Comparative evaluation of root resorption after orthodontic treatment in root-filled and vital teeth using CBCT

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Abstract
Objective: To evaluate whether root-filled teeth are similar to vital pulp teeth in terms of apical root resorption (ARR) after orthodontic treatment.

Materials and Methods: An original sample of cone beam computed tomography (CBCT) images of 1256 roots from 30 orthodontic patients were analyzed. The inclusion criteria included root filled teeth and their contralateral vital teeth. CBCT images of root-filled teeth were compared before and after orthodontic treatment in a split-mouth design study. Tooth measurements were made with multplanar reconstruction using axial-guided navigation. The statistical difference between the treatment effects was compared using the paired t-test.

Results: Twenty posterior root-filled teeth and their contralateral with vital pulp were selected before orthodontic treatment from six adolescents. No differences were detected between filled and vital root lengths before treatment (P=. 4364). The mean differences in root length between pre-orthodontic and post-orthodontic treatment in filled- and vital roots were 20.30 mm and 20.16 mm, respectively, without any statistical difference (P 5. 4197) between them.

Conclusion: There appears to be no increase in ARR after orthodontic treatment in root-filled teeth with no earlier ARR.

Keywords: root resorption; orthodontics; endodontics; cone beam computed tomography

Introduction
Confidence is an important aspect of one’s personality and a confident smile makes the picture Concern about apical root resorption (ARR) as a result of orthodontic treatment is justified by its high incidence levels. ARR, an irreversible orthodontic side effect, is typically identified by radiographic methods as the shortening of the root from the apex, brought about by clast cell activity. Different degrees of severity, varying from mild to severe, can occur after orthodontic treatment. The most preoccupying is severe ARR, diagnosed as the loss of more than one-third of the original root length and which affects less than 5% of anterior teeth. Although ARR is multifactorial and not yet fully understood, many studies have tried to identify the risk factors which involve ARR during orthodontic treatment. In general, such factors can be classified as either mechanical or biological. Mechanical factors are related to the magnitude, direction, and duration of orthodontic force, while biological factors include a history of traumatic injury, follicle with ectopic tooth eruption, presence of periapical lesions, root morphologies, previous root resorption, individual susceptibility, and genetic predisposition. Wickwire et al. 20 reported a greater frequency of ARR in the endodontically treated teeth in a non-controlled clinical study. Recent systematic reviews on this topic agree that the available literature is scarce and that root filled teeth do not increase the risk of ARR. On the other hand, evidence for less resorption in endodontically treated teeth following orthodontic treatment is not fully conclusive. Furthermore, these critiques are based on primary studies using conventional radiographs, which may underestimate the amount of apical structure loss. To date, no study has compared root-filled and vital teeth using three dimensional imaging methods, such as cone beam computed tomography (CBCT). Considering the lack of more reliable tools to detect ARR in previous studies, the aim of this study was to test the hypothesis that root-filled teeth are not individual predisposing factors for ARR after orthodontic treatment.
Materials and Methods
This study was approved by the Research Ethics Committee of Rajarajeswari Dental College Bangalore, (235/2017). In addition, written informed consent was obtained from the patients prior to orthodontic treatment. All patients presented permanent dentition and Class I malocclusion with moderate dental crowding. They were treated without extractions for an average of 22 months. Both interproximal stripping and dental arch expansion were done using a straight-wire technique (MBT prescription, 0.022 3 0.028-inch slot). No rapid maxillary expansion was needed. CBCT images were previously obtained using an i- CAT cone beam tomography unit (Imaging Sciences International, Hatfield, Pa) before and immediately after orthodontic treatment. Images were examined using Xoran 3.1.62 software (Xoran Technologies, Ann Arbor, Mich) in a workstation with Microsoft Windows XP Professional SP-2 (Microsoft Corp, Redmond, Wash). Volumes were reconstructed using 0.25-mm isometric voxel; tube voltage was 120 kVp, current measured 3.8 mA, and exposure time was 40 seconds (field of view: 13 cm). Other parameters included gray scale (14 bit), 0.5-mm focal distance, and image acquisition with single 360° rotation.

