THE EFFECT OF IBUPROFEN ON MASKING ENDODONTIC DIAGNOSIS

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INTRODUCTION

The importance of an accurate diagnosis is of the upmost importance before initiating endodontic treatment. Reproducing the patient's chief compliant can be challenging and requires consideration of multiple variables in order to reach an accurate diagnosis (Rowe and Pitt Ford 1990). Common endodontic diagnostic testing methods include palpation, percussion, cold, and Electric Pulp Testing (Walton and Torabinejad 2009). A methodical approach to providing endodontic treatment should include diagnosis, definitive dental treatment, and drugs, as known as the "3D" strategy. Clinicians are encouraged to prescribe analgesics preoperatively when considering the drug tactic of the "3D" strategy for treating endodontic pain (Hargreaves and Keiser 2004). There are occasions when the practitioner cannot reproduce the patient's chief complaint because the patient is no longer symptomatic at the dental examination, which can prove to be problematic for clinicians. Most clinicians will opt to defer treatment and send the patient home with instructions to return to the dental office once the symptoms have returned. One hypothesis is that medication taken preoperatively, such as ibuprofen, could "mask" or decrease or eliminate the patient's symptoms. The impact of these drugs on common endodontic testing methods is variable and not fully understood (Ryan et al. 2008).

Patients presenting with acute dental pain reported that 84% had tried some form of self-care strategy before seeking the care of a dental professional. Of the different strategies attempted, 64% of patients attempted to relieve their odontalgia, tooth pain, with over-the-counter analgesics, which was the most popular strategy. However, this

strategy only resulted in either temporary relief or reduced pain intensity for 49% of these patients (Stoller et al. 2001). Another study concluded that 81-83% of emergency patients with moderate to severe pain will have taken some type of medication(s) to help control their pain, and more women than men with irreversible pulpitis will take an analgesic. Of the patients that did take preoperative medication, they would get relief 62% to 65% of the time. More men than women with symptomatic teeth with necrotic pulps will experience pain relief (Nusstein and Beck 2003). Although no one instructed these patients to take over-the-counter analgesics, 64-83% of patients surveyed with acute dental pain decided to pursue pain relief with analgesics, such as ibuprofen (Stoller et al. 2001; Nusstein and Beck 2003). Therefore, over four-fifths of patients presenting to the dental clinic with acute dental pain will have taken analgesics before their dental visit. The remaining patients most likely will be instructed by dental clinicians to take 400-600 mg of ibuprofen to relieve their tooth pain. In fact, the majority of endodontists will prescribe 600 mg ibuprofen four times a day for patients in pain and not allergic to NSAID's, regardless of the patient's pain level, endodontic diagnosis, or treatment provided (Mickel et al. 2006). Dental clinicians should have a flexible analgesic strategy that begins with a prescription of 400-600 mg of ibuprofen. Often, this will be sufficient for mild to moderate pain of odontogenic origin. (Hargreaves and Cohen 2006; Hargreaves, Khan, et al. 2012).

To date, no study has measured the effect of a single dose of 800 mg of ibuprofen on percussion, palpation, and cold endodontic diagnosis testing. Nor has a study measured the effect of 800 mg of ibuprofen on the patient's mechanical pain thresholds (bite force measurement).

REVIEW OF THE LITERATURE

Patients presenting to emergency clinics with odontalgia, or tooth pain, often report that they know something is wrong with their tooth because it hurts to bite on it. From the history of symptoms the patient reports and the diagnostic testing that we perform in the clinic, dentists can usually diagnose the offending tooth (McCarthy et al. 2010). Some patient's clinical signs, however, do not match the patient's reported history of symptoms. This may be due to prior administration of non-steroidal anti-inflammatory drugs (NSAIDs) before their dental appointment, which may "mask" the pain caused by the offending tooth. Obviously, this makes a clinical diagnosis difficult for any practitioner and often results in rescheduling the patient's appointment until symptoms have reappeared, and the patient is instructed not to take analgesics prior to the dental appointment.

In the presence of tissue damage, a number of inflammatory mediators are released such as: histamine, prostaglandins, serotonin, bradykinins, cytokines (i.e. tumor necrosis factor-alpha, interleukins-1, -6, -8, and nerve growth factor), and neuropeptides (substance P and calcitonin gene related peptide). If the concentration of the inflammatory mediators is sufficient, nociceptors in the dental pulp are sensitized (i.e. prostaglandins) and activated (i.e. bradykinin).

