EFFECTS OF PREOPERATIVE IBUPROFEN, ANXIETY AND GENDER ON POST SEPARATOR PLACEMENT PAIN

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

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I thank my husband, Rod, for his love and support. I would not be where I am today without his belief in me. I thank Dante and Mikey for their unconditional love over the last seven years. I thank my son, Luke, for understanding all the extra time Mommy had to spend on this project.

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Abstract of Thesis Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Master of Science

EFFECTS OF PREOPERATIVE IBUPROFEN, ANXIETY AND GENDER ON POST SEPARATOR PLACEMENT PAIN

By

Curtice Kary Marris

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Chair: Timothy Wheeler
Major Department: Orthodontics

A common experience during orthodontic treatment is that of pain. A significant number of patients experience moderate to severe pain as a result of initial orthodontic treatment. The purpose of this study was to assess the effectiveness of adding preoperative ibuprofen to an ibuprofen regimen administered after separator placement in reducing the incidence and severity of post-separator placement pain and to assess the contribution of psychological factors and gender to the pain experience. Subjects were selected from patients presenting for orthodontic treatment at the University of Florida orthodontic clinics. This is an ongoing study with a current n=21 (10 female, 11 male). Each subject was randomly assigned to one of three experimental groups: Group 1: received 400mg ibuprofen 1 hour prior to separator placement (D1), 3 hours after separator placement (D2) and 7 hours after separator placement (D3); Group 2: received placebo at D1, 400mg ibuprofen at D2 and D3; Group 3: control group received placebo at D1, D2 and D3. The investigator was blinded to the groups. Prior to separator
placement, subjects completed a State and Trait Anxiety Inventory (STAI), Positive and Negative Affect Scale (PANAS), a Masticatory Performance Index and a Visual Analog Scale (VAS) for expected pain and pain experienced with the Masticatory Performance Index. A pain diary was kept for 24 hours. A follow up Masticatory Performance Index was performed at 24 hours.

Significantly less pain was experienced at 6 hours and at bedtime when ibuprofen was administered both before and after separator placement. Pain with Masticatory Performance Index showed a significant increase on day 2. Lack of significant differences with regard to gender and psychological factors could be due to small sample size.
CHAPTER 1
INTRODUCTION

A common experience during orthodontic treatment is that of pain. A significant number of patients experience moderate to severe pain as a result of initial orthodontic treatment.1-4 Although great inter-individual variation exists in orthodontic pain,3 most patients will experience the greatest amount of pain within the first three days following initiation of orthodontic treatment.2,3 A study by Wilson et al.5 found that following the placement of separators or arch wire, pain is present within 4 hours and continues until at least 24 hours1,5 dissipating by day 7.1,5,6

Pain is one of the leading reasons for the desire to discontinue orthodontic treatment.7 Studies considering the factors associated with compliance have found pain to be negatively correlated to compliance.6,8,9 Egolf et al.8 asked an open-ended question as to the reason noncompliant patients did not wear their headgear or rubber bands. Pain was the most frequent reason cited for lack of compliance. The long-term effects of poorly managed pain in childhood and adolescence produce anxiety in subsequent pain situations, which in turn will amplify pain.10 For these reasons, control of orthodontic pain should be a primary concern for the clinician and the patient.

Pain is a multi-dimensional sensation with contributions from cultural background, past experience and psychological factors.1,3,11-13 A large inter individual variation in reaction to noxious stimuli has been noted.1-3

In a study by Firestone et al.,14 assessments were made of expectation of pain and related side effects prior to orthodontic treatment and were compared to the perception of
pain during treatment. Standardized psychometric measures for pain and anxiety were not used and, therefore, difficulties may exist in comparing data across studies. However, the visual analog scale (VAS) was used which is valid and reliable, as well as simple enough for children to respond to without adult help. Results of this study find the expectation of pain is significantly correlated to perceived pain during treatment.

