Orthodontic Pain Management

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Abstract

This evidence-based review of the literature investigated the effect of various pain relieving modalities on orthodontic pain after fixed and separator appliance placement. The review included an electronic search followed by a review of the reference lists of relevant articles, a manual search of several orthodontic textbooks, and a grey literature search of unpublished studies, dissertations, current guidelines and the University of Toronto's Orthodontic Department's protocol. The search yielded one-hundred and two studies of which twelve articles were deemed relevant and were critically appraised according to the "Checklist to Assess Evidence of Efficacy of Therapy or Prevention". At this stage one study was excluded due to a low score. A total of ten relevant studies were analyzed in this review. All of the studies assessing drug interventions were ethical, placebo controlled, blinded, randomized control trials, and all of the studies validly and reliably measured both intervention and outcome. However there were conflicting results regarding the best choice of analgesic for relief of orthodontic pain. The results were far more congruent regarding the effectiveness of pre-emptive drug administration on the reduction of pain in orthodontic therapy. The number and quality of investigations on other alternatives such as the use of masticatory bite wafers, anesthetic gels, and transcutaneous electrical nerve stimulation have been insufficient to elucidate the effectiveness of these alternatives. Two separate studies supported the effectiveness of low-level laser therapy; however, neither study tested the validity or reliability of their outcome measure, and one of these studies used a split mouth randomized control trial. Overall the evidence supports the use of pre-emptive drug therapy but results are inconsistent about the best drug choice and the effectiveness of alternative therapies.

Introduction

Surveys of orthodontic patients have revealed that pain is among the most cited negative effect of orthodontic therapy[(1)] and even when compared with the pain of invasive procedures such as extractions, patients perceived orthodontic pain to be greater in both incidence and severity[(2)]. This is significant to both patients and dentists as studies have reported this reaction to be a major deterrent to orthodontic treatment and an important reason for discontinuing treatment. There exist differences among patients in the perceived pain dependent on factors such as individual pain threshold, the magnitude of the force applied, age, gender, cultural differences, previous pain experienced and present emotional state and stress[(3),(4),(5),(6),(7)(8)].

Orthodontic pain is the result of compression of the periodontal ligament by the tooth resulting in an inflammatory response mediated by cytokines and prostaglandin. Thus, anti-inflammatory medication such as ibuprofen, have been suggested as the gold standard in decreasing post-operative orthodontic pain[9],[10],[11],[12].

The major concern with using NSAIDs to manage orthodontic pain is that it may interfere with tooth movement by inhibiting cylcooxygenase activity and thus prostaglandin production. A number of animal studies have demonstrated decreased rates of tooth movement with NSAID administration[9],[10],[11],[12]. However, according to Profitt (2000), the use of NSAIDs is only of concern in chronic users and not when taken at modest doses over 3-4 days following treatment[13].

Other medications have been recently evaluated including aspirin, acetaminophen, misoprotol, indomethacin, naproxen sodium and cox-2 inhibitor, rofecoxib. Furthermore, recent studies have focused on preoperative administration of analgesic which provides blockage of afferent nerve impulses before they reach the central nervous system thereby limiting or preventing post-operative pain.

Alternative methods such as the application of low-level laser therapy to periodontal tissue[14], transcutaneous electrical nerve stimulation[15], anaesthetic gels, bite wafers and vibratory stimulation of the periodontal ligament[16] have been anecdotally effective at reducing orthodontic pain.

The visual analogue scale (VAS), McGill pain questionnaire (MPQ), Verbal Rating Scales (VRS) and algometers have been used to assess the pain experienced by patients. The VAS, particularly the graded and linear horizontal scale, has been shown to be the most reliable and accurate tool in the evaluation of subjective experiences such as pain[17]. Patients mark a point on a continuous scale bordered by descriptive words. The marked point is measured from the left end of the line to give a score. The McGill pain questionnaire (MPQ) is not the gold standard and the validity of this method has yet to be confirmed.

Despite the extensive number of research papers on pain reduction in

orthodontics there is no standard in the management of orthodontic pain and many orthodontists advise their patients to take analgesics as needed for post-operative pain. The purpose of this review is to organize the existing literature regarding orthodontic pain management in fixed and/or separator therapy to answer the following questions: What is the best analgesic to reduce orthodontic pain and what dosing schedule will optimize pain relief? Are alternative therapies effective in alleviating orthodontic pain? This paper summarizes the strongest sources of evidence to answer these questions and if possible a guideline should be developed to standardize treatment.

