

Review Article

An overview of analgesic methodologies in orthodontics

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ABSTRACT

Orthodontic treatments aim to enhance teeth functionality and aesthetics through various methods like permanent, removable, and functional appliances. These interventions may involve teeth removal, surgical procedures for alignment, and even jaw position adjustments. The treatment typically starts with the placement of an orthodontic device, followed by periodic adjustments. One major concern for patients is the associated pain, directly linked to the applied force. Various devices influence pain intensity, with fixed devices being more painful. Pain peaks after certain adjustments, like placing separators, and is attributed to decreased blood flow due to brace-induced force. Pain is the primary reason some patients consider discontinuing treatment. Pain management involves both pharmacological and non-pharmacological approaches, including the promising but still under-researched low-level laser therapy (LLLT) and light emitting diodes (LEDs). Dietary changes also play a role during treatment due to pain. Proper nutrition and oral hygiene guidance are essential from orthodontists and general dentists.

Keywords: Orthodontic, Pain, Low-level laser therapy, Light-emitting diodes

INTRODUCTION

Orthodontic procedures aim to enhance the functionality and aesthetics of teeth. The process can involve shifting teeth using different methods: permanent appliances that stay attached throughout the treatment, removable appliances that are generally worn continuously but can be taken out for cleaning, and functional appliances that can be either fixed or removable and are designed to reposition the teeth and influence jaw growth direction. Additionally,

orthodontic interventions might include removing teeth to make a location for alignment; surgical procedures to expose unerupted teeth and assist in their alignment; and, in some cases, surgery to adjust the jaw's position. While most orthodontic patients are children and adolescents, there is a growing trend of adults seeking this treatment.¹ The procedure typically begins by crafting and placing an orthodontic appliance, which can be either permanent, removable, or functional. This usually entails two appointments, each lasting approximately 30 to 45

minutes. Subsequently, adjustments are scheduled every four to six weeks throughout treatment, which typically lasts from 12 to 24 months. Once the treatment is complete, it takes about 30 to 45 minutes to remove the permanent devices, and patients receive retainers to maintain the corrected alignment of their teeth. The pain from the orthodontic process is directly related to the force exerted on the teeth. Various orthodontic devices can influence the pain's severity. It appears that fixed devices tend to be more painful than either removable appliances or functional devices, the latter being designed to influence facial growth.²

People often feel sharp pain right after separators are placed. After every adjustment appointment, which happens every four to six weeks, they might experience discomfort for a day or two. Pain can also occur suddenly or persist between these visits. The discomfort from orthodontic procedures is believed to be due to a decreased blood flow to the fibers connecting the tooth to its surrounding bone. This reduction occurs when braces exert force on the tooth, leading to inflammation and the release of certain chemicals that amplify pain signals.³

The primary reason patients consider stopping orthodontic treatment is the pain.⁴ In 1992, Jones made a noteworthy observation: individuals who underwent both premolar extractions and orthodontic tooth adjustments reported experiencing more significant discomfort 24 hours after the initial placement of the archwire compared to the discomfort they felt 24 hours after the tooth extractions.³ Discomfort tends to increase following the insertion of separators, which are small rubber bands used to make a site for metal orthodontic bands on the teeth. The peak of this discomfort is typically experienced on the day following the placement of separators and subsequently subsides. Within a week, pain levels have reduced to the same level as what patients typically feel within two hours after the treatment.⁵

The level of pain felt varies based on the kind of tooth adjustment being made (whether it is tipping or full bodily movement) and especially on an individual's tolerance to pain. Patients probably need medication to manage pain for just two to three days within a four-to-six-week period, implying that the long-term effects of such medication are likely minimal.

Orthodontic pain management can utilize both drug-based and non-drug-based approaches.⁶ Discomfort stemming from fixed orthodontic devices can significantly affect the patient's quality of life. Common issues contributing to this discomfort include challenges in maintaining oral hygiene, speech difficulties, eating problems, tooth movement, altered taste, bad breath, and gum bleeding. The kind of appliance also influences the severity of pain. For instance, patients with permanent fixtures tend to experience more intense pain than those with removable devices. Invisalign aligners, known for their various advantages, are found to

cause less pain than fixed appliances, especially during the early phases of treatment.⁷

METHODS

This study is based on a comprehensive literature search conducted on 06 October 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed an overview of analgesic methodologies in orthodontics. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