Commonly, women are thought to experience pain at a greater intensity, more frequently and for a longer period of time than men. However, some recent studies on orthodontic pain have not seen this gender difference in pain. Anxiety has been found to be a major factor in incidence and intensity of post-operative pain. The expectation of greater amounts of pain is associated with greater amounts of reported pain. An investigation into the reasons patients may avoid orthodontic treatment found that in patients less than 18 years old, anxiety increases with age and is reported more often by girls than boys. In support of this finding, Brown and Moerenhout report adolescents to have lower scores of psychological well being and that they correlate with higher levels of pain. Sergl et al. have suggested that patients with an internal locus of control, where the patient attributes treatment outcome to personal efforts, have a lower pain perception.

Application of noxious stimuli initiates conduction of sensation through primary afferent sensory neurons ultimately resulting in an increased sensitivity of nociceptors at the site of application. This is called peripheral sensitization. The decreased threshold of nociceptors leads to an increase of neuronal activity into the central nervous system (CNS). This causes changes in the CNS that contribute to persistent pain. This is called central sensitization. Both peripheral sensitization and central sensitization lead to
hyperalgesia. Hyperalgesia is an increased response to a stimulus that is normally noxious.\textsuperscript{11, 17} Preemptive analgesia is an attempt to block central and peripheral sensitization, thereby decreasing postoperative hyperalgesia.\textsuperscript{12}

Studies into the effects of prostaglandin application on tooth movement\textsuperscript{21, 22} have found prostaglandins to enhance tooth movement in a nearly 2 to 1 ratio. Studies assessing the effect of NSAIDs on tooth movement\textsuperscript{23-25} have found that these drugs cause a decrease in tooth movement due to their action in blocking prostaglandin production. On the basis of these findings, it has been suggested that to avoid a decrease in tooth movement, and subsequently an increase in treatment time, NSAID medications should be avoided when controlling pain due to orthodontic treatment.\textsuperscript{23, 24} However, prostaglandins are not the only mediators of bone resorption. Leukotrienes, cytokines and growth factors may contribute to bone resorption.\textsuperscript{26} Saito et al.\textsuperscript{26} found that indomethacin slowed tooth movement but did not stop it. Studies suggest that ibuprofen has both a direct initial analgesic effect and an indirect delayed analgesic effect via prostaglandin inhibition.\textsuperscript{27, 28} Tyrovola and Spyropoulos\textsuperscript{25} suggest only avoiding the long-term administration of NSAID drugs. Short-term use of NSAIDs will only temporarily reduce the levels of prostaglandins.\textsuperscript{29}

A limited number of studies have focused on the control of pain in orthodontics. In 1984, White\textsuperscript{30} found that 63\% of patients that chewed aspergum after an arch wire change reported a decrease in discomfort. However, a placebo gum was not used and therefore the effects of chewing gum alone cannot be separated from the effects of chewing aspergum.
Ngan et al.,\textsuperscript{29} in a study comparing a pre-separator placement dose of ibuprofen with aspirin and placebo, found ibuprofen and aspirin to provide significantly less pain than placebo. Ibuprofen provided significantly less pain at 24 hours than aspirin. This study concluded that ibuprofen is the analgesic of choice to control orthodontic pain.

Law et al.\textsuperscript{31} evaluated the effect of the administration of ibuprofen before separator placement or after separator placement on reported pain over 7 days. At 2 hours, those subjects who took preoperative ibuprofen reported less pain than placebo or postoperative ibuprofen groups. A small sample size may be a reason why no other significant differences were detected. A relatively high number of placebo group subjects sought rescue medication.

Bernhardt et al.\textsuperscript{32} compared the effectiveness of preoperative ibuprofen administration to postoperative ibuprofen administration and a combination of pre and postoperative therapies. At 2 hours, both groups that received preoperative ibuprofen were found to have a significant decrease in pain severity. No significant differences were found between the pretreatment group and the combined therapy group. Again, small sample size may have contributed to the lack of significant findings.

