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Review

Influence of orthodontic forces on human dental pulp: A systematic review



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ABSTRACT

Aim: The aim of the present study was to systematically review the influence of orthodontic force on human dental pulp.

Methods and results: The addressed focused question was “Do orthodontic forces affect the human dental pulp?” which was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a specific question was constructed according to the PICO (Participants, Interventions, Control, Outcomes) principle. Databases were explored from 1952 up to and including August 2014 using different combinations of the following keywords: “orthodontic force”; “dental pulp”; “reaction” and “tooth movement”. Literature reviews, letters to the editor, commentaries and case-reports were excluded. Thirty studies were included. Six studies assessed the effect of orthodontic forces on pulpal blood flow and 20 studies investigated the pulpal cellular responses to orthodontic forces. In 4 studies, pulpal responses to orthodontic forces were compared between previously traumatized- and non-traumatized teeth.

Conclusions: There is insufficient scientific validation regarding the association between orthodontic forces and human dental pulp. However, a history of dental trauma maybe considered a risk factor for loss of pulp vitality during orthodontic treatment.

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Contents

1. Introduction	348
2. Materials and methods	348
2.1. Focused question	348
2.2. Search protocol	348

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2.3. Quality assessment	349
2.4. Level of evidence	349
3. Results	350
3.1. Effect of orthodontic forces on pulpal blood flow	350
3.2. Influence of orthodontic forces on the cellular responses of the human dental pulp	350
3.3. Influence of orthodontic forces on the pulpal response in traumatized teeth	350
3.4. Quality assessment	350
4. Discussion	350
5. Conclusion	355
Acknowledgements	355
References	355

1. Introduction

Application of orthodontic forces to teeth for specific time periods has been reported to induce molecular changes in the cells of the periodontal ligament, alveolar bone and the pulp-dentine complex.^{1–7} Histologic studies have reported depression of pulp tissue respiration, vacuolization, circulatory disturbances, haemorrhage, fibro-hyalinosis and even necrosis as the major pulpal changes that may be encountered following the application of orthodontic forces to teeth.^{1,2,4} Hamersky et al.⁷ suggested that excessive and prolonged orthodontic forces when applied to teeth may result in loss of pulp vitality.

Laser Doppler flowmetry (LDF) by McDonald and Pitt Ford⁸ have reported a temporary decrease in pulpal blood flow (PBF). The decrease in PBF has been associated with a drop in the oxygen tension thereby increasing the possibility of cellular injury and apoptosis as determined by alterations in the expression of pulpal markers such as Aspartate Aminotransferase (AST) and alkaline phosphatase (ALP).^{9–11} However, results by Barwick and Ramsay¹² and Brodin et al.¹³ reported no significant effect of a orthodontic forces (intrusive and/or extrusive) on PBF. Studies^{5,14–16} have also reported that application of orthodontic forces on teeth for certain periods of time increase the expression of various growth factors (GFs), such as epidermal growth factor (EGF), platelet derived growth factor (PDGF), vascular endothelial growth factor (VEGF), fibroblast growth factor-2 (FGF-2) and transforming growth factor beta (TGF- β) in pulpal tissues, which in turn contribute to angiogenesis.

High levels of inflammatory mediators, such as interleukin (IL)-6, IL-1 β tumour necrosis factor alpha and receptor activator of nuclear factor kappa B have been identified in pulpal tissues of teeth exposed to orthodontic forces.^{17,18} Levels of inflammatory mediators in the gingival crevicular fluid have also been reported to be significantly elevated during orthodontic therapy.^{19,20} Therefore, from a clinical perspective, it is hypothesized that long-term application of orthodontic forces jeopardizes pulp vitality. Furthermore, pulpal necrosis (PN) has also been reported after the induction of orthodontic forces such as intrusion, extrusion and retraction.^{8,21} It is tempting to speculate that the magnitude of pulpal inflammation or injury is directly proportional to the degree of orthodontic force applied on the teeth.

The aim of the present study was to systematically review the influence of orthodontic force on human dental pulp.

2. Materials and methods

2.1. Focused question

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a specific question was constructed according to the PICO (Participants, Interventions, Control, Outcomes) principle.²² The addressed focused question was “Do orthodontic forces affect human dental pulp?”

(P) Participants: It was essential for participants to have undergone orthodontic treatment.

(I) Types of interventions: The interventions of interest were orthodontic forces (such as intrusion, extrusion, tipping, arch expansion and retraction).

(C) Control intervention: Teeth, which were either not subjected to orthodontic forces or pulp tissues which treated with antibodies other than those used in the test-groups, were considered as controls.

(O) Outcome measures: Human pulpal response to orthodontic forces.

2.2. Search protocol

In order to identify studies relevant to the PICO question, the MEDLINE (OVID) database, the EMBASE database, the Cochrane Central Register of Controlled Trials (CENTRAL), Scopus, Web of Knowledge, The Cumulative Index to Nursing and Allied Health Literature and Google-Scholar databases were electronically searched for available data. Databases were searched from 1954 up to and including August 2014 using different combinations of the following key words: “orthodontic force”; “human dental pulp”; “reaction” and “tooth movement”. Titles and abstracts of studies identified using the above-described protocol were screened by two authors (FJ AAK and GER) and checked for agreement. Full-texts of studies judged by title and abstract to be relevant were read by authors (FJ AAK and GER) and independently evaluated in accordance with the following eligibility criteria: clinical studies, application of orthodontic force on teeth and assessment of pulp tissues. Kappa scores (Cohen’s kappa coefficient) were employed to determine the level of agreement between the two reviewers.^{23,24} Letters to the Editor, historic reviews, commentaries, experimental (animal) studies and case-reports were excluded. Hand-searching of potentially relevant original and review articles was also performed. This was done to identify any studies that could

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