Prostaglandins are the by-products of the breakdown of arachidonic acid (AA) during cell injury. Once a cell is damaged, AA is released from the cell wall membrane. Then prostaglandins are produced following the oxidation of AA by cyclooxygenases (COX). There are two isoforms: COX-1 is responsible for renal blood flow, mucosal

protection in the stomach and formation of thromboxane (responsible for platelet aggregation and clotting). COX-2 produces prostaglandins through stimulation and is present in inflamed tissues. COX-2 has been found in inflamed dental pulp and contributes the formation of prostaglandins (Nakanishi et al. 2001). Dray found that prostaglandins can increase the painful properties of other mediators such as serotonin and bradykinin, and they can sensitize peripheral nociceptors (Dray 1995). Also, prostaglandins can increase the number and responsiveness of tetrodotoxin-resistant sodium channels (TTX-resistant Na+) in nociceptive neurons (Arbuckle and Docherty 1995; Gold et al. 1996). TTX-resistant Na+ channels are four times more resistant to lidocaine (Roy and Narahashi 1992); therefore, achieving anesthesia can be difficult during existing pulpal inflammation. There are several types of prostaglandins such as: PGE_2, PGD_2, PGI_2, and thromboxane. Their functions include inducing fever, promoting chemotaxis, increasing vascular permeability, and sensitizing nociceptive fibers to histamine and bradykinin (S. A. Cooper 1990).

Sensitization is exemplified as a decrease in threshold (contributing to allodynia), an increase in the response to threshold stimuli (contributing to hyperalgesia), and spontaneous activity (contributing to spontaneous pain) (Ingle, Bakland, and Baumgartner 2008). Allodynia is defined as a reduction in pain threshold. As a result, previous non-noxious stimuli now elicit a painful response. Hyperalgesia is defined as an increase or exaggerated responsiveness to normally noxious stimuli (Hargreaves, Goodis, et al. 2012). In addition, nociceptive fibers may begin to fire spontaneously. Afferent fiber sprouting, increases in the tissue pressure and temperature, and afferent proteins and

plasticity have been shown to be involved in sensitization (Byers et al. 1990; Narhi, Hirvonen, and Huopaniemi 1984; Meyer and Campbell 1981).

Peripheral sensitization alters the activity and increases the overall excitability of peripheral neurons in the presence of inflammatory mediators. Such mediators, like serotonin, increase the permeability and excitability by directly acting on membrane ion channels (Peters and Lambert 1989). Others, such as bradykinin, activate certain G-protein-coupled receptors which can lead to activation of intracellular signaling pathways also increasing the excitability of the neurons (Burgess et al. 1989). The increase of excitability of peripheral neurons can directly increase the sensitivity to pain locally at the site of tissue damage (Woolf and Thompson 1991).

Neuronal changes that occur in the peripheral nociceptors during inflammation, also can cause changes in central neurons leading to expansion of the receptive field, an increase in spontaneous firing (contributing to spontaneous pain), an increase responsiveness to noxious stimuli (contributing to hyperalgesia), and lower thresholds for nociceptor activation (contributing to allodynia). Excitation of central neurons is initiated by peripheral input from inflammatory mediators. However, after central sensitization is established, this process becomes less dependent upon peripheral input for its maintenance (Ingle et al. 2008). Central sensitization is a form of neuroplasticity where nociceptor activity triggers a prolonged increase in excitability of dorsal horn neurons (Merrill 2007). Central sensitization is the major mechanism of hyperalgesia and allodynia (Woolf 1996). Therefore, prolonged pulpal and apical tissue damage can result in the central release of inflammatory mediators such as glutamate and substance P, leading to activation of central receptors for glutamate (NMDA receptors, AMPA

receptors, kainite receptors and mGluR)and for substance P (NK1; Hargreaves and Goodis 2002). Under these conditions, medications aimed at inhibiting peripheral inflammation may no longer be as beneficial.

Ibuprofen is a non-steroidal anti-inflammatory drug that inhibits the enzyme cyclooxygenase (COX) which prevents the conversion of AA to prostaglandins (Vane 1971). The anti-inflammatory, anti-pyretic, and analgesic capabilities are attributed to inhibition of COX-2. The inhibition of COX-1 is responsible for the unwanted effects on the gastrointestinal tract and platelet aggregation. Its half-life is approximately 2 hours and its metabolites are excreted through the urine. The maximum dose of ibuprofen is 3.2 g in 24 hours (Gage and Pickett 2005). Ibuprofen is recommended for the management of both preoperative and postoperative pain in dentistry, where inflammation is often the cause of pain. Unlike opioids, they do not impair consciousness and NSAIDs are available over the counter, which makes them more accessible and less costly than prescription alternatives. A recent Cochrane systematic review found good evidence to support ibuprofen as an effective and safe analgesic in adults, with minimal adverse effects (Jeske and Zahrowski 2010). Single does of ibuprofen 200 to 400 milligrams provide relief of acute moderate to severe postoperative pain for approximately five hours in 50% of adults. The FDA approved it for sale without prescription in 1984 at low dosage (200 mg every 4-6 hours). Yet, larger dosages are available with prescription (400-800 mg every 4-6 hours). The 2007 Oxford league table of analgesic efficacy states that 600 mg to 800 mg of ibuprofen is very effective in management of acute pain. Analgesic efficacy is expressed as the numbers needed to treat (NNT), which is the number of patients who need to receive the active

drug for one to achieve at least 50% relief of pain compared with placebo over a 4-6 hour treatment period. Eighty-six percent of patients received at least 50% pain relief with 600 mg-800 mg of ibuprofen, which gives this dosage of ibuprofen a NNT of 1.7. The lowest (best) NNT on Oxford league table of analgesic efficacy is 1.5. In fact, 400 mg of ibuprofen is more effective analgesic than 1000 mg acetaminophen for patients with acute pain (Cooper et al. 1989). There is information on over 5,400 patients proving that ibuprofen 400 mg is an effective analgesic in postoperative pain (Collins et al. 1998; Derry, Wiffen, and Moore 2011). According to the league table, 800 mg of ibuprofen is at the top of the league, with the lowest (best) NNT of 1.6 and with 100% of patients achieving at least 50% pain relief. However, only 76 patients were involved in comparative trials with placebo.