Due to the effects of poorly managed pain and the importance of compliance to orthodontic treatment, determining a method to block or lessen pain in orthodontic patients is a worthwhile endeavor. Current standard of care in orthodontics is to decrease pain once it has occurred by means of an over the counter analgesic. Recent studies\textsuperscript{27,29,30} have indicated that administering analgesic prior to provoking pain with separator placement could be beneficial in decreasing orthodontic pain. However, due to
a lack of significant findings possibly due to small sample size, further investigation is warranted.

The purpose of this study is to assess the effectiveness of adding preoperative ibuprofen to an ibuprofen regimen administered after separator placement in reducing the incidence and severity of post-separator placement pain and to assess the contribution of psychological factors and gender to the pain experience. Specifically, the purposes are 1) to evaluate the effectiveness of anti-inflammatory medication (ibuprofen) administered prior to and after placement of spacers on evoked orthodontic pain, 2) to evaluate the effectiveness of anti-inflammatory medication (ibuprofen) administered after placement of spacers on evoked orthodontic pain, 3) to evaluate the effectiveness of placebo administration prior to and after placement of spacers on evoked orthodontic pain, 4) to examine associations between psychological factors and pain experienced after placement of spacers, 5) to examine sex differences in pain induced by placement of spacers and in ibuprofen analgesia.
CHAPTER 2
MATERIAL AND METHODS

This was a double blind, parallel arm, prospective clinical trial. Criteria for inclusion in this study were: 1) at least 13 years of age and no older than 30 years, 2) not pregnant, 3) starting orthodontic treatment for the first time, 4) require the placement of at least one separator in each of four quadrants as part of his/her orthodontic treatment, 5) no contraindications or adverse reactions to ibuprofen, 6) no contraindications or adverse reactions to nuts, and 7) give written informed consent for participation in the study.

The 21 subjects meeting the above inclusion criteria were selected from patients presenting for orthodontic treatment at the University of Florida orthodontic clinics. Each subject was randomly assigned to one of three groups stratifying for gender (Table 1).

Table 1. Sample Size, Dosing and Dosing Times

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>400mg ibuprofen</td>
<td>400mg ibuprofen</td>
<td>400mg ibuprofen</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>Placebo</td>
<td>400mg ibuprofen</td>
<td>400mg ibuprofen</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
<td>Placebo</td>
<td>Placebo</td>
<td>Placebo</td>
</tr>
</tbody>
</table>

*D1, one hour prior to separator placement; D2, three hours after separator placement; D3, seven hours after separator placement

We randomized in blocks of 10, with 3 assigned to Group A, 3 assigned to Group B, and 4 assigned to Group C. The first group of 7 subjects (5 female, 2 male) received 400mg ibuprofen at D1 (1 hour prior to separator placement) D2 (3 hours after separator placement) and D3 (7 hours after separator placement), the second group of 7 subjects (3 female, 4 male) received placebo at D1, 400mg ibuprofen at D2 and D3 and the third
group of 7 subjects (2 female, 5 male) were the control group and received a placebo at all three dosing times.

Ibuprofen tablets of 200mg were re-encapsulated and placebos were made to match. At each dosing time 400mg or two tablets were administered. In order to blind the investigator to the groups, the investigational drug pharmacy at Shands Hospital dispensed the tablets.

All subjects completed the following instruments immediately prior to time $D_1$ (time of first dosing):

1. Expectation of pain: subjects were asked to rate their expectation of pain consequent to separator placement using a 100mm Visual Analog Scale (VAS) (figure 2). Anchors of “no pain at all” (0mm) and “worst pain imaginable” (100mm) were used.  

2. Pre-existing affective state was assessed using the State and Trait Anxiety Inventory (STAI) and the Positive and Negative Affect Scale (PANAS).  

3. Mastication Performance Index: the subjects were asked to chew a bagged almond five times on the right side of the mouth without swallowing. This was repeated on the left side of the mouth. The protocol has been modified from Al-Ali, Heath and Wright, 1999. Subjects were asked to rate pain as a consequence of chewing the almond on a VAS for both right and left sides.  