Methods

Criteria for considering studies for review

A systematic method was used to evaluate the effect of different treatment modalities on the reduction of orthodontic pain. This method was used to identify, select and critically appraise relevant studies.

Search strategy

Electronic search

A search of the following databases was performed: Ovid MEDLINE(R) (1966 to present), Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, AMED (1985 to present), Cochrane DSR, Classic (1947-1979), EMBASE(1980 to present), Journals@Ovid, and HealthSTAR, all EBM reviews and International Pharmeutical Abstracts (1970-present). Detailed search strategies were constructed for each database; search terms (Table 1) and use of simple/advanced search engines were modified for each database.

Table 1: Search Terms

Population	Intervention	Outcome	study
Adolescence	Drug	Pain relief	Randomized
Adolescent	Drugs	Pain	Control trial
Adolescents	Medication	management	
Teen	Medications	Pain control	
Teens	NSAIDs	Quality of life	
Teenagers	Analgesics	Pain intensity	
Young adults	Ibuprofen	Pain duration	
Fixed	Acetaminophen	Pain frequency	
Orthodontic	Paracetemol	Aching	
Orthodontics	Naproxen sodium	Sore	
Orthodontia	Preemptive drug therapy	Tight	
Tooth		Hurting	
Tooth movement	Postopertive drug therapy	Tender	
	Laser		
	Bite wafer		

Combinations of the terms were used, and the results of all the searched items were combined and duplicates were removed. When the search engine allowed, limits were placed on the search to restrict the results to randomized clinical control

trials and adolescence. These searches were limited to studies of human subjects and English publications.

Handsearching

The references of relevant studies were reviewed for pertinent articles that were not included in the electronic results, based on title relevance. Several relevant textbooks, including orthodontic textbooks were reviewed for relevant articles. Cited articles in any of the aforementioned results not included in orthodontic journals were handsearched as necessary.

A grey literature search was also performed using Google Scholar, searching for available theses, dissertations and unpublished articles, and by speaking to faculty members at the University of Toronto.

A defined set of inclusion criteria for selecting the best evidence was formulated prior to the literature search. The criteria are listed below and were based on the PICO (population, intervention, controls, and outcomes) (Table 2).

Table 2: Inclusion and Exclusion Criteria used in the Selection Process

PICO	Inclusion/exclusion criteria
Study design	Studies were limited to randomized controlled clinical trials and modified randomized control trial designs.
Population	Studies were eligible for inclusion in the review if the participants were receiving fixed or separator orthodontic treatment and if the participants were in the adolescent age group (9-25 years).
Intervention	Any drug was taken by any route, at any dose regimen including preemptive delivery and/or post-orthodontic treatment delivery as an analgesic. Possible analgesics included were NSAIDS, including naproxen, ibuprofen and acetylsalicylic acid, or acetaminophen. Any alternative pain relief therapy delivered pre-emptively and/or post-orthodontic treatment were also included. Possible alternative therapies included bite wafers, low-level laser therapy, anaesthetic gels and transcutaneous electrical nerve stimulation.
Control	Placebo group or comparison to different interventions, including drugs with different active ingredients, different dose regimes or alternative therapies.
Outcome	**Primary** Pain relief or decrease in pain duration, intensity and/or frequency measured on a visual analogue scale (VAS). The VAS was limited to the linear and graded horizontal type because it was the most reliable and gave a more sensitive and accurate representation of pain intensity. **Secondary** Quality of life, days missed from school, and cost effectiveness analysis of various treatments. Also, adverse effects of painkillers including other systemic effects and NSAIDS effect on tooth movement. Any rescue (alternative) pain relief taken/prescribed, including dose and time, following last treatment. Failure to complete orthodontic treatment due to the pain experienced.

Data collection and analysis

Study selection

Articles were independently evaluated at the title stage by two review authors according to the inclusion and exclusion criteria. Abstracts of the accepted titles were assessed by three other review authors who used inclusion/exclusion criteria to either accept or reject them. For reliability there needed to be agreement amongst the three members in order for

the articles to be accepted. Their full reports were assessed by three review authors independently to ensure they met the inclusion criteria and were subsequently critically appraised using the "Checklist to Assess Evidence of Efficacy of Therapy or Prevention" adapted from Fletcher (2007), with a maximum possible score of 17 (Table 3)[18].

