth are the maxillary lateral incisor, central incisor, mandibular incisors and molars in that order.[18] Root resorption is unpredictable, particularly in patients with a genetic predisposition [19] or risk factors as allergy. [20]

Other predisposing factors of orthodontically induced external apical root resorption have been identified. These include general health [21] individual tooth form[22] and root length[23]

Some treatment-related factors have been associated with a high risk of root resorption. An important factor is the duration of treatment.[24] The amount of root apex movement was another associated factor. This may explain why class II and III, deep bite, increased overjet and treatment requiring extraction are more prone to resorption.

The Force magnitude, type, and different combinations of these have been linked to root resorption.[25] Heavy force magnitudes produced more root resorption than light forces.[26] According to the nature of the force continuous forces had a higher risk.[27] The direction of force shows that intrusion is more predisposing than extrusion. Intrusive forces with lingual root torque and jiggling movements were reported as the most detrimental.[28]

Bracket prescription and type showed that there was no difference between edgewise and straight wire appliances[29] or between self-ligating and conventional preadjusted brackets.[30]

Apical root resorption is usually asymptomatic. In general, it has a good prognosis. Once resorption stops, repair and remodeling are achieved shortly after orthodontic forces cease. Tooth stability and longevity are rarely affected since up to 3mm of apical root resorption will produce about 20% of periodontal attachment loss.[31]

The orthodontist must assess risk before the start of treatment by questioning family members about their history of orthodontic treatment and root resorption. A pre-treatment standardized periapical digital radiograph is required, of the maxillary incisors, to evaluate the pretreatment condition of the teeth, for all orthodontic patients. In susceptible patients, resorption was established by 6 months of treatment. [10, 11] The resorption severity at this time is a good predictor of root resorption at the end of treatment.[32] If patients are diagnosed at high risk before treatment or if excessive root resorption is detected at 6 months of treatment, periodic standardized radiographs are acquired every 3 months for comparison.

In susceptible patients, alternative treatment may be indicated that reduces the predisposing factors such as early interception including growth modification, eruption guidance, and palatal spurs in open bite cases.[33]

Also modifying the treatment plan is important to decrease the treatment time and the extent of tooth movement. Management during treatment includes the use of minimal intermittent forces, alternate arch activation every month to maintain archwires passive for 2-3 months and to allow repair.[8]

If severe apical root resorption occurs, preservation of alveolar bone is mandatory to maintain periodontal support. The combination of severe root resorption with even minimal alveolar crest resorption can drastically affect periodontal support and tooth mobility. Monitoring and prevention of traumatic occlusion are important as they may have severe consequences in high-risk patients.

A literature search showed that only one article statistically evaluated the correlation between pain and root resorption.[34]

In the present study, the patients under investigation showed high individual variation and an unprecedented report of no pain for the majority of them. There has been no previous mention of patients having reported no pain and how this was dealt with in the analysis. The infrequent number of pain events makes it difficult to test the association with root resorption. Therefore, the results of this study are only preliminary and not generalizable. Despite this, the results show a very weak positive correlation that was statistically insignificant.

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There was no evidence of a correlation between pain and root resorption. This was in agreement with the previous data reported by Cakmak et al.[34] In their study of 12 patients, there was no correlation between the level of pain and the amount of root resorption. They reported an insignificant weak inverse relationship between pain and root resorption.

The pain measurement tools are essential in research of pain origin, duration and pattern, as well as in the evaluation of the efficiency of treatment.

Many tools have been studied over the last few decades.[35] The VAS scale is a commonly used tool that has been around for some time. It is a numerical scale that provides more specific and robust information regarding intensity than just the dichotomous question if the patient is suffering from pain or discomfort or not.

However, pain relies on patient perception and therefore is a subjective outcome making its validation difficult. The other alternatives that measure pain objectively are either invasive, complex, or time-consuming.[36] The development of other tools to investigate pain may be helpful and may overcome the drawbacks met in this study.

6. Conclusion

Within the limitation of this study, an insignificant association was found between pain and root resorption. Further studies are needed to elucidate the correlation between pain and root resorption.

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