4. If patient is female and is of childbearing potential (i.e., post-menarche), a pregnancy test will also be administered at this time.

Please make a check (✓) on each of the lines below so as to show how much pain you are having in the following areas.

Example

![Visual Analog Scale](image)

Figure 1. Example of Visual Analog Scale used in pain diary, test of evoked pain and anticipation of pain
Separators were placed ($T_0$) one hour after the first dosing and administration of the above tests. Ormco posterior separators were used unless the clinical situation warranted the use of metal separators. At least one separator was placed in each quadrant. The methods of placement, either over or under contact, and type of separator, were recorded for each subject. Pain on placement of separator was recorded on a VAS.

Over 24 hours, subjects recorded discomfort when biting, chewing, fitting front teeth together and fitting back teeth together in a VAS pain diary, similar to that used in other studies.\textsuperscript{1, 29, 31, 32} Subjects recorded in the pain diary at: $T_1$ (2 hours post separator placement), $T_2$ (6 hours post separator placement), $T_3$ (at bedtime), $T_4$ (upon awakening) and $T_5$ (24 hours post separator placement). At 24 hours ($T_5$), the subject self-administered the Masticatory Performance Index with VAS (Table 2). The completed pain diary and the chewed bagged almonds were returned by mail.

The Visual Analog Scale (VAS) was used in this study to assess expectation of pain, pain on placement, and evoked pain (via pain diary and known force test). The VAS has been shown to be reliable and valid.\textsuperscript{1, 15, 16, 29, 33, 37}

The State and Trait Anxiety inventory (STAI) was used to assess situational anxiety (state anxiety), and anxiety as part of personality (trait anxiety).\textsuperscript{34} The STAI has been used to assess dental anxiety reliably.\textsuperscript{38-40}

The Positive and Negative Affect Scale (PANAS) provides a brief, easy to administer measure of mood state, characterized along the separate dimensions of positive and negative affect. The PANAS has demonstrated reliability and discriminant validity.\textsuperscript{35} It is widely used in clinical and experimental pain research.
Table 2. Treatment Timeline

<table>
<thead>
<tr>
<th>T₀</th>
<th>D₁</th>
<th>T₁</th>
<th>D₂</th>
<th>T₂</th>
<th>D₃</th>
<th>T₃</th>
<th>T₄</th>
<th>T₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consent</td>
<td>Group A: 400mg Ibuprofen</td>
<td>T₀, prior to dosing; Tx, separator placement</td>
<td>Group B: 400mg Ibuprofen</td>
<td>Group C: Placebo</td>
<td>Group B: 400mg Ibuprofen</td>
<td>Group C: Placebo</td>
<td>Masticatory Performance Index and Experienced Pain Rating</td>
<td></td>
</tr>
<tr>
<td>Randomize</td>
<td>Experienced Pain Rating</td>
<td>Pain Diary</td>
<td>Pain Diary</td>
<td>Pain Diary</td>
<td>Pain Diary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected pain rating</td>
<td>Placebo</td>
<td>T₁, 2 hours after separator placement</td>
<td>T₂, 6 hours after separator placement</td>
<td>T₃, bedtime</td>
<td>T₄, awakening, T₅, 24 hours after separator placement</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>STAI, PANAS</td>
<td></td>
<td>Pain Diary</td>
<td></td>
<td>Pain Diary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masticatory Performance Index and Experienced Pain Rating</td>
<td></td>
<td></td>
<td></td>
<td>Pain Diary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

-1.25 hr -1hr Separator +2hr +3hr +6hr +7hr Bed Wake 2hr

The Masticatory Performance Index was described in the literature by Manly and Braley in 1950. Modifications to the method have been made throughout the years. The protocol used in this study has been modified from Al-Ali, Heath and Wright (1999), using microwaved and bagged almonds to reduce oil and saliva. This makes a dry sieving process possible increasing the efficiency of the analysis.