In 2011, Moore and colleagues reported that combinations of ibuprofen (200 or 400 mg) plus acetaminophen (500 or 1000 mg) produced NNTs of 1.5 and 1.6, which is the lowest (best) NNTs observed in the dental pain model (Moore et al. 2011). Menhinick discovered the combination of ibuprofen with acetaminophen is more effective than ibuprofen alone (76% vs. 96%) for the management of postoperative endodontic pain (Menhinick et al. 2004). A recent study determined that concurrent administration of ibuprofen and acetaminophen provides significantly better analgesic efficacy than comparable doses of either ibuprofen or acetaminophen alone in the management of acute postoperative dental pain (3 to 4 impacted third molar extraction model). This study was continued for 72 hours and concluded that three doses of ibuprofen 200 mg/acetaminophen 500 mg and ibuprofen 400 mg/acetaminophen 1000 mg were significantly more effective in providing pain relief in moderate to severe acute

dental pain for 72 hours than comparable doses of ibuprofen or acetaminophen alone (Mehlisch, Aspley, Daniels, Southerden, et al. 2010; Mehlisch, Aspley, Daniels, and Bandy 2010). Although recent studies demonstrate the superior analgesic efficacy of the combination of ibuprofen and acetaminophen, many clinicians are not aware of these studies. As a result, ibuprofen alone continues to be the most popular analgesic prescribed for dental pain (Mickel et al. 2006). For that reason, we have chosen to test the masking ability of ibuprofen on endodontic diagnostic testing and bite force measurements, and not a combination of ibuprofen and acetaminophen.

As stated above, the impact of these drugs on common endodontic testing methods is variable and not fully understood. Few studies have measured the effect of analgesics on endodontic diagnostic testing, such as cold, percussion, palpation, and EPT (Ingle et al. 2008). As early as 1963, Mumford suggested dental EPT as a means of comparing pain relieving drugs (Mumford 1965). He also noted that painful pulpal inflammation alters mechanical and thermal pain thresholds; yet, EPT thresholds were not different during pulpal inflammation (Mumford 1967).

In 1979, Gracely conducted a study in which subjects rated the magnitude of painful electrical stimulation of their teeth before and after intravenous administration of either fentanyl, a short-acting narcotic, or placebo. The subjects picked from a randomized list of either sensory intensity (weak, mild, intense) or unpleasantness (annoying, unpleasant, distressing) descriptors. The researchers found that fentanyl, a narcotic, had been shown to reduce the pain intensity of EPT but not the unpleasantness of the stimuli itself (Gracely, Dubner, and McGrath 1979).

Nineteen years later, Carnes investigated the effects of 220 mg of naproxen sodium, 100 mg of meperidine, 1000 mg of acetaminophen, or placebo on pain thresholds using electric pulp tester. Their results confirmed that the electric pulp test (EPT) pain thresholds were not altered by the narcotic meperidine or naproxen sodium. Yet, acetaminophen significantly elevated the pain threshold on patients with moderate to severe dental pain. Admittedly, the authors noted that acetaminophen was statistically significant, but this difference was probably not clinically meaningful. Therefore, they observed no elevation in pain thresholds with narcotic drugs or NSAIDs and stated electric pulp tests of symptomatic patients who have taken these drugs preoperatively will have similar results to those patients who have not taken any drugs (Carnes et al. 1998).

In 2002, Kardelis administered 10 mg of hydrocodone/1000 mg of acetaminophen or placebo (double-blinded) to healthy Caucasian women with no pulpal or periapical inflammation. Electric pulp tester and cold tests were applied to healthy non-diseased teeth and mucosa at 2, 4, and 8 hours after the administration of the drug or placebo. The outcome of all the tests (cold and EPT) resulted in no statistically significant difference between the drug and placebo groups at any time point. Therefore, it was concluded that hydrocodone/acetaminophen has little impact on healthy pulp or mucosa in women (Kardelis et al. 2002). This study strengthens the validity of vital pulp responses to electrical and cold tests in patients taking pain relievers such as narcotics. However, this study does not address how these tests might be affected with regards to dental pulps with some degree of inflammation, after extended multiple doses of a drug, individuals or other ethnic groups, or in males.