There are different analgesic methodologies in orthodontics, focusing on pain management during and after orthodontic treatment. They may be pharmacological or non-pharmacological methods.⁸

Pharmacological management

Pain relief in orthodontics often involves the use of analgesics, which can be administered either locally or systemically. These pain relievers mainly belong to four categories: opioids, non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol, and local anesthetics. Typically, the first three are taken systemically within two hours post-orthodontic appointments and can be taken periodically until the pain subsides. For issues like ulcers in the mouth caused by the irritation of orthodontic devices, topical NSAIDs and anesthetics are often applied. These are usually used to address existing pain symptoms rather than prevent them. Pain relievers tailored for orthodontic discomfort are easily accessible, affordable, simple to administer, and generally safe with minimal side effects.³

Opioids

Opioids, sometimes known as narcotics, encompass drugs like codeine sulphate, tramadol, and morphine sulphate. They can be categorized as agonistic, agonist-antagonistic, or partial agonist based on their specific method of action, primarily targeting large A-δ fibers in the spinal cord's dorsal horn. These drugs latch onto opiate receptors linked with G-proteins on inhibitory fibers, halting stimuli to the "pain gate" and thus blocking pain signals to the brain. Tramadol, however, operates a bit differently. While it does share the aforementioned mechanism, it also inhibits the reuptake of monoamines, providing pain relief. This action limits the bone thinning effects often seen with other opioids. Due to this distinct mechanism, it is theorized that tramadol might have a reduced impact on the speed of orthodontic tooth movement compared to conventional

opioids. Yet, experimental findings have not necessarily confirmed this hypothesis.⁹

NSAIDs

Non-steroidal anti-inflammatory drugs (NSAIDs) are the primary choice for pain relief during orthodontic treatments.¹⁰ Examples include ibuprofen and aspirin. Their mode of action is to inhibit cyclooxygenase (COX) enzyme activity, which controls the conversion of prostaglandins from arachidonic acid within cell membranes.¹¹ Since prostaglandins play a role in causing pain, suppressing COX reduces their production, thereby alleviating pain. However, certain prostaglandins, like PGE1 and PGE2, are crucial facilitators of bone breakdown. As a result, using NSAIDs to curb their action might impact the speed of orthodontic tooth shifting. In a 1996 study by Kehoe, a notable difference in tooth movement rate was observed in guinea pigs treated with elastic separators and either misoprostol (a prostaglandin analogue) or ibuprofen, compared to a control group.¹² Nonetheless, this difference's clinical relevance is minimal. There was just a 1mm average gap between the test and control groups, and the experimentally administered doses were not reflective of regular clinical usage.

Paracetamol

Paracetamol, referred to as acetaminophen in the USA, has been prescribed as a painkiller in the UK since 1956 and became available over the counter in 1963.¹³ Its primary way of operating is akin to NSAIDs. It is believed to obstruct COX, mainly impacting COX-2. Unlike NSAIDs, paracetamol is considered to work primarily at the central nervous system level, not on cell membranes.¹⁴ Consequently, its suppression of prostaglandins is slight, leading to the belief that its usage does not influence the pace of tooth movement. Even though it is effective as a fever reducer and painkiller, paracetamol lacks anti-inflammatory properties. Hence, it is often paired with NSAIDs to manage pain more effectively.

Local anesthetics

There is a proposition that using local anesthetics, especially in the form of topical gels, could be a more secure choice compared to systemic pain relievers for managing pain before or during orthodontic treatments.¹³ These gels are designed to directly deliver the anesthetic to the gingival crevice. Due to this targeted application, their usage has been recommended for specific orthodontic procedures like band placement, archwire tying, and bracket removal.³

Non-pharmacological management

Non-pharmacological pain management methods have been explored, such as chewing gum and biting on wafers. However, a recent analysis of existing evidence

highlighted a deficiency in robust data supporting these interventions, indicating a need for more comprehensive research with long-term follow-up.¹⁵