One investigator did all data collection and separator placement. A Fisher Exact test was performed for differences in sex. Analysis of Variance tests were performed for differences between groups for STAI, PANAS, chewing performance index and VAS scales for chewing performance index, expected pain, pain on separator placement, and pain diary time points. Exact Wilcoxon Rank Sum Tests were performed to identify which groups differed if p<.05. Wilcoxon Rank Sum tests were also used to assess change between expectation of pain and pain on placement, as well as, differences between day 1 and day 2 for chewing efficiency index and VAS scores for chewing efficiency index.
CHAPTER 3
RESULTS

Baseline data showed no difference between groups with regard to gender, STAI, PANAS, expected pain and pain on separator placement (Table 3).

Table 3. Baseline Characteristics. Mean (s.d.) for Groups A, B and C.

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender (% Female)</td>
<td>71.4</td>
<td>42.9</td>
<td>28.6</td>
<td>.42</td>
</tr>
<tr>
<td>age</td>
<td>15.7 (3.2)</td>
<td>14.9 (2.4)</td>
<td>16.0 (3.7)</td>
<td>.78</td>
</tr>
<tr>
<td>sanx</td>
<td>37.7 (7.0)</td>
<td>34.7 (8.8)</td>
<td>31.3 (7.8)</td>
<td>.34</td>
</tr>
<tr>
<td>tanx</td>
<td>37.3 (5.3)</td>
<td>33.6 (7.0)</td>
<td>34.0 (8.9)</td>
<td>.58</td>
</tr>
<tr>
<td>panasp</td>
<td>32.3 (5.7)</td>
<td>33.3 (6.9)</td>
<td>33.0 (9.0)</td>
<td>.97</td>
</tr>
<tr>
<td>panasn</td>
<td>15.1 (5.9)</td>
<td>16.6 (3.0)</td>
<td>14.1 (3.7)</td>
<td>.59</td>
</tr>
<tr>
<td>vasexp</td>
<td>5.1 (1.8)</td>
<td>5.3 (1.8)</td>
<td>4.6 (1.5)</td>
<td>.77</td>
</tr>
<tr>
<td>vasplace</td>
<td>3.2 (2.9)</td>
<td>4.9 (3.4)</td>
<td>4.4 (2.2)</td>
<td>.53</td>
</tr>
</tbody>
</table>

\(^{c}\)sanx, state anxiety; tanx, trait anxiety; panasp, positive affect; panasn, negative affect; vasexp, expectation of pain; vasplace, pain on placement

Three time points for the 24-hour pain diary showed significant differences (Figures 2-5). At 2 hours, fitting front teeth together and fitting back teeth together were significantly different between groups (p<.05). Group A (ibuprofen at all 3 dosing times) was significantly different (p<.05) from both group B (ibuprofen after separator placement only) and group C (placebo) for fitting front teeth together. For fitting back teeth together, group A was significantly different (p<.05) from group B but not group C.

At 6 hours, chewing on the left side, biting on the left side and fitting front teeth together were significantly different (p<.05). Group A was significantly different (p<.05) from both group B and group C for biting on the left side. For chewing on the left side and fitting front teeth together, group A was significantly different (p<.05) from group B but not group C.
Figure 2. Mean VAS scores and standard error for chewing on the a) right and b) left sides of the mouth. *p<.05
Figure 3. Mean VAS scores and standard error for biting on the a) right and b) left sides of the mouth. *p<.05
Fitting Back Teeth

Figure 4. Mean VAS scores and standard error for fitting back teeth together.

Fitting Front Teeth

Figure 5. Mean VAS scores and standard error for fitting front teeth together.
At bedtime, chewing on the right and left side, biting on the right and left side and fitting front teeth together were significantly different (p<.05). Group A was significantly different (p<.05) from both group B and group C for chewing on the left side and biting on the left side. For biting on the right side and chewing on the right side, group A was significantly different (p<.05) from group B but not group C. For fitting front teeth together, group B was significantly different (p<.05) from group A and C.

