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Original Article

A radiographic study of external apical root resorption in patients treated with single-phase fixed orthodontic therapy

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ABSTRACT

Background: External apical root resorption (EARR) is one of the most common iatrogenic consequences of orthodontic tooth movement. Many factors like gender, duration, orthodontic force and duration of orthodontic treatment have been implicated to cause EARR.
Methods: Pre- and post-treatment OPGs of 60 orthodontic patients (30 males and 30 females) who had undergone treatment with a single phase of fixed orthodontic therapy were randomly selected from institutional archives. The root apices were evaluated for EARR by a single operator on an radiograph viewing box at a standardized source of light using a four-grade ordinal scale. Anterior EARR was measured on the maxillary and mandibular canines. Posterior EARR was measured on premolars, mesiobuccal and distobuccal roots of maxillary first molars and mesial and distal roots of mandibular first molars. The results were compiled and subjected to statistical analysis.
Results: The cases in which the patients underwent therapeutic extraction had a relatively higher amount of EARR compared to the cases in which the patients were treated by non-extraction therapy ($P < 0.001$). Odds ratio indicated that extraction cases had two-fold increased risk of EARR than non-extraction cases ($P < 0.001$). No statistically significant difference was observed in the distribution of EARR based on gender or duration of orthodontic treatment ($P > 0.05$).
Conclusion: Therapeutic extraction is an important determinant of post-treatment EARR. Gender and duration of orthodontic treatment may not be important variables in the causation of EARR according to the findings of this study. However, longitudinal studies with larger sample size are required to validate the results of this study.

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Introduction

External apical root resorption (EARR) is one of the most common iatrogenic consequences of orthodontic tooth movement. Histological evaluation shows microscopic areas of resorption lacunae on affected root surfaces often leading to permanent loss of tooth structure and shortening of root apex.[1,2] Its prevalence is up to 100% in histologically examined teeth and much lower in teeth examined by routine two-dimensional radiographs.[3,4]

EARR following orthodontic treatment can be caused by patient-related factors like age, sex, systemic conditions, type of malocclusion and treatment-related factors like appliance type, treatment duration, magnitude of orthodontic force and type of orthodontic tooth movement.[4,5] The magnitude of orthodontic force is believed to be an important factor in the aetiology of EARR and it is believed that too strong forces will cause an increased damage to the affected tissues leading to root resorption (RR). A few studies consider duration of force to be a more critical factor than the magnitude of the force, especially in connection with long treatment periods.[6] The orthodontic force produces a local inflammatory response with characteristic signs of inflammation. This inflammation, which is essential for tooth movement, is actually the fundamental component behind the RR process.[7,8]

Lateral cephalogram and orthopantomogram (OPG) are routinely ordered radiographs during various stages of orthodontic treatment and are often used to diagnose early conditions like EARR, so as to plan a suitable modification in the mechanotherapy. The advantages of OPG are less radiation exposure, both maxillary and mandibular skeletal and dental structures can be visualized in a single radiograph, low cost and usually there is no need for additional full mouth intraoral periapical (IOPA) radiographs for evaluating EARR. OPG being a two-dimensional representation of three-dimensional structures has certain limitations also like magnification errors, need of proper head positioning during radiography and inability to be readily repeated and reproduced. OPG often overestimates EARR by 20% when compared with periapical radiographs.[9,10] Though three-dimensional imaging modalities like magnetic resonance imaging (MRI) and computed tomography (CT) have provided better visualization, accuracy and greater degree of reproducibility than conventional radiography, their use in routine orthodontic practice is limited due to cost factor and high radiation exposure, as seen in CTs. In addition, trained radiologists are often required for the interpretation of CT images, which further reduces its use in routine orthodontic practice.[11,12]

Any flaws in predictability, prevention and early diagnosis of this condition, especially in cases of extensive RR, can cause drastic consequences to both orthodontic treatment and patient's health. It is therefore important to determine the magnitude and prevalence of RR in various populations, as well as related risk factors. Hence, a study was undertaken to evaluate EARR of teeth in patients treated with a single phase of fixed orthodontic therapy from the patient records available in the Division of Orthodontics and Dentofacial Orthopaedics at a government post-graduate teaching institution.

The aim of this study was to evaluate EARR of teeth in patients who have undergone single phase of fixed orthodontic therapy. The objectives were as follows:

- To determine EARR, if any, in healthy patients who underwent treatment with a single phase of fixed orthodontic therapy.
- To determine if any association existed between EARR and gender of the patient.
- To determine if any association existed between EARR and duration of orthodontic therapy.
- To determine if any association existed between EARR and therapeutic extractions associated with orthodontic therapy.

Material and methods

Study sample

The study sample was selected on the basis of convenience sampling, i.e. all the cases who had undergone treatment with a single phase of fixed orthodontic therapy at the division of orthodontics, AFMC Pune during 2006–2012 and met the inclusion and exclusion criteria of the study were selected for the study. The orthodontic records (hard copy of pre- and post-treatment OPG) of 60 orthodontic patients were finally selected based on the criteria mentioned below. All OPGs used in the study were recorded using the same machine (Model: ADVAPX cephalostat machine, Company: Panorraitic System, Printer: Fujifilms DRY PIX 7000) with a standardized technique.

Inclusion criteria

- OPGs of only those patients were selected for the study for which a complete medical history was taken prior to the treatment and any necessary investigations were carried out (if required) to rule out any known medical condition affecting bone metabolism (minimum of 800 teeth were included in the study sample).
- Complete pre- and post-treatment records of malocclusion, including orthodontic case sheet, study models and OPGs.
- Age between 15 and 40 years.
- Pre- and post-treatment OPG from same source of X-ray machine with a standardized technique.
- Patients treated with fixed orthodontic appliance therapy in both the arches.
- Extraction cases included class I bimaxillary protrusion cases treated with 1st premolar extraction and non-extraction cases included those treated for crowding less than 5 mm.
- The sample teeth, which have completed root formation, will only be evaluated.
- No radiographic evidence of pre-treatment EARR.

Exclusion criteria

- History of prior trauma.
- Incomplete apexogenesis.

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