An accurate diagnosis is the first and arguably the most important part of managing endodontic tooth pain (Khan et al. 2007a). Nonetheless, the diagnosis of pulpal and apical conditions can be very complicated and inaccurate. Mostly, practitioners use a mirror handle to record sensitivity to percussion, or they have the patients bite on a device such as a Tooth Slooth (Professional Results, Inc., Laguna Niguel, CA) (Walton and Torabinejad 2009). Unfortunately, these tests do not provide quantitative data and can yield variable results. Moreover, these tests can be subjective and produce a large margin for error (Khan et al. 2007a). Previous studies have shown a reduction in mechanical pain thresholds is termed (mechanical allodynia) which is manifested as sensitivity to percussion, biting, or pressure (Owatz et al. 2007).

Recently, Kahn et al. developed a diagnostic instrument for the measurement of mechanical allodynia and tested the reliability of this new bite force transducer to measure mechanical pain thresholds on normal healthy patients (Khan et al. 2007a). The results of this study indicate that the bite force transducer has substantial test-retest reliability and fair to substantial inter-rater reliability. For that reason, the bite force transducer has potential use for repeated clinical measurements where subjects are followed overtime. On the other hand, the fair to substantial inter-rater reliability suggests that clinical trial designs should include only one examiner to collect the mechanical threshold values.

After determining that the bite force transducer provided a reliable method for measuring mechanical pain thresholds in normal patients, the device was used to measure the mechanical pain thresholds and the effect of local anesthetic in patients with symptomatic irreversible pulpitis and symptomatic apical periodontitis (Khan et al.

2007b). This was an important study because it provided quantitative data on mechanical pain thresholds for the first time. Previous studies used to measure mechanical allodynia were underpowered due to the lack of a quantitative data and reproducible methods of measuring mechanical allodynia (Khan et al. 2007b). Khan et al. found that the mechanical pain thresholds of a given pair of contralateral teeth with normal apical tissues are similar pre and post administration of local anesthesia. This "contralateral allodynia" suggests the hypothesis of central sensitization in acute periradicular periodontitis as contralateral teeth exhibited mechanical allodynia without any evidence of tissue inflammation. They also found that local anesthesia reversed the mechanical allodynia of symptomatic teeth by 62%, with significant sex-specific effects (Khan et al. 2007a).

The purpose of this randomized double-blinded clinical trail is two fold: 1.) to quantitatively measure the effect of ibuprofen on mechanical allodynia on patients with odontalgia caused by symptomatic apical periodontitis (AAE Consensus Conference Recommended Diagnostic Terminology 2009), 2.) to measure the effect of ibuprofen on endodontic diagnostic tests such as cold, percussion, and palpation.

HYPOTHESIS AND SPECIFIC AIMS

Hypothesis:

H_o=In patients presenting with endodontic pain, there is no difference in maximum mechanical pain thresholds and endodontic diagnostic testing after the administration of 800 mg of ibuprofen.

H_1=In patients presenting with endodontic pain, there is a difference in maximum mechanical pain thresholds and endodontic diagnostic testing after the administration of 800 mg of ibuprofen.

Specific Aims:

The objectives of this study are two fold:

1. Quantitatively measure the impact of ibuprofen administered to patients with endodontic pain on bite force using a bite force transducer. We will measure the mechanical pain threshold (biting force) in patients with symptomatic apical periodontitis before and one hour after giving 800 mg of ibuprofen.
2. Measure the impact of ibuprofen on endodontic diagnostic tests. This data then can be used to either reject or accept our null hypothesis stated above. Our results will add to the body of knowledge that has previously been accumulated on mechanical allodynia (Khan et al. 2007a,b).

This valuable data can be applied clinically to assist in accurate and precise diagnoses and improve on our traditional methods of testing mechanical allodynia in

cases where diagnosis in uncertain. Clinically, patients are constantly presenting with symptoms odontalgia, which require non-surgical root canal therapy. The problem is that symptoms reported by patients sometimes do not match clinical observations after our endodontic diagnostic testing, and sometimes no conclusive diagnosis can be made if patients have taken NSAIDs, such as ibuprofen, prior to their dental appointment for relief of their symptoms. It is commonly believed that NSAIDs can "mask" or eliminate the patient's symptoms temporarily (Ryan et al. 2008). This makes it difficult to accurately diagnose the offending tooth, since the key to diagnosing endodontic pain is reproducing the patient's symptoms and presenting chief complaint. Obviously, if data from this study can be correlated clinically, then more accurate diagnoses could be made. These results can also be used to test the validity of the results and research design used by Khan 2007.

MATERIALS AND METHODS

The Institutional Review Board at the University of Minnesota approved the protocol for this study. Patients presenting to the University of Minnesota School of Dentistry seeking treatment for the relief of pain of odontogenic origin were screened for possible inclusion into this study.