A particularly intriguing development in the realm of pain management is low-level laser therapy (LLLT). Originally introduced as a method for pain control in orthodontic treatment, LLLT has not just demonstrated analgesic effects but also claims to speed up tooth movement and enhance tissue recovery. There are two types of lasers in use: high-intensity and low-intensity, and these differ in terms of their working action and potency.¹⁶ The low-intensity laser also known as a cold laser does not have any destructive potential and rather stimulates anabolic activities and bone remodeling and enhances tooth movement.¹⁷ Commonly employed low-energy lasers include galliumarsenide (904 nm wavelength), semiconductor (780–950 nm wavelength), helium-neon (632.8 nm wavelength), and gallium-aluminium-arsenide (805 nm wavelength).¹⁸ Previous research has shown that the gallium-aluminiumarsenide laser has greater penetration and is, therefore, more effective in managing pain associated with orthodontic treatment (Figure 1).¹⁹⁻²¹ It has been seen that low-level laser therapy induces cellular proliferation which results in the differentiation of osteoblasts bringing about bone formation.^{22,23} Low-energy lasers have also been found to help enhance orthodontic tooth movement, but more research is still being conducted on the same.²⁴ In recent times, the use of photobiomodulation, which employs light emitting diodes (LEDs) for promoting healing, managing inflammation, and alleviating pain, has gained traction.²⁵ When LEDs interact with human tissues, they trigger varied responses like photothermal, photomechanical, and photochemical reactions, producing diverse outcomes.²⁶ Specifically, LEDs around the 670 nm wavelength have proven effective in treating oral mucositis in cancer patients. However, the near-infrared spectrum, approximately 850 nm, aids in the secretion of growth factors and induces vasodilation, which fosters wound recovery. In rat-based studies, LED application was observed to diminish osteoclast numbers in periodontal ligaments and boost orthodontic tooth movement.²⁷ Although many studies on LEDs have been conducted recently, their findings have been inconsistent. Therefore, more in-depth research is essential for more reliable and consistent outcomes.²⁶

Delving into its effectiveness, a comprehensive meta-analysis was conducted. Out of 186 studies considered, 14 randomized clinical trials (RCTs) were found to meet the required criteria. These studies, which involved 659 participants, showed that diode LLLT contributed to a 39% pain reduction when compared with placebo groups, a statistically significant result ($p=0.02$).²⁶ However, despite these findings, the available studies did not conclusively support LLLT's effectiveness. The call was made for more well-structured research with adequately sized samples to determine LLLT's potential as a regular orthodontic pain control method.



Figure 1: Application of LLLT.²¹

Another study found that single-dose helium-neon laser therapy effectively reduced pain in patients undergoing maxillary canine retractions, showing a 12.1% reduction in pain compared to placebo treatments. Yet, the study was not without its limitations, and there had been no prior research comparing helium-neon laser therapy with other types of lasers.²⁸

Despite some promising outcomes, the broader consensus remains that more rigorous studies are needed to ascertain LLLT's potential. A systematic review concluded that while LLLT may accelerate tooth movement and modulate acute pain, the evidence quality supporting its use is currently low.²⁹ Of all the interventions studied, analgesics and laser irradiation remained the most effective in managing peak orthodontic pain. Again, the collective sentiment highlighted the need for better research to improve evidence quality.²⁶ Beyond pain management, dietary adjustments play a critical role during orthodontic treatment. Patients often need to alter their eating habits due to pain and treatment requirements. In a study of 180 patients, it was observed that those undergoing orthodontic treatment had a different dietary intake compared to controls, consuming more calories, proteins, and carbohydrates but less fiber, chromium, and beta-carotene. Given the change in dietary habits due to pain, it becomes imperative for orthodontists to provide proper nutritional guidance, especially emphasizing the consumption of soft diets to reduce sensitivity.²⁶ Despite the insights, it is worth noting that these studies had limited sample sizes. The responsibility is not solely on orthodontists. General dentists too should actively contribute to offering oral hygiene and nutritional advice to those under orthodontic care. One innovative approach to patient care and pain management highlighted in recent research by Cozzani et al is the use of telephone follow-ups post-treatment, which potentially helps in reducing the patient's pain threshold.³⁰ However, the feasibility of such an approach in a bustling orthodontic practice remains a question.

CONCLUSION

Orthodontic procedures, designed to improve teeth aesthetics and functionality, encompass methods ranging

from fixed and removable appliances to surgeries that adjust the jaw's position. Initiation of treatment often involves two sessions for appliance placement, followed by regular adjustments for 12 to 24 months. Pain, a significant concern linked to the force exerted on teeth, varies by the type of orthodontic device and individual pain tolerance. Pain management in orthodontics, both pharmacological and non-pharmacological, remains crucial, with methods like LLLT and LEDs showing promise, though requiring further research. Additionally, the orthodontic journey influences dietary habits, necessitating proper nutritional guidance from healthcare providers.

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