

PAIN THERAPY ASSOCIATED WITH ORTHODONTIC TREATMENT

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Abstract

Orthodontics is based on tooth movement through bone resulting from the application of mechanical forces. The bone remodeling takes place through an inflammatory process associated with pain or discomfort. Many practitioners recommend to their patients to use analgesics such as non-steroidal antiinflammatory drugs (NSAIDs) to control the discomfort associated with the inflammatory process, unaware that studies have shown that most of NSAIDs inhibit orthodontic tooth movement. This review tries to find the best therapeutically approach in terms of pain relief and rate of orthodontic movement based on today knowledge.

Rezumat

Terapia ortodontică se bazează pe deplasarea dinților în urma aplicării unor forțe mecanice. Remodelarea osoasă, care are loc în urma deplasării dentare, se face printr-un proces inflamator asociat de cele mai multe ori cu durere sau disconfort. Mulți ortodonți recomandă pacienților lor analgezice, cum ar fi antiinflamatoarele nesteroidiene (AINS) pentru diminuarea durerii determinate de procesul inflamator, fără să știe că studiile existente au arătat că cele mai multe dintre AINS inhibă deplasarea ortodontică a dintelui. Acest *review* încearcă să găsească cea mai bună abordare terapeutică atât din punctul de vedere al ameliorării durerii cât și al deplasării ortodontice bazându-se pe datele științifice actuale.

Keywords: NSAIDs, orthodontic pain relief, orthodontic tooth movement

Introduction

The available reports underline the fact that discomfort and pain are potential side-effects of fixed appliance orthodontic therapy [1, 2] which can negatively influence the acceptance to undergo treatment [3], compliance [4], and treatment outcomes [5].

The pain is generated by the orthodontic movement which is a complex biomechanical process induced by prolonged application of mechanical forces, creating pressure and tension zones in the periodontal ligament and alveolar bone [6]. Bone is deposited on the alveolar wall in the tension zone and resorbed by osteoclasts in Howship's lacunae in the pressure zone [7]. Remodeling occurs in dental and paradental tissues, including dental pulp, periodontal ligament, alveolar bone and gingiva. These tissues, when exposed to mechanical loading, express significant macroscopic and microscopic changes. At cellular level, orthodontic tooth movement is characterized by initial acute inflammation, followed by a chronic inflammatory process [8], which prevails by the next clinical appointment, when the orthodontist activates the tooth-moving appliance, thereby starting another period of acute inflammation, superimposing it on the ongoing chronic inflammation.

For the patient, the periods of acute inflammation are associated with painful sensations and reduced activity. It has been reported that the peak of pain occurs the day after the adjustment, with a decrease over the next 6 to 8 days [2, 9-12].

A number of studies reveal that the initial and delayed pain response following orthodontic force application is caused by the hyperalgesia of the periodontal ligament. The hyperalgesia makes the periodontal ligament sensitive to the high levels of the released algogens such as histamine, bradykinin, prostaglandins, and serotonin [14].

Ninety to ninety-five percent of orthodontic patients report experiencing this discomfort [13]. Even though, there are differences among patients in the perceived pain, which are dependent on factors such as individual pain threshold, the magnitude of force applied, age, gender, cultural differences, previous pain experienced, and emotional state and stress, one of clinician's concerns is the well-being of the patient, with pain relief as a key element. The most common group of medications used in orthodontics for pain relief consists of nonsteroidal anti-inflammatory drugs (NSAIDs) [14, 15], but currently there is no universal protocol on the use of analgesics in orthodontic pain reduction.

The aim of this systematic review is to present an update of the optimal NSAID in terms of pain relief in relation with the current knowledge of their effects on orthodontic tooth movement process. We consider that this kind of information is essential in clinical practice, enabling the health care professionals to consider all the factors related to the orthodontic treatment, and to select the best individual therapeutic strategy for each case.

A computer based literature research was performed using several data bases (MEDLINE, PUBMED etc.) with no language restriction. Clinical trials conducted in humans on pain relief using NSAIDs, as well as studies on animals concerning the effects of NSAIDs on orthodontic tooth movement, were identified and further used for analysis.