Inclusion Criteria

- Premolar or molar with a clinical diagnosis of symptomatic apical periodontitis as defined by the 2009 AAE Guidelines of Diagnostic Terminology (Anon. 2009)

Exclusion Criteria

- American Society of Anesthesiologist's classification of physical status of 4 or 5
- Periodontal pocketing greater than 6 mm
- Absence of contralateral tooth
- Sensitivity to percussion in the contralateral tooth
- Persistent use of medication such as steroids and antidepressants for greater than 7 days (which could alter the pain report)
- Subjects that had taken NSAIDs in the previous 12 hours
- Allergy to NSAIDs

Research Design

Patients included in the study provided informed consent and information about all medications taken in the previous 24 hours which was recorded. Then patients were asked to rate their present odontogenic pain and maximum pain using a verbal numeric rating scale (VNRS). Buccal and lingual gingiva were palpated with finger pressure on both contralateral and affected teeth to assess for the presence of sensitivity to palpation and the results were recorded. Both the contralateral tooth and the affected tooth were percussed with a mirror handle for the presence of sensitivity to percussion and results were recorded. Then the contralateral and affected teeth were tested using 1, 1, 1, 2-Tetrafluoroethane, also known as Green Endo Ice (Hygenic Corp, Akron, OH) and the subject's response was recorded. A large cotton pellet was sprayed for 3-5 seconds similar to that described by Jones (Jones 1999). The contralateral un-inflamed tooth, the affected tooth, and the patient's contralateral and affected adjacent two teeth were percussed, palpated, cold tested, and examined for mobility and the results were all recorded.

The contralateral, unaffected tooth's bite force or mechanical pain thresholds and the affected tooth's mechanical pain thresholds were measured using the bite force transducer (Occlusal Force-Meter, GM10; Nagaro Keiki, Tokyo, Japan). The bite force transducer was modified, similar to Khan's study, by attaching the head of a Tooth Slooth (Professional Results, Inc., Laguna Niguel, CA) to the end of the biting tab using acrylic resin as seen in Figures 1A and 1B (Khan et al. 2007a).

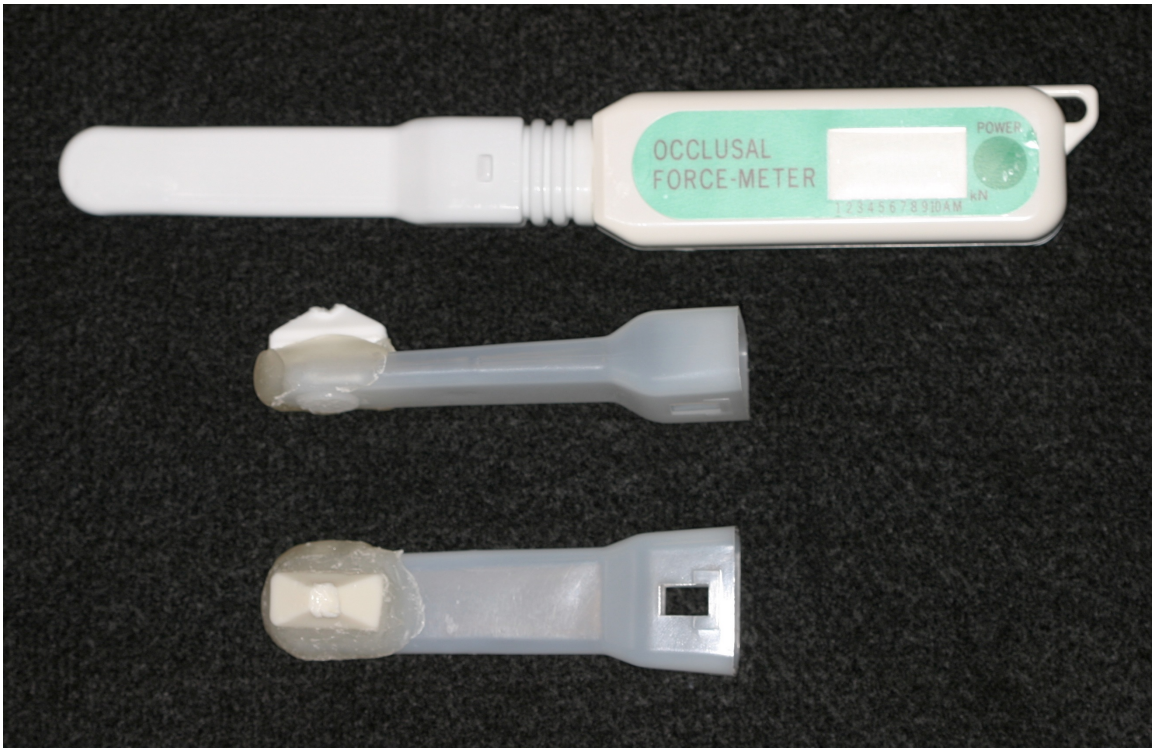


Figure 1A. Picture of the Bite Force Transducer. Modified by attaching the head of a Tooth Slooth to the detachable plastic sleeve.