The data were obtained from the Digital Imaging and Communications in Medicine (DICOM) database. A total of 1256 roots were initially evaluated based on the following inclusion criteria: permanent teeth, clear CBCT root image before and after orthodontic treatment, and root-filled teeth with vital contralaterals.

Root-filled teeth were measured in their maximum long axial length from root apex to corresponding cusp tip. These measurements were done before and after orthodontic treatment using the axial guided navigation method. All measurements were performed by a single calibrated orthodontist with the aid of specific tomography software (version 3.1.62 Xoran, Xoran Technologies). Measurements were obtained in tenths of millimeters, and the data were recorded using Microsoft Office Excel, version 2007. The vital contralateral teeth (homologs) were used as a control group (Figure 1).

Results
The sample was composed of 20 root-filled teeth from six adolescents originally selected after analyzing 1256 roots from 30 orthodontic patients. The teeth selected were first upper premolars (n =51), second upper premolars (n=51), first upper molars (n= 54), and first lower molars (n =52). These root-filled teeth were similar in root length to their contralateral vital teeth before orthodontic treatment (P = 0.4364). The degree of root shortening after orthodontic treatment was minimal, with no statistical difference between root-filled (P = 0.0552) and vital teeth (P =0.3178) Table 1. The orthodontic treatment response (mean difference in root length before and after treatment) induced a root shortening of 0.30 mm and 0.16 mm, respectively, Table 2 for filled and vital teeth, without any statistical difference between them (P = 0.4197).

Discussion
This study showed that after evaluation by CBCT root-filled and vital teeth induced ARR to a similar degree in the wake of orthodontic treatment. The sample was composed of posterior teeth in a split mouth design study with no difference in root length before treatment, which presupposes no presence of external ARR prior to treatment. The selection criteria excluded teeth with any previous history of trauma, ankylosis, or presence of periapical lesions. Thus, the influence of these confounding variables was controlled, and the isolated effect of endodontic treatment was also considered. CBCT is a reliable diagnostic tool that provides a more accurate image of root resorption, including posterior teeth measurements, than conventional radiographs. For this reason, CBCT
scans have been recommended to identify different types of resorption along the root surface. [16] The teeth were measured in their maximum long axial length from root apex to its corresponding cusp tip. It is expected that the cusp tip would be preserved after orthodontic treatment and that no significant occlusal abrasion would occur during the orthodontic treatment interval between T1 and T2. The research showed that the level of ARR was mild and that there was no statistical significant difference in root lengths before or after orthodontic treatment between root-filled and vital teeth. This contrasts with results of studies by Spurrier et al. [15] and Esteves et al., [17] who found significant differences in the occurrence of ARR due to orthodontic treatment. Although the mean resorption in root-filled teeth (20.30 mm) was almost twice that of the vital teeth (20.16 mm), there was no statistical difference between them. In conclusion, the shortening of both filled and vital teeth was similar and mild, and could be considered of no clinical significance. The majority of earlier studies corroborate the findings that root-filled teeth do not increase, or may even reduce resorption as a result of orthodontic treatment [15].

Our results support the finding that orthodontic force can be applied both to fill and vital teeth in a similar way. It can be hypothesized that orthodontic tooth movement occurs using the same biological mechanisms in endodontically treated or vital teeth. Based on this result, root-filled teeth will not demand more time between adjustments or modification in the biomechanical orthodontic planning unless earlier ARR is detected as a result of trauma, the ectopically eruption of an adjacent tooth, a persistent periapical lesion, or unknown factors [5, 8].

Conclusions
1. Root-filled posterior teeth do not seem to increase ARR after orthodontic treatment.
2. No change in orthodontic planning is required to move root-filled teeth unless earlier ARR, attributed to other etiologic factors, is detected.

References