

Differences in Root Resorption between Root Canal treated and contralateral vital tooth during Orthodontic Tooth Movement: A Systematic Review

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ABSTRACT

It is believed that root canal treated tooth apex goes under more resorption than contralateral vital tooth during orthodontic movement. The concept is still contradictory and therefore the aim of this systematic review was to search the evidence regarding this issue. The clinical trials performed on human subjects with vital and contralateral root canal treated tooth were included in the study. The evidence was searched in PubMed, EMBASE, Medline, Cochrane and Scopus. No language barrier was imposed. From analysis it found that there was no difference in amount of root resorption between vital and contralateral tooth. But, degree of resorption was determined by the intensity of force applied, force application technique (continuous or interrupted), duration of force application and direction of force application. From the above fact it can be concluded that root canal treated tooth can be moved equal distance as vital contralateral tooth.

Keywords: dental pulp, orthodontic tooth movement, pulp blood flow, root canal treatment, root resorption

INTRODUCTION

Root canal treatment is a procedure carried on the tooth with necrosed pulp. The common reason of pulp necrosis is entry and colonization of bacteria in pulp chamber. The extension of bacteria and bacterial product from infected root canal to the surrounding periodontal ligament area causes apical periodontitis, and lesion forms after surrounding bone, dentinal hard tissue and periodontal attachment is resorbed. American Association of Endodontics describes resorption as the physiologic or pathologic loss of cementum and dentin from root.¹ Orthodontic force moves the teeth within the bone confinement. During orthodontic tooth movement, resorption of root apex is common undesired outcome.

The search in this systematic review is framed under PICO format [problem (p), intervention (i), comparison(c) and outcome (o)]; which are as follows: on patient undergoing orthodontic treatment, does a root canal treated tooth compared to vital tooth, results any difference in pattern and amount of root resorption, and does this resorption increases the susceptibility of root canal treatment failure.

The detailed information on outcome of root canal treated tooth when subjected to the orthodontic movement is sparse. The clear picture on the amount of resorption that occurs on root canal treated tooth and the fate of existing previous apical seal is still not clear. Thus, the objective of this review is to explore the answers to the questions raised on the root canal treated tooth.

Literature search of clinical trials

Search were under taken on PubMed, EMBASE, MEDLINE database and six data bases [Networked Digital Library of

Theses and Dissertation, Proquest Digital Dissertations, OAlster, Index to Theses, Australian Digital Theses program (Dissertation.com) and one conference report database (BIOSIS[®]review@)]. Root canal treatment, root canal therapy, endodontic treatment, pulpectomy, orthodontic tooth movement and root resorption were medical search headlines (MeSH) used to retrieve the related articles. The strategy of systematic review was adopted from Cochrane Handbook of Systematic Reviews of Interventions.²

A forward search was undertaken from the Science Citation Index (<http://www.isinet.com>) and Research gate (<http://www.researchgate.net>), while references lists of included studies were used for backward search.