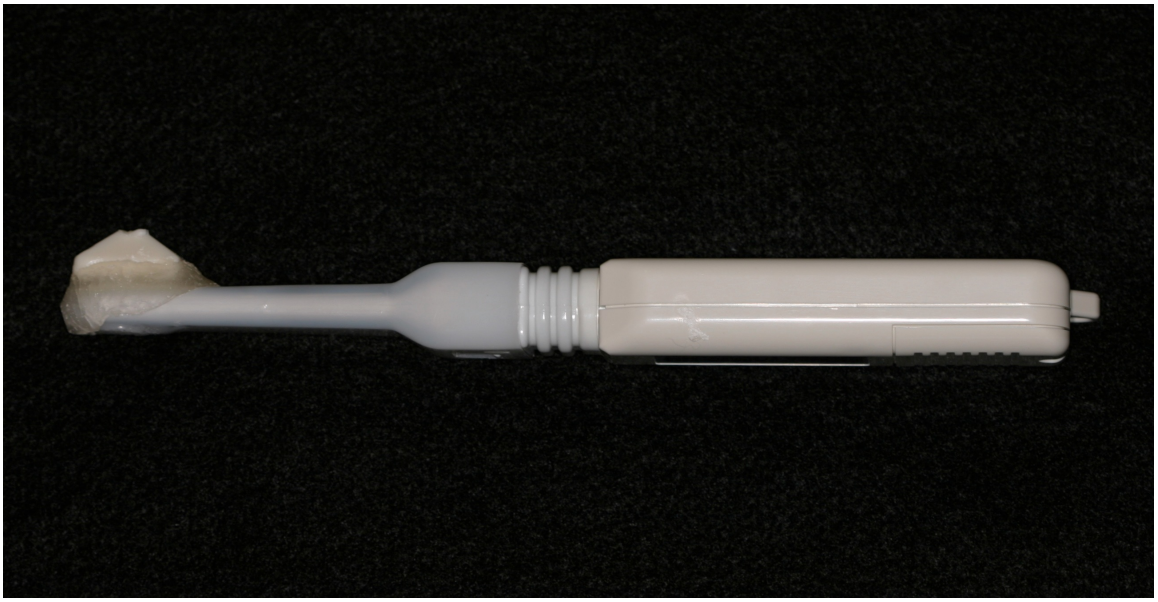


Figure 1B. Lateral View of the Bite Force Transducer.

The patient was given the following instructions: "**This device measures how hard you can bite down. It is similar to a scale. If you jump or move on a scale, then you will not receive a consistent reading. The same is true for this device. This device requires constant pressure to produce an accurate measurement. Therefore, I would like you to gently close until your upper and lower teeth first contact the device. When I say 'begin', bite down as hard as you can with constant pressure until you hear a beep. Once you hear a beep, the device has produced a measurement. The beep usually takes three to five seconds. I will do this five times on the side that does not hurt and only two times on the side that hurts**." The bite force transducer was placed on the subject's contralateral control tooth and the subject was instructed to bite down on the bite force transducer with instructions stated above. This procedure was repeated four more times for a total of five mechanical pain threshold measurements recorded for the contralateral tooth. In addition, the examiner obtained two more readings and recorded the mechanical pain thresholds in Newtons of the inflamed, affected tooth using this same procedure as described above. The method in this study is similar to previous studies for measuring mechanical allodynia; therefore, our testing methods are consistent with methods of those previous studies (Khan et al. 2007a,b). After these measurements were gathered, the examiner administered 800 mg of ibuprofen or placebo to the patient (double blinded). After one hour, endodontic diagnostic testing (cold, percussion, and palpation) and mechanical pain threshold measurements for the affected tooth (two mechanical pain threshold measurements) and contralateral control tooth (five mechanical threshold measurements) were repeated as

described above. All of the above information was recorded on a Clinical Data Sheet (Appendix X) for each individual participant.

Statistical Analysis

All collected demographic, pre and postoperative clinical data, diagnosis, and comments from each participant's Clinical Data Sheet (Appendix 4) were transferred to a spreadsheet (Appendix 7) that appeared similar to Clinical Data. Then this data and the assignment of which test group was uncovered (ibuprofen or placebo) and tabulated to summarize the averages of pre- and post-bite force measurements and transferred to another spreadsheet that was submitted for statistical analysis (Appendix 6).

Descriptive statistics were used to summarize the demographics, patient characteristics, and outcome measures. Two group t-tests were used to compare the mean change in the outcomes from pre-treatment to post-treatment between the groups. P-values less than 0.05 were considered statistically significant. SAS V9.1.3 (SAS Institute Inc, Cary, NC) was used for the analysis. Pearson's and Spearman's rho correlation were calculated to determine the comparison of mechanical pain thresholds (bite force) to percussion and palpation, and to compare association of palpation to percussion preoperatively. To evaluate the effect of ibuprofen on mechanical allodynia, delta values were calculated by taking the difference between mechanical pain thresholds for the affected tooth minus mechanical pain thresholds for the contralateral tooth.

Spearman's correlation coefficient was used to determine the association between the pain VNRS and mechanical allodynia. In addition, a Wilcoxon signed-rank test will be utilized to compare the before and after measurements of cold tests (response or no

response), palpation (sensitive or not sensitive) and percussion (sensitive or not sensitive) that have been assigned ordinal values.

RESULTS

Forty-two subjects were enrolled to this double-blinded randomized clinical trial. However, three subjects were unable to complete this study. One subject had an upper complete denture and was unable to bite down on the bite force transducer without dislodging his upper denture. The other two subjects could not bite down hard enough on the bite force transducer to produce a measurement. Therefore, they were excluded from the study, and thirty-nine subjects completed the study and were included for analysis.