Results and Discussion

In the relation between pain and rate of orthodontic movement an important link seems to be prostaglandins (determined by mechanical deformation of the periodontal ligament as a result of orthodontic force). Prostaglandins are synthesized from arachidonic acid by the cyclooxygenases (COX). The two types of COX, COX-1 and COX-2, have different roles. While COX-1 has physiological functions such as vascular hemostasis and maintenance of the normal gastric mucosa, COX-2 is being regulated by inflammatory mediators and generates prostaglandins that have a role in pathophysiological and inflammatory processes including pain (Figure 1).

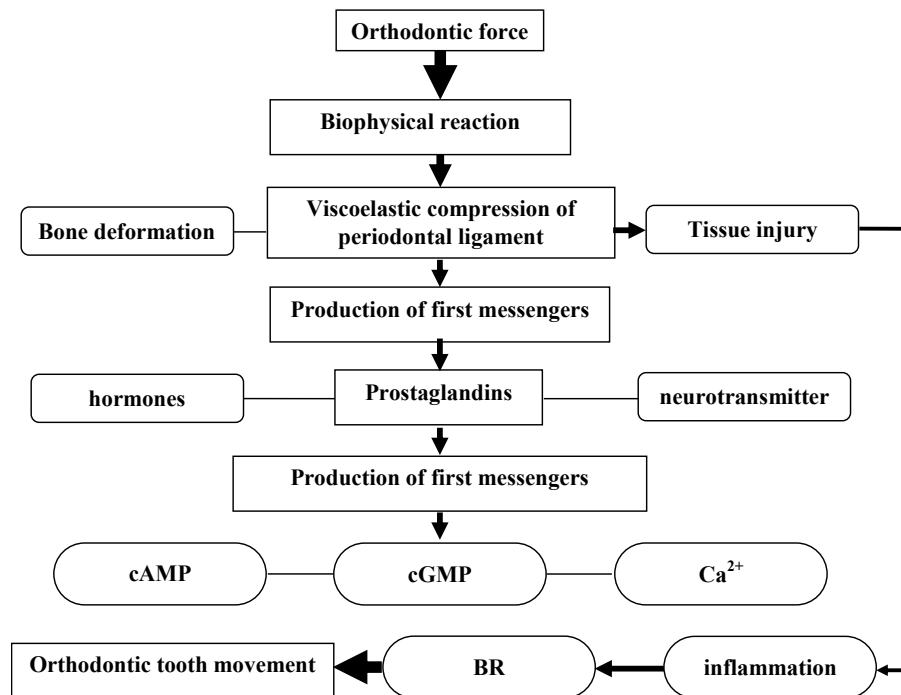


Figure 1.

Biochemical reactions in orthodontic tooth movement [16]

cAMP = adenosine 3', 5' monophosphate (cyclic AMP); cGMP = guanosine 3', 5'- monophosphate (cyclic GMP); BR = bone remodeling.

A number of studies have already stated the critical role of prostaglandins in the inflammatory process that allow for orthodontic tooth movement through their ability to increase vascular permeability and dilation [17]. Some researchers found that an extra amount of prostaglandins increase the amount of tooth movement [18]. Prostaglandins not only mediate inflammation, but also participate in bone formation and induction of bone resorption through activation of osteoclastic cells [16], being responsible for increasing the number of osteoclasts through enhancement of their ability to form a ruffled border [8]. Prostaglandins also stimulate osteoblastic differentiation and new bone formation [7]. Therefore, prostaglandins play a significant role in mediating orthodontic tooth movement [36].

The most common group of drugs used in orthodontics for pain relief consists of nonsteroidal anti-inflammatory drugs (NSAIDs) [14, 15] and paracetamol. Even though NSAIDs are chemically disparate (salicylates, arylalkanoic acids, arylpropionic acids or profens, oxicams and coxibs), they produce their therapeutic effects by the common ability to inhibit the activity of the COX enzymes [19], being PGs (prostaglandins) inhibitors. Paracetamol is also used in pain relief, but the mechanism of action is not well established, its analgesic effect being supposed to be produced at the central nervous system level and does not act over cell membranes, as those described previously [20]. Paracetamol is considered to be a very weak PG inhibitor and displays no significant anti-inflammatory effects.

