Original Article

Pain Control During Fixed Orthodontic Appliance Therapy

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Abstract: The control of pain during orthodontic treatment is of great interest to both clinicians and patients. However, there has been limited research into the control of this pain, and there is no standard of care for controlling this discomfort. This prospective study determines the pain sequelae in fixed orthodontic treatment and evaluates comparatively the analgesic effects of nonsteroidal anti-inflammatory drugs for the control of this pain. One hundred and fifty orthodontic patients who were to have teeth bonded in at least one arch were randomly assigned to one of six groups: (1) placebo/placebo, (2) ibuprofen/ibuprofen, (3) flurbiprofen/flurbiprofen, (4) acetaminophen/acetaminophen, (5) naproxen sodium/naproxen sodium, and (6) aspirin/aspirin. The pain evaluations were made during chewing, biting, fitting the front teeth, and fitting the back teeth using a 100-mm visual analogue scale (VAS) for seven days. All the analgesics succeeded in decreasing the pain levels compared with the placebo group. However, naproxen sodium and aspirin groups showed the lowest pain values, and the acetaminophen group showed VAS results similar to those of the two analgesics. (*Angle Orthod* 2005;75:214–219.)

Key Words: Orthodontic pain; NSAID

INTRODUCTION

Dental therapy is often painful, and pain during orthodontic treatment is not much less.[1] In a study that consisted of 203 Chinese orthodontic patients, 91% of them reported pain caused by fixed orthodontic appliances and 39% reported pain during every visit.[2] It was reported that 95% of orthodontic patients experienced varying degrees of discomfort during treatment.[3,4]

Among the factors that are thought to influence the degree of pain felt by the individual are previous pain experiences,[5,6] present emotional state and stress,[6] cultural differences,[1,6] sex,[1,6] and age.[1,6] Clinicians have not reached an agreement on the role of sex differences in the degree of pain felt by the orthodontic patient.[6–9] Possible sex differences in pain response are thought to be related to culture rather than physiological factors.[1,10]

Pain during fixed orthodontic treatment increases gradually from the fourth hour to the 24th hour but returns to a normal degree on the seventh day.[4,5,8,9]

Different methods have been developed to understand the pain mechanisms and to control pain. Methods like application of low-level laser therapy to periodontal tissues,[11] transcutaneous electrical nerve stimulation,[12,13] and vibratory stimulation of the periodontal ligament[14] have been tried, and pain control to some degree has been achieved. Proffit[15] recommended biting of a plastic wafer or a chewing gum to increase the blood flow in a compressed ligament area, thereby blocking the transmission of impulses to nerve receptors.

The use of nonsteroidal anti-inflammatory drugs (NSAIDs) is the preferred method to control pain related to fixed orthodontic appliances. However, to date, no standard medication protocol has been developed on this subject. For the control of orthodontic pain, anti-inflammatory drugs like aspirin and ibuprofen have been evaluated in the literature. Ngan et al[16] reported the first studies on analgesics and evaluated the analgesic efficacy of ibuprofen and aspirin. They found that the placebo group felt more pain than both ibuprofen and aspirin patients. They also found that patients who received ibuprofen felt less pain then patients who received aspirin after separator or archwire insertion.

Recently, most of the studies in both medical and dental literature on pain control have reported on preoperative analgesics. This approach provides blockage of afferent nerve impulses before they reach the central nervous system. As a result, the treatment is preventive, not symptomatic. If NSAIDs are given before the procedure, the body absorbs the NSAID before tissue damage occurs with subsequent prostaglandin production. NSAID application before oral surgery has been reported to decrease the pain intensity and

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TABLE 1. Groups with Mean Age and Sex Distribution