Of the thirty-nine subjects, there were 21 females and 18 males. Unfortunately, there was statistically significant gender imbalance between the two treatment groups even though this study was a double-blinded randomized clinical trial. Nineteen subjects received ibuprofen, and 20 subjects received placebo. Of the 19 subjects in the ibuprofen treatment group, 14 (74%) were male. Of the 20 subjects in the placebo treatment group, 16 (80%) were female.

The age of the participants ranged from 19-77 years old, with a mean age of 48. Twenty-eight subjects were white, six were African Americans, two were Asian, two were Hispanic, and one was Middle Eastern. The top three most prevalent pre-treatment diagnoses of affected teeth were Symptomatic Irreversible pulpitis/Symptomatic Apical {Periodontitis (SIRP/SAP) (44%), Necrotic/SAP (23%), and Previously Treated/SAP (18%) (AAE Consensus Conference Recommended Diagnostic Terminology 2009). When comparing vital pulp (Reversible pulpitis, Asymptomatic Irreversible Pulpitis,

Symptomatic Irreversible Pulpitis) versus non-vital pulp (Necrotic, Previously Initiated, Previously Treated) diagnoses, 51.3% of affected teeth contained vital pulps and 48.7% contained non-vital pulps. The subjects mean current Verbal Numerical Rating Scale (VNRS) was 1.36. The subjects mean maximum VNRS was 6.72. Demographic data can be found in Table 1.

Table 1. Demographics by Treatment Group

	Ibuprofen n=19	**Placebo n=20**	**Total n=39**
Age, mean(sd)	45.47 (15.63)	50.35 (19.56)	47.97 (17.69)
range	24-72	19-77	19-77
Sex†, n (%)			
Female	5 (26)	16 (80)	21 (54)
Male	14 (74)	4 (20)	18 (46)
Ethnicity, n (%)			
AA	2 (11)	4 (20)	6 (15)
Asian	2 (11)	0	2 (5)
White	14 (74)	14 (70)	28 (72)
Hispanic	1 (5)	1 (5)	2 (5)
Middle Eastern	0	1 (5)	1 (3)
Diagnosis, n (%)			
AIRP/SAP	1 (5)	0	1 (3)
Nec/AAA	0	1 (5)	1 (3)
Nec/CAA	0	1 (5)	1 (3)
Nec/SAP	5 (26)	4 (20)	9 (23)
PI/SAP	1 (5)	0	1 (3)
PT/SAP	4 (21)	3 (15)	7 (18)
RP/SAP	0	2 (10)	2 (5)
SIRP/SAP	8 (42)	9 (45)	17 (44)
Current VNRS, mean(sd)	1.58 (1.74)	1.15 (1.81)	1.36 (1.77)
Max VNRS, mean(sd)	6.37 (2.11)	7.05 (3.17)	6.72 (2.69)

† p=0.0012 (Fisher's exact test comparing treatment groups). There was a statistically significant gender imbalance between the groups.

In Table 2, the responses and percentage of each categorical response for percussion, palpation, and cold test (endodontic diagnostic testing) was recorded for pretreatment and post treatment group. Notably, of the 19 subjects in the ibuprofen treatment group, 5 of the subjects that were sensitive to percussion (S+) preoperatively changed to non-sensitive (NS) to percussion 1 hour after the administration of ibuprofen (27% decrease in S+ subjects from pre to post treatment). In addition, one female subject from the placebo group that was sensitive to percussion preoperatively changed to NS after the administration of the placebo.

In the ibuprofen treatment group, 1 subject changed from moderately sensitive (S++) to slightly sensitive (S+), 3 subjects changed from slightly sensitive to non-sensitive (NS), and one subject changed from NS to S+. This was a net decrease in sensitivity to percussion by 11%. Two subjects in the placebo group that were S+ to percussion preoperatively changes to NS postoperatively for a net 10% decrease in sensitivity to percussion. Wilcoxon signed-rank test was used to measure the difference in pretreatment and post treatment for both ibuprofen and placebo. There was no statistically significant difference for palpation or percussion, with $p = 0.07$ and $p = 0.66$, respectively (Table 3).

In the ibuprofen treatment group, 2 subjects changed from sensitive, lingering (S+L+) cold response to responsive non-lingering (RNL). Moreover, 1 subject changed from RNL to no response (NR) to cold tests. In the placebo treatment group, 2 subjects changed from sensitive, non-lingering (S+NL) to S+L+, and 1 participant changed from RNL to NR. This data can be found in Table 2.

