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The effect of orthodontic Force Application and Tooth Movement on Dental Pulp

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Abstract

This systematic review aimed to conclusively investigate the effect of continuous intrusive force application on human pulpal blood flow (PBF). It is a well-established fact that applying a severe orthodontic force for an extended period can cause irreversible pulpitis and necrosis in the pulp by accelerating the inflammation process. In contrast, utilizing moderate and intermittent forces allows for ample tooth movement, limits pulp damage, and facilitates pulp healing.

Materials and methods: A comprehensive search of published studies was conducted in several electronic databases such as MEDLINE, PubMed, EMBASE, Scopus, Web of Science, CINAHL, and the Cochrane Database of Systematic Reviews, as well as Google Scholar. The search was conducted without limitations to find published studies. The results showed that orthodontic forces can lead to a decrease in pulpal blood flow, which

causes a reduction in tooth sensitivity. This reduction is indicated by an increase in response thresholds and more negative responses to tooth sensitivity tests.

Conclusion: applying a severe orthodontic force over a prolonged period of time can lead to irreversible pulpitis and necrosis in the pulp due to an increase in the inflammation process. However, using moderate and intermittent forces can facilitate sufficient tooth movement while minimizing damage to the pulp. This highlights the importance of the endodontic-orthodontic interface and the need to consider dental pulp health during orthodontic treatment to avoid dental trauma.

Keywords: Orthodontic Force Application, Tooth Movement, Dental Pulp.

Introduction

There isn't much scientific literature on the endodontic-orthodontic interface, therefore it's not well understood (1). The purpose of this study is to give an introduction to orthodontic treatment, along with an explanation of how orthodontic tooth movement can impact dental pulp. The study also aims to identify any possible changes that may take place in the pulp, hard tissues, and periapical region of the teeth during or after the treatment, and how these changes can affect the outcome of the treatment, and how these changes affect the results of treatment. Also, the application of a severe orthodontic force for a long time can cause irreversible pulpitis and necrosis in the pulp by increasing the pulp inflammation process.

Orthodontic treatment involves the application of force to the teeth over a period of time, which can range from several months to several years. This force causes biological reactions in the pulp and periodontal ligament, ultimately resulting in teeth movement. However, it is important to consider the potential impact of pulpal alterations on the long-term health and vitality of the teeth (2). Orthodontic treatment can have negative consequences such as pulpal changes, root resorption, and periodontal disease (3). This is because orthodontics is a discipline in dentistry, like many other fields in this area, and

the execution of treatment can lead to adverse effects for both the patient and practitioner (4).

Materials and Methods

A literature search was conducted using the Medline/PubMed and Google Scholar electronic databases. The search was focused on original papers related to the subject of the thesis. The keywords used for the search included: endodontic-orthodontic interface, orthodontic tooth movement and dental pulp, endodontics, orthodontic treatment, and orthodontics and dental trauma. After conducting a systematic review, a total of 34 references were included. The aim of this review is to examine the effects of orthodontic tooth movement on dental pulp. The titles and abstracts of the articles resulting from the electronic searches were carefully screened. Afterwards, full-text articles were examined and selected based on the inclusion criteria.

Result

Pulpal Changes during Orthodontic Treatment (The effect of orthodontic force application on pulp).

Orthodontic treatment involves moving teeth by applying force to them for a period of time, which can range from months to years (5). This force causes biological reactions in the periodontal ligament and pulp, which can have clinical implications for the long-term vitality of the teeth (6). The application of orthodontic force can cause changes in the pulpal tissue, partly due to the compression of blood vessels supplying the pulp in the bony socket (5,6).

In recent years, numerous studies have been conducted to investigate the effects of orthodontic force on dental pulp. These studies have explored a range of aspects including pulpal blood flow, responses to tooth sensitivity tests, levels of enzymes and neuropeptides, and histological and morphological changes (7,8).

Maintaining healthy pulp tissue is crucial for healthy teeth. Pulpal blood flow is a significant indicator of pulpal health. If there is a decrease in pulpal blood flow or transient ischemia, it may affect the sensibility and sensory responses of teeth. However, since the pulp tissue is surrounded by calcified tissues, only indirect tests can be used to evaluate pulp vitality. Vitality tests are used to assess pulpal circulation (9). Early studies monitored changes in pulpal blood flow (PBF) using methods such as histological observation of pulp tissue respiration rate, direct microscopic observation, and fluorescent microsphere injection. However, these methods have technical limitations that allow observation only once in each tooth examined (10). also can be evaluated by using Laser Doppler Flowmetry (LDF). LDF is a non-invasive method of measurement that utilizes the frequency change (Doppler shift) of light reflecting from moving red blood cells (11).

The Laser Doppler Flowmetry (LDF) technique can measure the Pulpal Blood Flow (PBF) of a single tooth multiple times without causing any harm to the pulp. When laser light is directed towards the tooth surface, a portion of it penetrates the enamel prisms and dentinal tubules, eventually reaching the tooth pulp. The reflected Doppler-shifted signal from the pulp can provide valuable information about the PBF of the tooth (12).It has been confirmed that the technique is valid through the examination of extracted teeth with artificial blood circulation. Laser Doppler Flowmetry (LDF) cannot estimate the absolute blood flow value, but it can monitor the relative change during continuous measurement. LDF has been used to monitor transient PBF changes produced by brief intrusive force (13), as shown in Figure 1.