	Preoperative Analgesic	Postoperative Analgesic	Preoperative Dose	Postoperative Dose	Mean Age	No. of Boys	No. of Girls
1	Placebo	Placebo	1 tablet	1 tablet	16 ± 6.1	10	10
2	Ibuprofen	Ibuprofen	600 mg	600 mg	15 ± 2.8	15	5
3	Flurbiprofen	Flurbiprofen	100 mg	100 mg	15 ± 4.5	13	7
4	Acetaminophen	Acetaminophen	500 mg	500 mg	16 ± 4.6	15	5
5	Naproxen sodium	Naproxen sodium	550 mg	550 mg	15 ± 2.9	13	7
6	Aspirin	Aspirin	300 mg	300 mg	15 ± 3.7	10	10

delay the onset and peak pain levels.[17] Preoperative ibuprofen produces a higher analgesic effect compared with postoperative prescriptions.[18] In the orthodontic literature, Law et al[19] and Bernhart et al[20] evaluated the efficacy of preoperative analgesic consumption and found that ibuprofen taken one hour before separator application lowers the pain levels from two hours after bonding until nighttime.

The object of this study is to determine the pain characteristics during orthodontic treatment, evaluate the efficacy of commonly used nonsteroidal analgesics, and determine whether preoperative administration of these analgesics decreases orthodontic pain.

MATERIALS AND METHODS

Subjects

One hundred and fifty orthodontic patients who were scheduled to receive fixed orthodontic treatment agreed to participate in this study. A detailed medical history was taken for each patient. Both the parents and the patients were informed about the procedure, and an informed consent was obtained.

The following selection criteria were required for participation: (1) no prophylactic antibiotic coverage required, (2) no systemic diseases, (3) no current use of antibiotics or analgesics, (4) no contraindication to the use of NSAID, and (5) no teeth extraction at least two weeks before bonding. Proposed treatments were either nonextraction or extraction, but patients with minor or extreme crowding and patients with open bites were excluded from the study.

Experimental conditions

Patients were randomly assigned to one of six experimental groups: group A, lactose placebo capsule; group B, 400 mg ibuprofen; group C, 100 mg flurbiprofen; group D, 500 mg acetaminophen; group F, 550 mg naproxen sodium; and group E, 300 mg aspirin. In all groups, the patients took two tablets, one an hour before the appointment and the other six hours after bonding for five groups, but four hours after bonding for flurbiprofen, according to the half-life of the preparate. All tablets were identical in color, and the patient and research assistant were both blind to each subject's experimental group. Either 0.014 or 0.016 inch archwires were used for leveling archwires. The age and sex distributions of the experimental groups are shown in Table 1.

Data collection

Subjects were given routine posttreatment instructions and asked to complete a questionnaire at appropriate intervals during the week after the bonding appointment. The questionnaire was in the format of a seven-page booklet that contained 100-mm horizontal visual analogue scales (VAS) on which the patient marked the degree of discomfort at the indicated time periods. The patients were instructed to make a check on the scale at each time interval to represent the perceived severity of pain during each of four activities: chewing, biting, fitting the back teeth, and fitting the front teeth. Incidence and severity of pain were recorded by the patient at two hours, six hours, bedtime on the day of the appointment, 24 hours after the appointment, and two days, three days, and seven days after bonding. Patients were asked to return the questionnaire at the next appointment.

Patients were instructed not to take any additional analgesics. If additional ''rescue'' medication was needed, they were instructed to indicate the date and the dosage of the medication taken. Of the 150 patients who agreed to participate in the study, 128 patients returned the completed questionnaires. Eight of the patients who returned the completed questionnaires were more than 30 years and were excluded from the study. Of the 150 patients, none had taken additional medication. The remaining 120 patients were evenly distributed among the six groups.

Statistics

All the statistical analyses were made using SPSS for Windows (Version 10.0, SPSS, Cary, NC). Descriptive statistics were calculated for pain scores at each time interval for the experimental groups. Analysis of variance (ANOVA) was used to find the differences in age among the groups.