Table 3: Checklist to Assess Evidence of Efficacy of Therapy or Prevention

1. Was the study ethical?
2. Was a strong design used to assess efficacy?
3. Were the outcomes (benefits and harms) validly and reliably measured?
4. Were interventions validly and reliably measured?
5. Was the treatment effect large enough to be clinically important?
6. Was the estimate of the treatment effect beyond chance and relatively precise?
7. If the findings were "no difference" was the power of the study 80% or better?
8. Was the assignment of patients to treatments randomized, and were all patients who entered the trial properly accounted for and attributed at its conclusion?
9. Was loss to follow-up less than 20% and balanced between test and controls?
10. Were patients analyzed in the groups to which they were randomized?
11. Was the study of sufficient duration?
12. Were patients, health workers, and study personnel "blind" to treatment?
13. Were the groups similar at the start of the trial?
14. Aside from the experimental intervention, were the groups treated equally?
15. Was care received outside the study identified and controlled for?
16. Were all clinically important outcomes considered?
17. Are the likely benefits of treatment worth the potential harms and costs?

Articles were included if they scored above 80% with a 90% concurrence rate amongst reviewers. The cut off was chosen after determining the minimum number of checklist items that would be essential to a good quality study. Disagreements at the title, abstract and full article stage were resolved by discussion and a record was kept referencing all included, rejected, and discussed articles.

The search yielded a total of 102 studies of which 44 were accepted at the title review stage. The abstracts of the remaining articles were reviewed and 10 articles were accepted. Otasevic et al. (2006) was the only study that was excluded based on a low score (below 70%) at the critical appraisal stage. Reason for exclusion was that the intervention was not validly measured[30].

Data extraction

The evidence from the remaining papers was recorded into an evidenced-based table (Table 4) which included information regarding population including age and sex, intervention and control, sample size, outcome, and critical appraisal criteria. The table also included the author and date of publication and required a conclusion about the strength of evidence and classification. The criteria for communicating the strength of the findings

in the articles followed the Canadian Task Force recommendations for quality of evidence (I-III) and final recommendations (A-E, I) for articles alleging to show efficacy[13].

RESULTS

A total of nine relevant studies were analyzed in this review and their results are presented in the evidence-based table (Table 4). All of the studies achieved a score of 12 out of 16 or greater and hence they were all considered to present strong evidence. They were all randomized clinical trials[19],[20],[21],[22],[23],[24],[25] with the exception of one split mouth design study[26]. The studies evaluated adolescent patients (age range 9-25) who were already scheduled to undergo orthodontic treatment. The type of orthodontic treatment varied between studies; four studies were based on fixed orthodontic appliances[19],[20],[25],[26], four studies on separators only[20],[22],[23],[24], and one did not indicate the type of orthodontic therapy[10]. Of these studies, seven assessed the efficacy of various drug therapies[10],[19],[20],[21],[22],[23],[24] and the other two assessed low-level laser therapy[25],[26]. In four of the pharmacological studies, the drugs were administered pre-operatively and post-operatively[19],[20],[22],[24], in the two other studies they were only administered pre-operatively[20],[22], and in one study the drugs were only given post-operatively[10]. The drugs analyzed included but were not limited to ibuprofen, naproxen sodium, acetaminophen/ paracetemol, and aspirin. All drug trials provided a placebo comparison group except for Bird et al. (2006) and Bradley et al. (2007). The degree of pain relief was measured in all of the studies over a period of seven days except for Bird et al. (2006), Youssef et al. (2007) and Turhani et al. (2006). These studies were carried out for a period of 24 hours, 54 hours and 14 days, respectively[25],[26]. The VAS was used to measure the outcome in all studies except for Youssef et al. (2007) and Turhani et al. (2006) which used pain questionnaires instead. The results of the above studies varied[25],[26].

Drug Therapy

Which drug type is superior?