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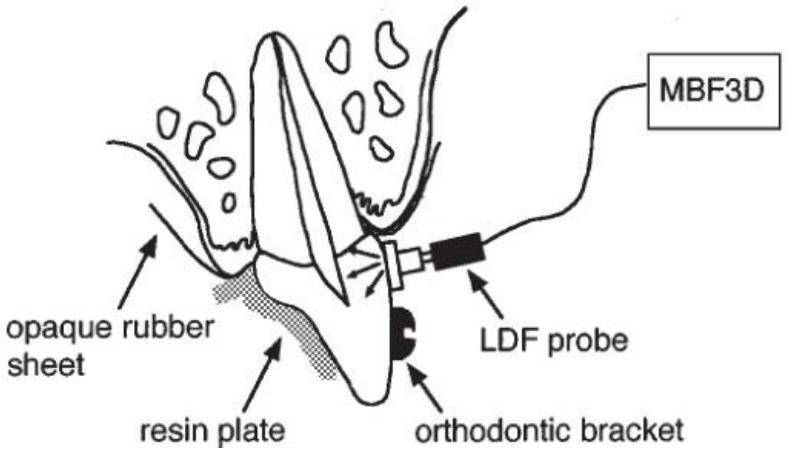

Figure 1 A schematic drawing of pulpal blood flow measurement in the upper left central incisor using laser Doppler flowmetry is presented in Figure 1.

Tooth movement is a process that involves cell damage, inflammation, and wound healing. These factors may have an impact on the health of the dental pulp (14). However, Proffit et al. have noted that light continuous force has little or no effect on the pulp but may affect the periodontal ligament (15). However, pulp necrosis may occasionally be found during orthodontic treatment.is usually related to previous dental trauma including severe periodontal injury (16). In certain cases, such as a large decay, excessive orthodontic force, or dental movement outside the trough of the alveolar process, the blood supply entering the chamber of the tooth may be blocked. Studies have shown that excessive intrusive or extrusive force magnitude can disturb the circulation of dental pulp and healthy controls, leading to the degeneration of the odontoblastic layer. These factors can potentially cause pulpal necrosis (17,18).

Discussion

Elective orthodontic treatments require special care to avoid any damage to the teeth and their pulps due to orthodontic forces. While previous studies have mainly focused on the possible changes in PBF (pulp blood flow), it is important to note that orthodontic forces

can cause various other responses and changes in the pulp. There is a possibility that the reduction in PBF is a direct effect of the orthodontic force, and many of the other observed changes may be secondary effects caused by the reduction in blood flow. (19–20,21,22–23. According to recent studies, it has been found that there is a significant decrease in pulpal blood flow (PBF) during the initial few days or weeks of orthodontic force application. This finding is consistent with previous research which reported that the application of short-term intrusive force resulted in a reduction in PBF (24,25). According to Barwick & Ramsay's study applying intrusive force on maxillary central incisors for a short period of time (4 minutes) did not result in significant changes in PBF. However, the small sample size used in the study may have hindered small changes in PBF from appearing statistically significant (26).

Under normal circumstances, the blood flow to the pulp is regulated both locally and remotely through the release of vasoactive substances and stimulation of the local sensory nerves by the autonomous nervous system (27).

The dental pulp receives its blood supply from blood vessels that enter through the narrow apex area. During orthodontic treatment, the blood vessels are directly mechanically compressed, resulting in a reduction in PBF (22,26). The movement of the apical root area in relation to the surrounding bone is caused by the orthodontic force. Depending on the type of force, different forms of movement occur, which may affect PBF differently. Traditionally, intrusion has been believed to be the type of movement that is most likely to cause changes in PBF. However, recent studies have shown that other types of movement can also lead to reductions in PBF (21). Laser Doppler flowmetry Laser Doppler flowmetry was commonly used in human studies to evaluate changes in pulpal blood flow associated with orthodontic treatment (28,29. In most studies, there was a decrease in basal blood flow regardless of the type of teeth movement (28). Another study reported no change in pulpal blood flow during the first 4 minutes after the application of intrusive force (29).

There were conflicting results on the magnitude of the applied force for increase related and not related to force (29,30). Javed et al. suggested that long-term application of severe forces may have a greater effect on pulpal blood flow than short-term applications of the same forces (31).

It is common for pulp calcifications to occur in the population. Generally, they are related to age and the number and size of pulpal calcifications increase in patients who undergo long-term orthodontic treatment. Dystrophic calcification findings related to orthodontic forces include large nodules of root canal space and total calcification (32). Popp et al. conducted a radiographic evaluation of pulp sizes in teeth that received orthodontic treatment and those that did not. They found that the pulp cavity decreased in size. It is recommended to use moderate and intermittent forces when applying orthodontic treatment to ensure sufficient tooth movement, limit damage to the pulp, and allow for damaged pulp to heal (33).

Completion of endodontic treatment before orthodontic treatment, with careful clinical and radiographic evaluation, is crucial for successful orthodontic movement (34).

Conclusion

Application of severe orthodontic forces over an extended period can cause irreversible pulpitis and pulp necrosis by exacerbating the pulp inflammation process. The movement of teeth can trigger biological reactions in the periodontal ligament and pulp. The clinical importance of pulpal alterations after orthodontic force depends on whether or not it will endanger the long-term vitality of the teeth causing pulpal tissue change due in part to the compression of the blood vessels supplying the pulp in the bony socket It is strongly recommended to apply moderate and intermittent forces during orthodontic treatment. This helps to ensure sufficient tooth movement, minimize pulp damage, and allow for proper healing of any damaged pulp. Before starting orthodontic treatment, it is important to thoroughly evaluate any teeth that require endodontic treatment with both clinical and

radiographical assessments. A successful endodontic treatment is essential for successful orthodontic movement. The quality of any previous root canal treatment should also be taken into consideration.

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