Comparisons between the six experimental groups for four parameters were made using repeated-measures two-way ANOVA. If the results of the repeated-measures ANOVA were found significant, a one-way ANOVA with Bonferroni correction was carried out for each time interval and

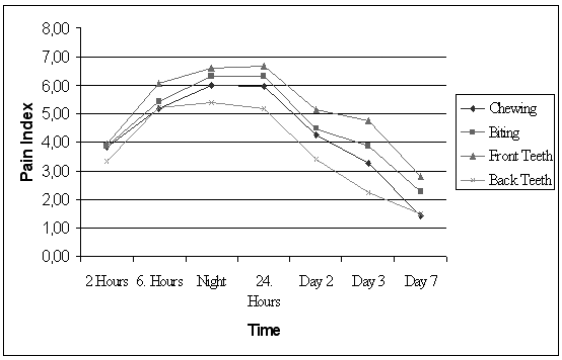

FIGURE 1. Time course of postoperative pain.

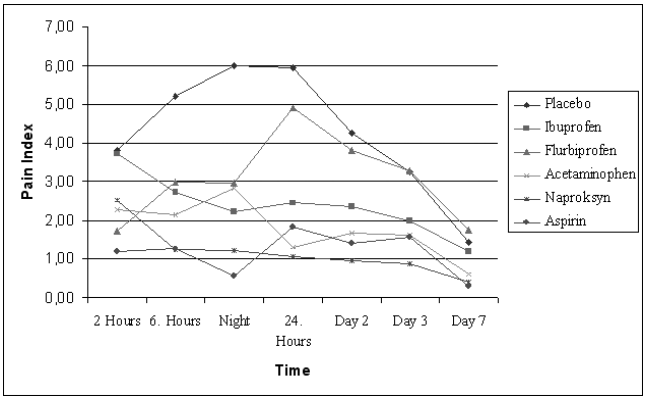

FIGURE 2. Mean pain scores for chewing by condition and time.

multiple comparisons were made with Tukey honestly significant difference test.

Time-related differences between the groups were made with one-way ANOVA with Bonferroni correction, and multiple comparisons were made with paired *t*-test. In this study, the level of significance for repeated-measures ANOVA and Tukey test was determined as $P < .05$ and for other analyses as $P < .003$ because of the Bonferroni correction.

RESULTS

The course of postoperative pain

In placebo group, peak pain occurred after bracket placement at night with respect to fitting the front teeth and at 24 hours with respect to chewing, biting, and fitting the back teeth (Figure 1). Pain levels started to decrease gradually from the peak pain to seven days after the insertion of the archwires. Mean pain index values and standard deviations are given in Table 2.

Differences in postoperative pain between experimental conditions in pain on chewing

The results of ANOVA demonstrated significant pain differences in chewing at six hours, night, 24 hours, and two days after bonding ($P < .003$) (Figure 2). Multiple comparisons showed that at six hours, patients who had taken acetaminophen, naproxen sodium, and aspirin felt less

