

Original Research Article

Lack of pulp sensitivity in maxillary canines submitted to orthodontic traction: a retrospective clinical study

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Abstract

Introduction: Orthodontic movement may cause a great number of tissue alterations in the dental pulp. However, these changes may not be entirely recognized owing to the difficulty in simulating clinical situations. **Objective:** The aim of this study was to clinically assess the incidence of negative pulp sensitivity to cold among maxillary canines in infraocclusion submitted to orthodontic traction. **Material and methods:** Two study groups were selected: an experimental group, comprising 32 canine teeth with complete root formation that had been submitted to orthodontic traction, and a control group, comprising 32 canine teeth with complete root formation that had never been submitted to any orthodontic movement. **Results:** Fourteen teeth from the experimental group showed lack of pulp sensitivity, whereas only one tooth from the control group showed negative pulp sensitivity. Fischer's exact test revealed a significant difference between the groups ($p < 0.05$). **Conclusion:** In conclusion, the teeth that had been submitted to orthodontic traction were more likely to lack sensitivity than those that had not been submitted to the same procedure.

Introduction

The dental pulp is a singular connective tissue confined by rigid walls of mineralized tissue, in an environment that has a low tolerance to inflammation, and where the tissue is supplied by the blood vessels passing through the apical foramen.

Studies have been conducted on the effects of applying orthodontic forces to teeth in order to assess the effects of these forces on the dental pulp [1, 5, 9, 13]. However, much research has focused solely on the response of the alveolar bone or the periodontal ligament, as well as on pulpal blood flow [2, 16, 19].

Induced tooth movement may cause histological changes in the dental pulp, compromising its function. However, these changes may not be completely recognized owing to the difficulty involved in simulating clinical situations [18].

Applying orthodontic forces may result in pulp tissue alterations owing to the compression of the blood vessels that supply the pulp in the alveolus [8]. A light force (below 1.6 g) acts by influencing the periodontal ligament, whereas a heavy force (above 4 g) acts by partially or totally occluding blood vessels, potentially leading to degeneration or necrosis of the periodontal ligament and dental pulp [19].

Histological data demonstrate that the dental pulp is affected by orthodontic movement, and the ensuing reactions range from vascular stasis to necrosis [28]. However, the specific cellular response of the pulp to orthodontic movement has not yet been investigated.

Orthodontic forces may impede pulp circulation, causing vascular congestion and pulp edema, leading to pulp damage [14, 27] and even necrosis in teeth submitted to traction [29]. It has been established that excessive intrusion or extrusion forces cause pulp necrosis and non-regeneration of the odontoblast layer [4].

Studies conducted in 1965 found similar characteristics between the pulp of teeth submitted to orthodontic movement and that of teeth with periodontal involvement. A radiographic analysis of teeth submitted to induced orthodontic movement showed that they seemed to age more rapidly than those that were not submitted to this procedure, demonstrating that pulp atrophy resulting from the obliteration of the root canal by reparative dentin may be involved [24].

Irreversible damage to teeth may vary from apical resorption to pulp involvement, resulting in ischemia and necrosis [1]. However, it is known that pulp necrosis caused by induced tooth movement

also depends on the stage of dental root development, and that teeth with an open apex have a better prognosis [10].

The aim of the present study was thus to assess clinically the lack of pulp sensitivity to cold among maxillary canines in infraocclusion submitted to non-surgical orthodontic traction.

Material and methods

This study was approved by the Ethical Committee in Research of São Leopoldo Mandic Dental Research Center, under protocol n. #2010/0165.

Sample selection

In this study, the experimental group comprised twenty four patients, 7 males and 17 females, for a total of 32 maxillary canines in infraocclusion that had been submitted to orthodontic traction. The control group comprised 16 patients, 5 males and 11 females, who had never used an orthodontic appliance or suffered any type of dental trauma, for a total of 32 canines.

Patients having a history of dental trauma, as well as teeth with incomplete apex formation or previous endodontic treatment were excluded from the study. Both groups were randomly selected among patients treated by the authors of this study in the Brazilian cities of Manaus, AM, and Campinas, SP.

Sensitivity test

The hemi-arch involved was isolated with cotton rolls. Endo-Frost (Coltene-Roeko, Germany) refrigerating gas was then applied with a cotton pellet, firstly onto the canine, then onto the lateral incisor and finally onto the first premolar. The patient's sensory response to the contact between the tooth and refrigerated cotton was recorded as either positive or negative.

Radiographic analysis

The teeth showing no pulp sensitivity were submitted to periapical radiography using periapical film (Kodak – New York, USA) and film positioners, according to the parallel technique. Radiographic analysis was then conducted to check for the occurrence of any periapical lesion, periodontal ligament thickening or pulp calcification.