Table I.
Available studies on NSAIDs efficiency on orthodontic pain relief

Study title / description	Sample size	NSAIDs	Conclusions	References
The effect of ibuprofen on the level of discomfort in patients undergoing orthodontic treatment	77	ibuprofen vs. aspirin	Ibuprofen produced significantly less discomfort than aspirin and is the preferred analgesic in the treatment of orthodontic discomfort.	[21]
Pain control during fixed orthodontic appliance therapy	150	ibuprofen vs. flurbiprofen vs. Paracetamol naproxen sodium vs. aspirin	Preoperative administration of all the analgesics used in this study successfully eliminated orthodontic pain two hours. Naproxen sodium and aspirin relieved pain and gave minimum pain values for all the parameters and time groups. The Paracetamol group showed slightly higher values compared with these groups, but these were statistically insignificant.	[22]
A randomized clinical trial comparing the efficacy of ibuprofen and acetaminophen in the control of orthodontic pain.	159	ibuprofen vs. Paracetamol	Preoperative and postoperative administration of ibuprofen is more effective than Paracetamol in the control of orthodontic pain.	[23]
Comparison of the effect of paracetamol and ibuprofen on orthodontic pain	56	ibuprofen vs. Paracetamol	There was no significant difference between ibuprofen and Paracetamol regarding control of orthodontic pain except during the first two hours after arch wire insertion when Paracetamol was observed to be slightly more effective than ibuprofen	[24]
Comparison of the efficacy of ibuprofen and Paracetamol in controlling pain after orthodontic tooth movement.	60	ibuprofen vs. Paracetamol	Paracetamol, ibuprofen, and placebo were equally effective in reducing discomfort after initial orthodontic appliance placement.	[25]
A study on efficacy of NSAIDs in control of pains caused by orthodontic	75	ibuprofen vs. naproxen, vs. mefenamic acid vs. aspirin	NSAIDs were more or less effective in pain control; ibuprofen was relatively more effective in decreasing the pain level. Preoperative prescription of NSAIDs can cause significant decreases in pain 2 h after placement of arch wire.	[26]
Tenoxicam controls pain without altering orthodontic movement of maxillary canines	36	tenoxicam	It was effective for pain control and did not present any pre-emptive analgesic effect. Tenoxicam didn't influence orthodontic movement of the upper canines.	[27]
Effectiveness of piroxicam and ibuprofen premedication on orthodontic patients' pain experiences. A randomized control trial	90	piroxicam vs. ibuprofen	Premedication with piroxicam results in significantly decreased pain, compared to premedication with ibuprofen. Piroxicam has a longer duration of the analgesic effect compared to ibuprofen.	[28]

Table II.
Available studies on NSAIDs influence on orthodontic tooth movement

Study title / description	Model	NSAIDs	Conclusions	References
The effect of acetylsalicylic acid on orthodontic tooth movement in the guinea pig	Guinea pig	aspirin	Aspirin did not appear to significantly affect tooth movement.	[29]
The influence of indomethacin in bone turnover related to orthodontic tooth movement in miniature pigs	Guinea pig	indomethacin	Resorption surfaces were decreased significantly in the indomethacin treated animals. Formation surfaces were also decreased although not significantly. The bone turnover, but not the mineralization rate, was influenced.	[30]
The effect of acetaminophen, ibuprofen, and misoprostol on prostaglandin E2 synthesis and the degree and rate of orthodontic tooth movement	Guinea pig	Paracetamol vs. ibuprofen vs. misoprostol	Results of this study suggested that Paracetamol is the analgesic of choice for the relief of minor discomfort associated with orthodontic treatment.	[31]
The effect of acetaminophen on tooth movement in rabbits	Rabbits	Paracetamol	Paracetamol had no effect on the rate of tooth movement in rabbits undergoing orthodontic treatment.	[32]
Orthodontic tooth movement after inhibition of cyclooxygenase-2	Wistar rats	diclofenac vs. rofecoxib	Both rofecoxib and diclofenac significantly inhibited dental movement, partially in the case of rofecoxib and totally in the case of diclofenac. Nevertheless, no statistically significant difference was found between the effects of rofecoxib and diclofenac. There is no substantial advantage in using selective COX-2 inhibitors compared with nonselective COX inhibitors to avoid interference with tooth movement.	[33]
Aspirin, Paracetamol, and ibuprofen: Their effects on orthodontic tooth movement	Wistar rats	aspirin vs. Paracetamol, vs. ibuprofen	Aspirin and ibuprofen diminished the number of osteoclasts, probably by inhibiting the secretion of prostaglandins, thereby reducing orthodontic tooth movement. Paracetamol did not affect orthodontic tooth movement in rats, and it might be the analgesic of choice for treating pain associated with orthodontic treatment.	[20]
Effects of short- and long-term celecoxib on orthodontic tooth movement.	Wistar rats	celecoxib	Although celecoxib administration did not affect the number of osteoclasts, the osteoclast activity might be reduced, which could explain the inhibition of tooth movement observed in the celecoxib-treated animals.	[34]