TABLE 2. Mean Pain Index Values and Standard Deviations

		Pain Index Values						
	Groups	2 h	6 h	At Night	24 h	2 d	3 d	7 d
Chewing	Placebo	3.81 ± 3.28	5.19 ± 3.31	5.99 ± 2.89	5.94 ± 3.12	4.23 ± 2.8	3.27 ± 2.81	1.43 ± 1.81
	Ibuprofen	3.7 ± 2.75	2.73 ± 3.18	2.22 ± 2.8	2.45 ± 3.26	2.35 ± 2.78	2.00 ± 2.53	1.17 ± 1.88
	Flurbiprofen	1.71 ± 2.21	2.99 ± 2.4	2.94 ± 3.00	4.9 ± 3.47	3.81 ± 3.41	3.29 ± 3.96	1.74 ± 3.52
	Acetaminophen	2.28 ± 2.65	2.13 ± 2.94	2.82 ± 3.49	1.31 ± 2.47	1.66 ± 2.49	1.62 ± 2.26	0.61 ± 1.48
	Naproxen sodium	2.53 ± 3.2	1.23 ± 2.98	1.21 ± 2.58	1.05 ± 2.62	0.96 ± 2.27	0.87 ± 2.00	0.4 ± 0.69
	Aspirin	1.19 ± 2.09	1.26 ± 2.08	0.56 ± 1.46	1.82 ± 3.23	1.4 ± 2.21	1.57 ± 2.33	0.31 ± 0.71
Biting	Placebo	3.91 ± 3.42	6.05 ± 3.27	6.61 ± 2.92	6.66 ± 2.96	5.15 ± 3.03	4.76 ± 2.97	2.81 ± 2.21
	Ibuprofen	1.3 ± 2.07	2.37 ± 3.08	3.35 ± 3.83	2.62 ± 3.29	1.82 ± 2.99	2.16 ± 2.51	1.23 ± 1.54
	Flurbiprofen	1.93 ± 2.51	3.85 ± 3.50	3.88 ± 3.91	4.78 ± 3.69	4.43 ± 3.80	3.66 ± 3.68	2.15 ± 3.69
	Acetaminophen	1.00 ± 2.01	1.03 ± 1.51	1.52 ± 2.85	2.64 ± 3.46	2.48 ± 3.61	1.48 ± 2.16	0.52 ± 1.05
	Naproxen sodium	0.87 ± 2.04	0.92 ± 2.31	1.37 ± 2.79	0.97 ± 2.53	0.91 ± 2.4	0.92 ± 2.22	0.51 ± 1.02
	Aspirin	1.12 ± 2.58	1.86 ± 3.06	0.82 ± 2.03	0.53 ± 1.53	1.48 ± 2.58	0.83 ± 1.68	0.48 ± 0.92
Fitting front teeth	Placebo	3.91 ± 3.42	6.05 ± 3.27	6.61 ± 2.92	6.66 ± 2.96	5.15 ± 3.03	4.76 ± 2.97	2.81 ± 2.21
	Ibuprofen	1.30 ± 2.07	2.37 ± 3.08	3.35 ± 3.83	2.62 ± 3.29	1.82 ± 2.99	2.16 ± 2.51	1.23 ± 1.54
	Flurbiprofen	1.93 ± 2.51	3.85 ± 3.50	3.88 ± 3.91	4.78 ± 3.69	4.43 ± 3.80	3.66 ± 3.68	2.15 ± 3.69
	Acetaminophen	1.00 ± 2.01	1.03 ± 1.51	1.52 ± 2.85	2.64 ± 3.46	2.48 ± 3.61	1.48 ± 2.16	0.52 ± 1.05
	Naproxen sodium	0.87 ± 2.04	0.92 ± 2.31	1.37 ± 2.79	0.97 ± 2.53	0.91 ± 2.40	0.92 ± 2.22	0.51 ± 1.02
	Aspirin	1.12 ± 2.58	1.86 ± 3.06	0.82 ± 2.03	0.53 ± 1.53	1.48 ± 2.58	0.83 ± 1.68	0.48 ± 0.92
Fitting back teeth	Placebo	3.33 ± 3.01	5.20 ± 3.35	5.38 ± 3.20	5.17 ± 3.29	3.39 ± 3.03	2.22 ± 2.21	1.49 ± 2.04
	Ibuprofen	1.65 ± 2.54	3.08 ± 3.21	2.93 ± 3.37	2.22 ± 2.66	1.29 ± 2.42	1.55 ± 1.79	0.70 ± 1.12
	Flurbiprofen	1.00 ± 1.50	3.20 ± 3.26	3.27 ± 3.03	4.58 ± 3.44	3.64 ± 3.73	3.14 ± 3.79	1.61 ± 3.48
	Acetaminophen	0.42 ± 0.67	1.33 ± 2.44	1.37 ± 2.72	1.53 ± 2.31	1.91 ± 2.45	1.17 ± 2.21	0.23 ± 0.49
	Naproxen sodium	0.40 ± 1.11	0.77 ± 1.65	0.69 ± 1.43	0.63 ± 1.23	0.51 ± 1.10	0.39 ± 0.87	0.17 ± 0.33
	Aspirin	0.62 ± 1.56	1.34 ± 2.92	0.57 ± 1.52	1.49 ± 2.52	1.36 ± 2.29	0.99 ± 2.05	0.41 ± 0.91