Comparing gender for baseline variables, no significant differences were found. However, a trend exists (p=.06) toward more pain on placement with males.

Masticatory Performance Index and VAS for Masticatory Performance Index showed no differences between groups for both day 1 and day 2. Change in pain rating between day 1 and day 2 for Masticatory Performance Index was significantly different (p<.0001) despite no differences between groups (Table 4). Gender was compared for difference in change in pain rating for Masticatory Performance Index but was not significant.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>s.d.</th>
<th>Median</th>
<th>p-values</th>
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<tbody>
<tr>
<td>Right</td>
<td>-6.92</td>
<td>2.59</td>
<td>-7.30</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Left</td>
<td>-6.94</td>
<td>2.81</td>
<td>-7.80</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
CHAPTER 4
DISCUSSION

This study was undertaken with the aim of assessing the effectiveness of adding preoperative ibuprofen to an ibuprofen regimen administered after separator placement in reducing the incidence and severity of post-separator placement pain and assessing the contribution of psychological factors and gender to pain. The principle findings of this study indicate that if ibuprofen is administered both before and after separator placement, less pain is experienced at 2 hours after separator placement when fitting front teeth together, 6 hours after separator placement when biting, and at bedtime when biting and chewing. Also, a significant increase in pain exists from day 1 to day 2 when performing the chewing efficiency index with no differences seen between the different dosing regimens. No contributions to pain could be determined for psychological factors and gender.

Ngan, et al.\textsuperscript{1} assessed pain after separator placement without analgesic at 4 hours, 24 hours and 7 days. Increases in pain were found for 4 hours and 24 hours. Our study found no significant difference between groups for pain at 24 hours. However, differences in pain between groups at 6 hours in our study are somewhat consistent with the increase in pain found in the Ngan et al. study at 4 hours. Also, consistent with our study, the Ngan et al. study found no differences between genders.

Law et al.\textsuperscript{31} assessed pain after separator placement using ibuprofen as an analgesic. Subjects were assigned to 1 of 3 groups: 1) ibuprofen before separator placement, 2) ibuprofen after separator placement and 3) placebo. Pain was assessed at 2
hours, 6 hours, 24 hours, as well as at 2 days, 3 days and 7 days. Significantly less pain was observed at 2 hours. Our study found a difference between groups at 2 hours after separator placement only when fitting front teeth together.

Bernhardt et al.\textsuperscript{32} also assessed pain after separator placement using ibuprofen as an analgesic. The three experimental groups were slightly different from our study: 1) ibuprofen before separator placement, 2) ibuprofen after separator placement and 3) ibuprofen both before and after separator placement. Pain was assessed at 2 hours, 6 hours, at bedtime, upon awakening, at 2 days, 3 days and 7 days. Differences were found for the time points 2 hours and bedtime. Our study similarly found differences at 2 hours and at bedtime. Lack of additional significant findings for Bernhardt et al.\textsuperscript{32} could be attributed to by small sample size, high incidence of subjects turning to rescue medication and uneven distribution of gender among groups.

Although previous studies of this type\textsuperscript{31,32} had a high incidence of subjects resorting to rescue medication, this study had no medication requests. This is perhaps due to the protocol followed in instructing the subjects and parents about rescue medications. Subjects and parents, if the subject was under 18 years old, were told to call anytime day or night if the subject was experiencing enough pain to need medication. At this time, the investigator would instruct the subject or parent on what medication could be taken and the dosage.

Geographic sampling bias may exist in this study. Subjects were chosen from patients presenting to the University of Florida graduate and faculty clinics. Patients presenting themselves to a teaching facility may have a scientific curiosity, which may not represent the true population of all orthodontic patients.
A socioeconomic bias may also exist. Subjects participating in this study were offered a reduction in their orthodontic fee of $200. Socioeconomic need may have been a significant motivator in consent to participate.