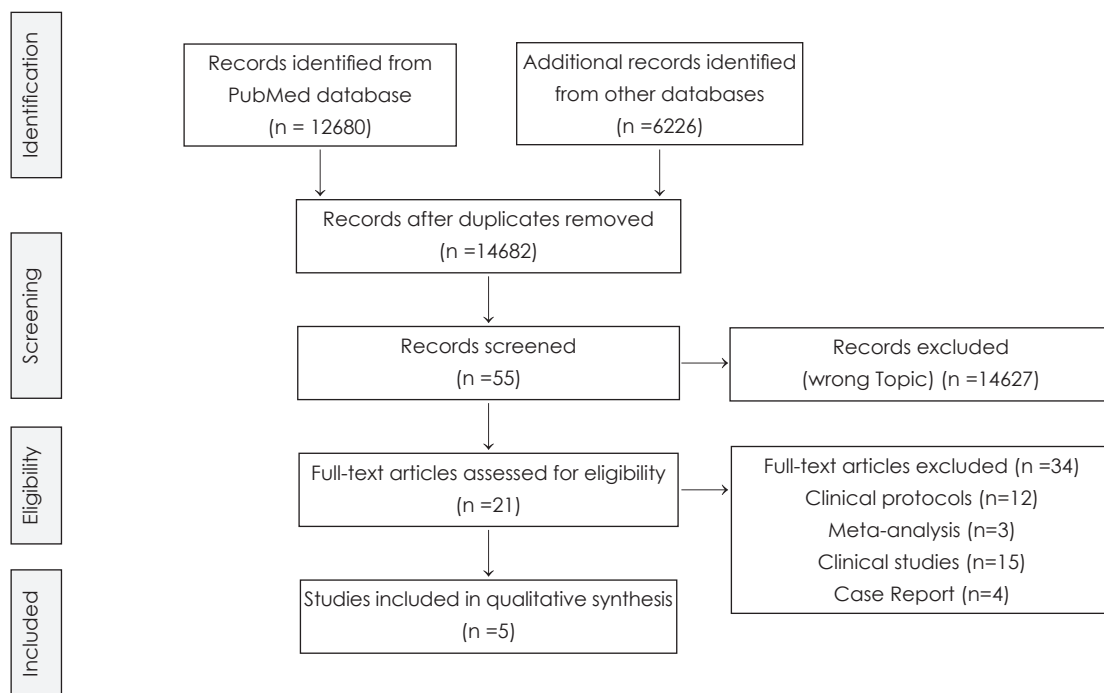
We included clinical trial conducted as split-mouth protocol on same patients and compared the amount of root resorption after orthodontic treatment in both vital tooth and contralateral root canal treated tooth. Articles published in all language were included for analysis. Two reviewers (LY and SKT) individually reviewed and collected the relevant studies, retrieved data and analyzed bias in included studies. The presence of bias was followed according Cochrane Handbook of Systematic Reviews of Interventions.² Disagreement between two reviewers (LY and SKT) during data retrieval and analysis was resolved by the discussion: if no agreement could be reached, third reviewer (LP) reviewed the protocol and analysis; and made the final decision.

The statistical analysis of the included studies was not performed because due to heterogeneity among the studies. Thus, the aim of this review was shifted to search the biological reasons of root resorption during orthodontic movement rather than statistical analysis.

Table 1: Summary of included studies

Study	Methods	Result
Spurrier <i>et al</i> , ³ 1990	Pre- and Post-orthodontic treatment radiographs were compared for analysis. Calculations were done by measuring the difference in root length between pre- and post-treatment radiographs. All teeth were measured from incisal edge to root apex in pre- and post-orthodontic treatment radiographs. 43 patients, incisors included for study.	Vital incisor teeth resorbed significantly more than contralateral root canal treated teeth.
Mirabella & Artun, ⁴ 1995	Calibration of study: same as Spurrier <i>et al</i> ³ 500 patients, Age: 20-70 years Duration: 0.6- 5.2 years.	The teeth with previous root canal treatment had less resorption than contralateral vital teeth.
Esteves <i>et al</i> , ⁵ 2007	Calibration of study: same as Spurrier <i>et al</i> ³ 16 patients, Active orthodontic treatment duration: minimum 20 months.	No significant differences were observed between vital and non-vital contralateral teeth.
Llamas-Carreras <i>et al</i> , ⁶ 2010	Calibration of study: same as Spurrier <i>et al</i> ³ 77 patients, Age: 32.7± 10.7 years. Duration of treatment: 26.8±8.9 months.	
Llamas-Carreras <i>et al</i> , ⁷ 2012	Calibration of study: same as Spurrier <i>et al</i> ³ 38 patients, Age: 30.7± 10.2 years. Duration of Treatment: 24.0±12.0 months.	

Figure 1: PRISMA flow diagram



RESULT

Five studies performed as split-mouth design were retrieved and included for the analysis.³⁻⁷ Figure 1 shows the methodology adopted for study retrieval. Methodology of the study selection was adopted from PRISMA 2009 flow

diagram.⁸ The characteristic of included studies is present in Table 1. Reviewed articles state that the root canal treated teeth were least resorbed than the vital counterpart and apical resorption did not disrupt the apical seal.

DISCUSSION

The objective of this review was to analyze the differences in apical root resorption between vital tooth and root canal treated tooth during orthodontic movement, thus to search the reason for resorption. After the search of all fore-mentioned data bases, five selected articles were retrieved.^{3,7} The studies were conducted on human subjects and were designed as split-mouth technique. The split-mouth technique eliminates the possibility of inter-personal bias and provides the strength to the study design.