As it is showed in Table I, in terms of pain relief, most of the tested NSAIDs display variable efficiency. Among them, ibuprofen is not only the most used, but it seems to be the most efficient. Ngan PS et al [21] concluded that ibuprofen was the analgesic of choice for decreasing pain during orthodontic treatment, as also did it Padisar P [26] after a study in which he compared the efficacy of 4 groups of drugs (ibuprofen, naproxen, mefenamic acid, aspirin). Law SLS et al [12] advanced the research one step further and found evidence to support the use of pretreatment with ibuprofen for the discomfort after the orthodontic appointment. Bernhardt MK et al [35] have also noted a decrease in pain reported by those who had taken ibuprofen before treatment compared to those who had taken it only after treatment. Later reports showed that a premedication with piroxicam results in significantly decreased pain level, compared to premedication of ibuprofen and has a longer duration of the analgesic effect compared to the last one.

It is debatable if these results are really reliable because the studies weren't conducted in the same conditions. Differences were noted in the intensity of the applied orthodontic force, duration of treatment and administered doses.

Regarding the influence of NSAIDs on the rate of orthodontic tooth movement, human studies on this topic are lacking. In animal studies, acetylsalicylic acid, flurbiprofen [36], indomethacin [30], and ibuprofen [20] have shown reduction in the rate of orthodontic tooth movement [31]. Moreover, the long-term effect of celecoxib has shown to reduce the rate of orthodontic tooth movement [34]. Recently, Jerome et al [37] showed that celecoxib administered in rats during the application of orthodontic forces did not interfere with tooth movement and seemed to offer some slight protection against root resorption.

Weak points of the studies include animal subjects, variability in experimental design, drug administration techniques, and force characteristics [18]. Also, it is debatable whether findings from animal experiments can be extrapolated to the human situation as morphological and physiological differences between animal and human alveolar bone and periodontal ligament have to be considered. Even if one accepts the extrapolation, the dosage of the anti-inflammatory drugs used in these studies was much higher than over-the-counter therapeutic doses. In clinical orthodontics, lower doses are used for a short duration after orthodontic activation.

The analysis revealed two studies on this topic performed in humans. By comparison of the effects of ibuprofen and paracetamol on prostaglandin

E₂ (PGE₂) levels in gingival crevicular fluid during orthodontic tooth movement showed a significant decrease in PGE₂ levels in the ibuprofen group when compared to the paracetamol group and the control group [38].

Paracetamol showed no significant effect on prostaglandin synthesis and may be the safe choice compared to ibuprofen for relieving pain associated with orthodontic tooth movement.

From the point of view of the impact of this type of therapeutic approaches on orthodontic tooth movement, the current knowledge allowed us to state that paracetamol appears to be the analgesic of choice for orthodontic patients because it has been shown to have no effect on tooth movement.

Conclusions

Practitioners have to be aware of the mechanisms implied by the drugs administered to patients that could interfere with tooth movement, in order to reduce the negative effects of prolonging orthodontic treatment.

Further research on this topic should include studies analysing the effects of NSAIDs in humans during orthodontic treatment, but in the light of the information available today, we think that even though ibuprofen can be recommended for short term use with good results in terms of pain relief, paracetamol appears to be the safest approach as analgesic of choice as it has been shown to have no effect on tooth movement, while being effective in controlling orthodontic discomfort.

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