Differences may exist between those who will sign an informed consent and those who will not. A person’s refusal to participate in this study may be a reflection of the desire to avoid pain, an expectation of pain or the anticipated reaction to pain.

Previous pain experience may influence the pain response. We controlled this extraneous factor by not accepting individuals who have prior experience with orthodontic treatment. Bergius et al.\textsuperscript{45} assessed pain after separator placement by telephone interview over 7 days. Previous pain experience was found related to VAS assessments made on days 3 through 7.

The most important limitation of the current study is small sample size. The lack of differences found for gender, psychological factors, expected pain and pain on separator placement might be due to small sample size. With regard to gender, percent female is 71\% in group A, 43\% in group B and 29\% in group C. While this is not particularly well distributed, not enough power exists to say that it is statistically significant.

For five data points, fitting back teeth together at 2 hours after separator placement, chewing on the left side and fitting front teeth together at 6 hours after separator placement and chewing on the biting on the right side at bedtime, experimental groups A and B differ but neither differs from the placebo group. For one data point, fitting front teeth together at bedtime, group B experienced more pain than group A or the placebo group. Again, small sample size could contribute to these unlikely occurrences. Other
possible contributions could be from the method of placement of the separator, whether over or under the contact, and need for use of metal separator. Both the use of a metal separator and the placement of an elastic separator under the contact could generate more pain than an over the contact placement of an elastic separator.

Despite no differences between groups with regard to chewing efficiency and pain with Masticatory Performance Index, a significant increase in pain exists from day 1 to day 2. The lack of differences between groups could be because no ibuprofen was in the bloodstream at the time of the assessments. The last dose of ibuprofen was taken 7 hours after separator placement and the second Masticatory Performance Index is taken at 24 hours.

Modifications made to methods used in previous studies are among the strengths of this study. Ibuprofen administered before and after separator placement was compared to both ibuprofen administered after separator placement and placebo. This essentially is adding a preoperative dose of ibuprofen to the current standard of care, administration of ibuprofen after the noxious insult, and comparing both to placebo. Previous studies collected data over time points covering 7 days. Since significant differences were only seen over the short term in these studies, the protocol was modified to cover several time points within 24 hours. The Masticatory Performance Index was added as a measure of function relating pain to the ability to chew food. In addition, this study added psychometric measures as experimental factors.

The current study is ongoing and, therefore, the sample size will increase. At the current sample size of 21 with 7 per group, no definitive conclusions can be made, only observations. The first observation is that the use of pre-emptive analgesia is effective in
reducing pain at 6 hours after separator placement and at bedtime. The second observation is that despite the use of analgesics a significant increase in pain exists when chewing on day 2 compared to day 1.

Several directions for future research in this area are apparent. Differences in chewing efficiency at 24 hours may be seen if the ibuprofen regimen is continued through 24 hours. If a higher dosage of ibuprofen is used, greater differences may be seen between groups. Medications besides ibuprofen, such as COX-2 inhibitors or acetaminophen, may be more effective with fewer side effects. While most patients would not discontinue orthodontic treatment due to pain caused by separators, pain does influence compliance\(^6\)\(^-\)\(^9\) which is crucial to many aspects of orthodontic treatment. Therefore, continued research into orthodontic pain will hopefully yield a method to decrease pain, thereby, increasing compliance producing more favorable orthodontic outcomes.
LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Curtice Kary Marris was born in Rochester, New York, in 1967. She graduated cum laude from University of Central Florida in 1997 with a B.S. in microbiology and molecular biology. Kary attended the University of Florida for her dental education and graduated with honors in 2001 obtaining a Doctor of Dental Medicine degree. She is a Hinman Scholar and a member of Omicron Kappa Upsilon. Kary continued her dental education at the University of Florida to complete a degree of Master of Science with a certificate in orthodontics. She plans to complete her residency in May of 2004 and then enter private practice in Orlando, Florida.