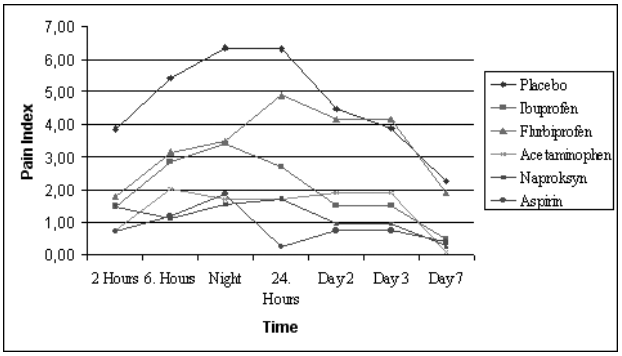

FIGURE 3. Mean pain scores for biting by condition and time.

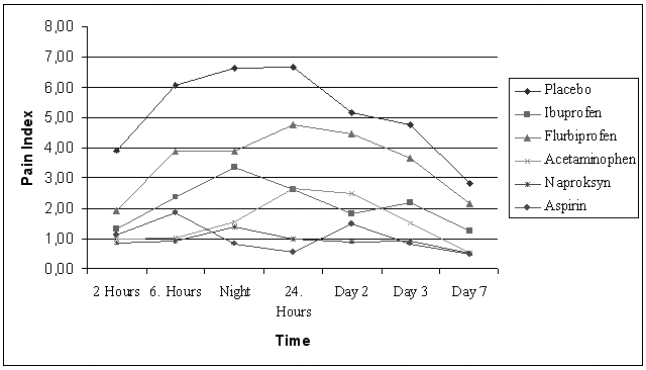

FIGURE 4. Mean pain scores for fitting the front teeth by condition and time.

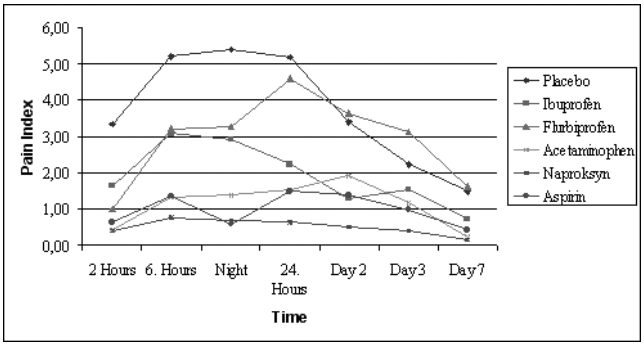

FIGURE 5. Mean pain scores for fitting the back teeth by condition and time.

''pain on chewing'' compared with patients in the control group ($P < .05$).

Mean pain scores calculated for the placebo group were significantly higher than all the analgesic groups at night ($P < .05$). At this time interval, the least pain scores were calculated for patients who took aspirin (0.56 ± 1.46), but the five medication groups did not statistically differ from each other ($P > .05$) in the level of discomfort.

At 24 hours, patients taking ibuprofen, acetaminophen, naproxen sodium, and aspirin showed decreased pain scores compared with the placebo group ($P < .05$). At day 2, significant differences with respect to chewing were present between the placebo group and the acetaminophen, naproxen sodium, and aspirin groups ($P < .05$).