There has been conflicting results regarding the best choice of analgesic for relief of orthodontic pain. All of the drugs

were superior to placebo but there was no consensus regarding which drug type is most effective. With regards to ibuprofen, Ngan et al. have found that ibuprofen produced significantly less discomfort than placebo and aspirin at all time periods (2, 6 hrs and 2, 3, 7 days following archwire placement)[8]. Although less effective than ibuprofen, aspirin still resulted in less discomfort than placebo[27]. Subsequent studies compared ibuprofen to various other potential analgesics, however, the results varied. Polat et al. found a significant decrease in pain with ibuprofen but sodium naproxen was significantly better than ibuprofen ($p < .05$), particularly in relieving pain during biting at 2 and 6 hours and relieving pain when chewing, fitting front teeth and back teeth together at 2 and 6 hours and night[20]. Furthermore, Bird et al. found no statistical significant difference in pain relief between acetaminophen and ibuprofen[22]. Bradley et al. also reported a non-significant difference between ibuprofen and acetaminophen from days 1 to 3 ($P=0.07$) and at day 7 ($P=0.16$) in relieving pain. However, this study found that ibuprofen was significantly more effective at relieving pain from 2 hours to night ($p= 0.004$)[23].

When should the drugs be administered?

Pre-emptive administration of ibuprofen has been shown to be better at reducing pain at 2 hours compared to post-operative administration ($p < 0.05$)[7],[24]. Polat et al also demonstrated similar effects for aspirin, naproxen and acetaminophen($p< 0.05$)[19]. This beneficial effect of pre-operative analgesia has been shown to last up to bedtime on the day of treatment[21]. However, long-term relief may require supplementation with post-operative analgesia. Bernhardt et al. found that a double-dosing strategy, in which a second dose of ibuprofen was given six hours after the appointment, resulted in lower pain scores in patients at most time intervals beginning on day two[21].

What are the other options?

Low laser therapy

Only two articles met the inclusion criteria for alternative therapies. These articles investigated the effects of low-laser irradiation therapy (LLIT) on pain levels in orthodontic patients undergoing fixed appliance therapy using semiconductor lasers (GaA1A, wavelength 809nm)[27, 28].

Turhani et al., treated seventy-six patients in a single-blind study in which the control group received placebo laser therapy without active laser irradiation and the other group received low level laser irradiation therapy for 30 seconds per banded tooth. All patients were treated with fixed edgewise metal brackets. In both groups, patients underwent irradiation of either the maxilla or the mandible or both, in accordance with the location of the orthodontically treated teeth. The difference in the location of treatment had no bearing on the outcome for treatment. The group with low-laser irradiation therapy experienced a significant reduction in pain ($P<0.05$) in post treatment pain levels at 6 and 30 hours but not at 54 hours. Some patients took analgesic drugs during the course of the treatment but the authors found that this had no statistical significance[25].

The study by Youssef et al. assessed 15 patients (ages 14 to 23) who underwent fixed orthodontic therapy. The right side of the upper and lower jaws was subject to LLIT (30 seconds per tooth), whereas the left side underwent laser without irradiation. Pain assessment was done according to a basic visual pain scale developed by the authors over a period of 14 days. The results demonstrated a decrease in the pain level of the LLLT group as compared to the control. No damage was observed radiographically to the periodontal ligament (PDL) during LLLT[26].

DISCUSSION

According to this systematic review the evidence for the use of pre-operative analgesia to reduce orthodontic pain is strong; however, there is insufficient evidence regarding the most effective type of analgesic drug. The number and quality of studies on other alternatives, particularly low level irradiation, have been insufficient to elucidate their effectiveness.

Which drug type is superior?

The five randomized clinical trials investigating the effectiveness of various types of drugs in the management of orthodontic pain have revealed conflicting results. Each is an internally strong study; however, there was a significant degree of variability in the methodology between the studies and these differences made it very difficult to make comparisons between

studies. For example, the studies often applied different dosing regiments and administered different amounts of drugs, some lacked a placebo control group[22, 23], others had a significant loss to follow up and did not report NNT or power[21, 24] and some failed to provide a statistically adjusted effect while controlling for confounders[21].

Furthermore, none of the studies in this review examined other clinically important outcomes following the administration of analgesics such as adverse effects. The major concern with using NSAIDs to manage orthodontic pain is that it may interfere with tooth movement. This, and other potential side effects, should be investigated to help guide the practitioner in selecting the best analgesic for the patient.

The degree of pain relief following the administration of various analgesics has been based on the visual analogue scale because it has been shown to be the most reliable and accurate tool in the evaluation of subjective experiences such as pain. Unfortunately, pain is a multi-dimensional experience that is influenced by biological, physiological, psychological, emotional, and social factors[27]. Thus, a wide range of pain responses makes studying pain and the management of pain difficult. Additionally, most studies in this review failed to measure a baseline level of discomfort among the patients upon placement of the appliance. Also, the studies did not measure and control for the magnitude of the force applied by the orthodontic appliances and this may have influenced the pain responses[13,27].