Results

Fischer's exact test revealed a significant difference between the experimental and control groups ($p < 0.05$). In the control group, 3.1% of the teeth had no sensitivity, whereas those lacking sensitivity represented 43.8% in the experimental group (table I).

Table I - Comparison between teeth submitted to orthodontic traction (experimental) and teeth never submitted to any orthodontic movement (control)

Group	Sensitivity				Total
	Positive	%	Negative	%	
Experimental	18	56.3	14	43.8	32
Control	31	96.9	1	3.1	32

p-value: 0.0001962

In the experimental group, 14 of the 32 teeth that had been submitted to orthodontic traction presented negative sensitivity. Analysis of the periapical radiographs revealed a periapical radiolucid image in three teeth and root canal atresia in one tooth. In the control group, only one tooth had a negative response to the cold sensitivity test, and a radiolucid periapical area was observed radiographically.

Discussion

Few studies have been conducted on the actual effects that induced tooth movement may have on the pulp, mainly on extrusion movements. The existing studies report the occurrence of histological alterations [5, 17, 26] varying from temporary degeneration – either reversible or irreversible – to pulp necrosis [4, 6, 17], as well as circulatory or respiratory disturbances of the pulp [2, 16, 22].

The effects of orthodontic forces on pulpal circulation and blood flow are related to patient age, apical foramen size, dentinogenic activity and the movement itself [2, 11]. The results of the present study agree with those of a study reporting more significant histological disturbances in teeth with a small apical foramen [26]. However, although teeth with an incompletely formed apical foramen have a reduced risk of sequelae, they are not immune to them [12]. Pulp blood circulation is also altered during tooth movement [13]. However, it is believed that teeth may recover from orthodontic trauma if given sufficient resting time [9, 22].

Several investigators suggest that the trauma caused by induced tooth movement is permanent, and that the pulp may occasionally lose its vitality [1, 10, 11]. Others reject this correlation [7, 15],

or otherwise argue that necrosis of healthy teeth submitted to orthodontic movement is caused by trauma suffered by the patient and not because of the movement *per se* [7].

Teeth submitted to orthodontic movement may not display pulp alterations immediately. However, when teeth are submitted to forces considered as heavy, the neuropeptide calcitonin presents itself in the pulp as a response [6]. Although degenerative changes may manifest long after the time of injury [25], some results show that pathologic signs appear right after the force is applied [9]. Furthermore, the tissue changes are reversible if the aggression does not exceed the threshold of histological tolerance [23]. No inflammatory reactions or pulp tissue alterations were observed when teeth were moved under an extrusion force of 75 g [28]. Whereas some authors consider a force of 150 g [5] as an optimal force for tooth movement in adults, others suggest optimal levels ranging from 25 to 30 g [21]. Hence, there is no consensus regarding the force threshold up to which tooth movement may be induced without the risk of causing pulp damage.

A study aimed at determining the effects of ischemia and necrosis following orthodontic movement in monkey teeth found that vascularity is promptly restored by collateral circulation after force removal. Nevertheless, contradictory results have been reported, varying from a temporary reversible degeneration to a permanent irreversible one, and even to pulp necrosis [4]. These findings agree with those of our study, where 14 of the 32 patients from the experimental group presented negative pulp sensitivity, contrasting with the control group, which presented only one case of negative sensitivity.

It is known that different types of tooth movement have distinguishable effects on the pulp tissue. Pulp reactions were detected when orthodontic extrusion forces were compared to non-extrusion forces [17], a finding confirmed by a number of studies [1, 26].

Some studies suggest that extreme tooth movements may cause changes in pulpal blood flow [5, 26], but the relationship between the magnitude of vascular damage and the onset of pulp alterations remains unclear [30]. On the other hand, a compromised pulpal blood flow combined with reduced apical vessel capacity during orthodontic extrusion may explain the great increase in pulp necrosis in teeth with periodontal involvement.

There is no correlation between necrosis and extrusion or orthodontic treatment time. However, in one study, more than 70% of the cases of necrosis occurred during the initial period of extrusion, highlighting the importance of exercising caution when applying orthodontic forces to traumatized teeth [3]. Previous studies have also reported the occurrence of pulp necrosis during orthodontic treatment of non-traumatized teeth [20, 25]. Excessive tooth movement has also been reported as increasing the risk of pulp alterations, such as pulpal obliteration, in more than 20% of impacted canine teeth [30]. These findings agree with those of our study, insofar as the canine teeth that had been submitted to traction in some of our patients eventually suffered pulp necrosis years after completing the orthodontic treatment.

Conclusion

Within the limitations of the applied methodology and based on the results obtained in this study, it can be concluded that maxillary canine teeth submitted to non-surgical orthodontic traction presented a greater incidence of negative sensitivity, compared to teeth not submitted to orthodontic treatment.

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