Differences in postoperative pain between experimental conditions in pain on biting

The results of ANOVA showed significant differences at two hours with respect to ''pain on biting'' between the placebo group and the ibuprofen, acetaminophen, naproxen sodium, and aspirin groups ($P < .05$) (Figure 3). At six hours, acetaminophen, naproxen sodium, and aspirin groups showed lower levels of pain scores than those who had no analgesic ($P < .05$). Measurements made at night after archwire placement showed significantly less pain scores in all the treatment groups compared with the placebo group ($P < .05$). At 24 hours, the ibuprofen, acetaminophen, naproxen sodium, and aspirin groups felt less pain than the placebo group ($P < .05$). At day 2, the control group and the ibuprofen, acetaminophen, naproxen sodium, and aspirin groups showed significant differences ($P < .05$).

Differences in postoperative pain between experimental conditions in pain on fitting the front teeth

When evaluating the differences with respect to ''pain on fitting the front teeth,'' patients who had taken ibuprofen, acetaminophen, naproxen sodium, and aspirin reported less pain than the control group at two hours, six hours, night, 24 hours, and day 3 after bonding ($P < .05$) (Figure 4). At day 2 after bonding, both the placebo and flurbiprofen groups had less pain index values than the naproxen sodium and aspirin groups ($P < .05$).

Differences in postoperative pain between experimental conditions in pain on fitting the back teeth

When evaluating ''pain on fitting the back teeth'' at two hours, patients in the control group showed higher pain scores than the flurbiprofen, acetaminophen, naproxen sodium, and aspirin groups (Figure 5). At six hours, the control group demonstrated higher levels of pain than the acetaminophen, naproxen sodium, and aspirin groups ($P < .05$). At night, patients taking no analgesics after archwire placement reported higher pain scores than patients taking ibuprofen, acetaminophen, naproxen sodium, and aspirin ($P < .05$). At 24 hours, the placebo group showed higher VAS values compared with the acetaminophen, naproxen sodium, and aspirin groups ($P < .05$). At all time intervals, group 5 showed the least pain scores with respect to pain on fitting the back teeth.

DISCUSSION

The course of postoperative pain

In this study, pain increased from two hours after orthodontic bonding to a peak level at night or 24 hours after

archwire placement. The results of measurements made at night and 24 hours were similar in all the groups. This is in agreement with the results of several other studies. Law et al,[19] Bernhardt et al,[20] and Wilson et al[21] reported peak discomfort at 24 hours with a gradual decrease in pain levels until seven days after separator placement.

All the studies investigating the nature of pain during orthodontic treatment have reported that peak pain occurred with respect to pain on chewing and pain on biting. In this study, this peak pain occurred when fitting the front teeth, but the differences between the four parameters were insignificant.

Differences in postoperative pain between experimental conditions

According to Furstman and Bernik[22] pain during orthodontic treatment is a combination of pressure, ischemia, inflammation, and edema. Davidovitch and Shanfield[23] noted that the early stages of orthodontic treatment involve an inflammatory response that shows periodontal vasodilatation and tenderness to pain. The inflammatory nature of pain makes NSAIDs a good choice for orthodontic pain control.

Recent studies have reported on the control of the inflammatory response using preoperative analgesics.[19,20] If NSAIDs are given before the procedure, the body absorbs them before prostaglandin production and the inflammatory response is decreased. According to this study, at two hours after archwire insertion, the pain responses in all the analgesic groups with respect to pain on biting, pain on fitting the front teeth, and pain on fitting the back teeth were significantly lower than that in the placebo.

Evaluation of VAS scores at two hours showed that patients taking acetaminophen, naproxen sodium, and aspirin had quite low pain scores for pain on biting, pain on fitting the front teeth, and pain on fitting the back teeth. The studies that investigate the effects of preoperative analgesic administration before archwire placement in orthodontic literature have investigated only the effects of ibuprofen.[19,20] Law et al[19] found that preemptive ibuprofen significantly decreased pain on chewing at two hours compared with postoperative ibuprofen or placebo. Bernhart et al[20] also found decreased pain scores in patients taking pre- and postoperative ibuprofen compared with patients taking only postoperative ibuprofen. In addition, Jackson et al[17] and Dionne and Cooper[18] concluded that preemptive NSAIDs caused the delayed onset of pain and decreased levels of pain intensity after third-molar extractions.