There has been a substantial amount of research regarding specific pharmacological interventions for the management of orthodontic pain but there remains to be a definitive consensus. Based on the results from this review, all analgesics are more effective than a placebo treatment; however, there is insufficient evidence to recommend a specific type of analgesic.

When should the drugs be administered?

The four randomized clinical trials investigating the optimal time of administration of the analgesic indicate that the drug should be administered 1 hour prior to treatment along with subsequent

post-operative follow-up doses as needed. Two studies by Polat et al. confirmed that pre-operative administration of an analgesic was superior to a placebo treatment[19],[20]. Although the results from these studies are promising, there was no discussion regarding pre-operative treatment in comparison to the standard post-operative pain management. Furthermore, there was an uneven distribution of gender amongst the treatment groups and this may have confounded the results. Neither study considered other clinically important outcomes besides pain, including adverse effects or delayed tooth movement.

The Law et al. and Bernhardt et al. studies present additional evidence to the claim that pre-operative analgesia is effective and they further investigated the advantages in comparison to post-operative analgesia[24],[21]. The two studies scored above 11 out of 16 on the evidence checklist, they were both triple-blind randomized control trials and they used the VAS to evaluate pain. Despite these strengths, there was a major flaw in both studies due to a loss to follow-up of greater than 20%. In Bernhardt et al.'s study, only 41 subjects of the 114 subjects who agreed to participate remained for data collection[21]. However, this loss was balanced between the test and control groups and therefore the validity of the results was maintained. Unfortunately, it did result in a significantly reduced sample size and there was no mention of a NNT analysis and power calculation. Furthermore, there was an uneven distribution of males and females amongst the treatment groups which may have confounded the results.

Despite these limitations, all of the above studies have revealed the benefits of pre-operative analgesia. However, the greatest relief is obtained with a combination of pre- and post-operative medication. It is recommended that the patient take an analgesic 1 hour before treatment to supplement the traditional post-operative drug administration.

What are the other options?

Low Laser therapy

The two included studies had strong designs, however the study done by Youssef et al., was subject to a lack of randomization due to the study being a split-mouth trial[26]. Furthermore, the split

mouth design may obscure the reported pain as orthodontic pain is often generalized to the whole mouth and cannot be located to one half or the other. A difficulty that was encountered when reviewing the articles was the lack of standardization of criteria used to assess pain since both studies used a different pain scale. In recognition of the fact that it is hard to quantify pain since it is a subjective quality, it would have been an improvement to use the VAS as a reliable pain measurement[17]. The Hawthorne Effect cannot be ignored in both cases, and the reduction in pain prevalence may be a consequence of this. Since the operator was not blinded in both studies this could also be a potential confounding variable.

CONCLUSIONS

The evidence on drug therapy suggests a consistently greater reduction in pain when analgesics are taken pre-emptively. However, the evidence is insufficient to make a recommendation for the best analgesic due to sub-optimal study design and inadequate number of studies. Furthermore, previous studies have been largely limited to separator associated pain, which is reportedly far less than the pain experienced with fixed orthodontic therapy. Future research should 1) assess different drugs and dosing regimens; 2) record how many patients are needed for the sample to have sufficient power; 3) account statistically for patients who are lost to the study because they took additional analgesics; 4) independently test reliability and validity of the outcome measure; 5) assess secondary outcomes of drug therapy including tooth movement inhibition, stomach upset, cost effectiveness, increase in quality of life and decrease in days missed from work or school.

At present, the number and quality of investigations on other alternatives such as the use of masticatory bite wafers[28], anesthetic gels[29], and transcutaneous electrical nerve stimulation (TENS)[15] have been insufficient to elucidate their effectiveness. Research investigating alternative therapies should employ stronger study designs to enable any sort of discussion on their effectiveness at reducing orthodontic pain. This is particularly important in light of the possible contraindications to pharmacological therapeutics and the need for a greater

armamentarium to work with. Future recommendations include 1) implementation of blinded, randomized control trials on a number of different alternatives; 2) use of outcome measures that are independently tested for reliability and validity; 3) comparison between pharmacological therapeutics and alternative methods; 4) determination of alternative methods that may be appropriate adjuncts to pharmacological therapeutics.

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