Although the results of the included studies were consistent but the methods adapted to analyze external root resorption was not uniform. Differences were found in image study, standardization of pre-treatment and post-treatment radiographs, study method of external root resorption and type of teeth included for analysis. Due to the presence of these variations among the studies, the considerable result could not be retrieved. Therefore, we designed the analysis based on the histological and biochemical studies rather than the statistical analysis.

External root resorption is an undesired side-effect during orthodontic tooth movement. Histological studies revealed that more than 90% of root apex undergo resorption during orthodontic treatment.⁹⁻¹⁰ Bone is under the constant process of remodeling due to the presence of osteoblast and osteoclast within it but such process is absent in cementum because of its devoid of cementoclast cells. Osteoclasts get activated immediately after force application but cementoclasts need to be formed from hemopoietic progenitor cells. Cementoclasts progenitor cell is delivered to the desired area by increased blood flow, either by vasodilatation or by angiogenesis. Expression of endothelial stimulating growth factors in affected area is confirmed from previous studies.¹¹⁻¹³ Progenitor cells delivered to the affected site first resorb precementum, then cementum and finally dentin;¹⁴ and this mechanism of apical root resorption is similar among vital and root canal treated teeth.

It is believed that the pulp neuropeptides play an important role in apical root resorption. Calcitonin gene related peptide (CGRP) and substance-P (SP) are two groups of neuropeptides released when tooth is subjected to orthodontic forces.¹⁵ CGRP is potent peptide vasodilator and function in transmission of pain,^{16,17} while SP is associated with inflammatory process and pain. The dual actions of these two molecules provoke tolerable discomfort in patient following active orthodontic treatment. The release of neuropeptides stimulates clastic cells (osteoclasts and cementoclasts) to resorb alveolar bone and cementum. Root canal treated tooth is devoid of pulp tissue thus they show less apical root resorption in compare to the contralateral vital tooth¹⁸ and this could be the reason why studies found comparatively less resorption with root canal treated tooth.^{3,7}

Duration of active tooth movement and amount of force applied are the two critical factors governing amount of root resorption. In 1930, Schwarz proposed that orthodontic force less than or equal to capillary pressure is sufficient to maintain the vitality of tooth.¹⁹ Force exceeding this limit causes collapse of capillaries, disrupt the blood supply to pulp and initiate apical root resorption.^{20,21} It is also noticed that the amount of apical root resorption and the intensity of force applied are directly related.^{22,23} If the duration of continuous force on the tooth is prolonged; considerable apical root resorption is seen.^{23,24} Therefore, it is advised to apply intermittent force and provide adequate time for repair which will minimize the severity of apical root resorption and pulpal consequences.^{25,26}

Tooth with the history of trauma before orthodontic treatment shows more apical resorption and possibility of tooth to be non-vital is high.²⁷⁻³⁰ The possibility of loss of vitality is more in tooth with obliterated canal.^{30,31} Tooth with vital pulp or unobliterated pulp after trauma responds similar to normal vital tooth.²⁷ However, still the conclusive remark could not be made on the prognosis of orthodontic tooth movement in traumatized tooth due to lack of randomized controlled clinical trial.

CONCLUSION

Based on the current review; it can be concluded that:

1. The orthodontic force can cause inflammatory and/or degenerative changes in dental pulp. The prognosis of tooth depends on the duration and amount of force applied.
2. No significant differences in amount and severity of resorption were seen between vital and root canal treated tooth with equal amount of force application. This outcome was seen in well cleaned, shaped and obturated tooth, and tooth with no coronal leakage or no path for bacterial access to periapical tissue.
3. The traumatized tooth can be moved orthodontically with minimal risk if the pulp is vital. The tooth exhibiting signs and symptoms of pulp pathology must undergo root canal treatment before orthodontic treatment.
4. If the root apex of traumatized tooth exhibits resorption before orthodontic treatment, the possibility of farther resorption during treatment is high.
5. Rest period should be provided between active orthodontic tooth movement which will allow the resorbed cementum to heal.

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