For the placebo group, postoperative pain for all parameters started to increase at six hours after archwire placement. Compared with the placebo, the acetaminophen, naproxen sodium, and aspirin groups showed decreased VAS values for all the parameters. Law et al[19] and Bernhart et al[20] found no differences in pain scores at six hours.

After the adjustment of the archwires, peak pain levels were found at night, and all the analgesics were successful in decreasing the pain. Patients taking aspirin felt the least pain on fitting the front teeth at this time interval. When fitting the back teeth, naproxen sodium and aspirin provided high analgesic activity compared with the placebo group. Bernhardt et al[20] found that at night, after the adjustment, patients taking preoperative and postoperative ibuprofen had significantly lower pain values than the placebo.

Measurements made at 24 hours still showed higher pain index scores in the placebo group. In all four conditions, acetaminophen, naproxen sodium, and aspirin decreased the pain levels compared with the placebo. These results show that all the analgesics were effective and maximum pain scores were felt in the placebo group. Patients who took naproxen sodium and aspirin felt almost no pain at this interval.

At two days after bonding, naproxen sodium gave the lowest pain values on chewing. During this time interval, naproxen sodium vs aspirin groups still showed analgesic activity in all the conditions and the acetaminophen group demonstrated analgesic activity on chewing, biting, and fitting the front teeth.

When choosing an analgesic for an orthodontic patient, special attention should be given to the adverse effects of the NSAIDs. Gastric or duodenal ulceration, bleeding disorders, renal insufficiency, asthma and allergy, hypertension, congestive heart problems, and atherosclerosis[6] are the commonly seen side effects. In this study, besides classical drugs, we used analgesics like flurbiprofen and acetaminophen that have fewer side effects. An enteric-coated aspirin is preferred to reduce the gastric intolerance.

This study shows that all the analgesics provide pain relief in almost all the conditions and time intervals compared with the control group. However, because of the fact that these drugs inhibit the cyclooxygenase pathway and therefore the production of prostaglandins, it was thought that they might affect the osteoclastic activity necessary for tooth movement and slow the rate of orthodontic tooth movement.[24] The dosages of the anti-inflammatory drugs used in these studies were much higher than over-the-counter therapeutic doses. In clinical orthodontics, lower doses are used for a short duration after orthodontic activation.

Kehoe et al[25] found that ibuprofen significantly inhibited the production of prostaglandin E in the periodontal ligament and, subsequently, decreased the rate of tooth movement. On the other hand, although the acetaminophen had an inhibitory effect on peripheral prostaglandin E synthesis at the level of the periodontal ligament, the rate of tooth movement was not significantly different from that of the controls. They concluded that acetaminophen is the analgesic of choice for the relief of orthodontic discomfort. In this study, acetaminophen relieved orthodontic pain in a manner similar to other efficient analgesics and can be pre-

ferred as the analgesic of choice because of its minor adverse effects.

CONCLUSIONS

1. Orthodontic pain started two hours after bonding. Peak pain occurred between nighttime and 24 hours after archwire placement. Pain started to decrease after the second day and reached a minimum at day 7.
2. For all the parameters except pain on chewing, the pain index scores two hours after bonding were statistically lower than that of the placebo group. Preoperative administration of all the analgesics used in this study successfully eliminated orthodontic pain at two hours.
3. Naproxen sodium and aspirin relieved pain and gave minimum pain values for all the parameters and time groups. The acetaminophen group showed slightly higher values compared with these groups, but these were statistically insignificant.
4. The clinician should also consider the side effects of analgesics when making the choice of an analgesic.

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