Table 2. Summary of Palp, Perc and Cold tests by Treatment Group

	Ibuprofen n=19		Placebo n=20		Total n=39	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Palp, n (%)						
NS=0	5 (26)	10 (53)	12 (60)	13 (65)	17 (44)	23 (59)
S+=1	14 (74)	9 (47)	8 (40)	7 (35)	22 (56)	16 (41)
Perc, n (%)						
NS=0	1 (5)	3 (16)	0	2 (10)	1 (3)	5 (13)
S+=1	16 (84)	15 (79)	18 (90)	16 (80)	34 (87)	31 (79)
S++=2	2 (11)	1 (5)	2 (10)	2 (10)	4 (10)	3 (8)
Cold, n (%)						
NR	8 (42)	9 (47)	8 (40)	9 (45)	16 (41)	18 (46)
RNL	3 (16)	4 (21)	1 (5)	0	4 (10)	4 (10)
S+NL	0	0	2 (10)	0	2 (5)	0
S+L+	8 (42)	6 (32)	8 (40)	10 (50)	16 (41)	16 (41)
S++L++	0	0	1 (5)	1 (5)	1 (3)	1 (3)

We compared the actual pretreatment mechanical pain thresholds from the contralateral healthy tooth to the affected inflamed tooth for both treatment groups (Figure 1). As expected, the mechanical pain thresholds for the contralateral teeth were consistently higher than the affected inflamed teeth with an average of 71.04 Newtons (N). As demonstrated in Table 3, the post treatment mechanical pain thresholds were higher than the 1-hour prior pretreatment measurements. The mechanical pain thresholds for the control (contralateral) teeth increased an average of 24 N for the ibuprofen group and 25 N for the placebo group. Also, the mechanical pain thresholds increased an average of 20 N for the ibuprofen group and 33 N for the placebo group on the affected teeth. Paired t-test revealed no statistically significant difference for change in mechanical thresholds on the contralateral or affected teeth ($p = 0.94$ contralateral, $p =$

0.61 affected). As the biting force remains relatively constant compared to the control teeth values (both treatment group and control increased post treatment), the overall biting force on the affected teeth remained much lower compared to the control teeth, both pre and post treatment (Figure 2).

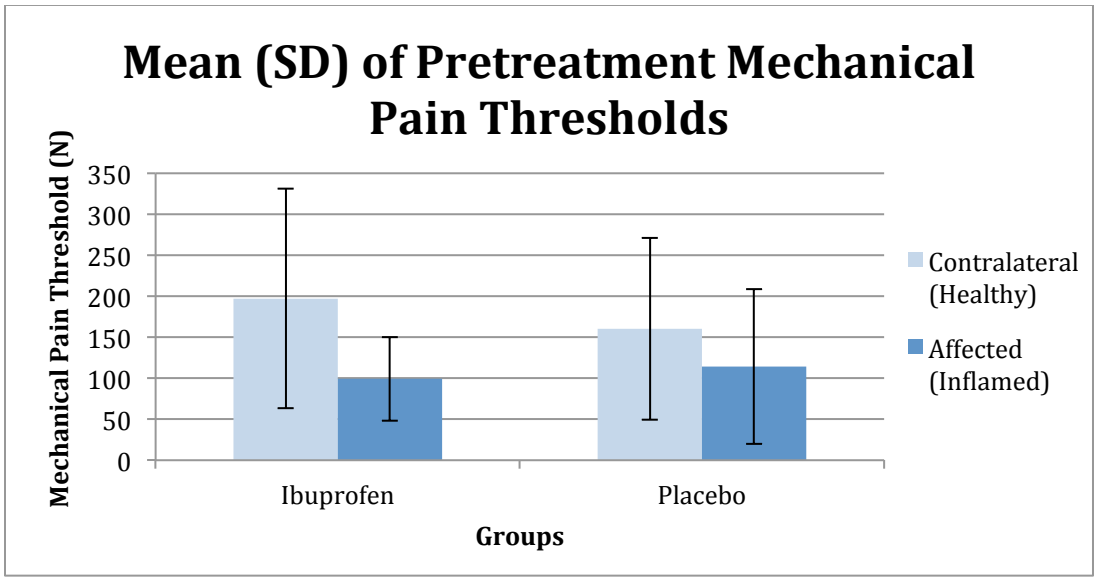


Figure 2. Mean Pretreatment Mechanical Pain Thresholds

In order to measure the effect that ibuprofen or the placebo had on mechanical allodynia, we must first calculate the delta values. Delta value is defined as the difference between mechanical pain thresholds (bite force) for the affected tooth minus pain thresholds for the contralateral tooth. Since a reduction in mechanical pain thresholds is termed mechanical allodynia, we need to determine a baseline of normal healthy mechanical pain thresholds or bite force measurements (Owatz et al. 2007). The contralateral un-inflamed tooth should serve as the baseline. Then subtract the inflamed, affected tooth's mechanical pain thresholds from the baseline mechanical pain thresholds

(contralateral tooth) to determine the reduction, if any, in mechanical pain threshold also known as mechanical allodynia. Referring to Table 3 and Figure 2, the delta values or bite force change actually increased slightly (4.21 N) from -97.77 N preoperatively to -101.97 post operatively for the ibuprofen treatment group. Furthermore, the bite force decreased 8.15 N in the placebo group. The change in bite force (delta value) was not statistically significant (p = 0.68).

Table 3. Outcomes by Treatment Group

	Ibuprofen n=19	**Placebo n=20**	**Total n=39**
CL Bite Force, mean(sd)			
Pre	197.19 (133.94)	160.08 (110.97)	178.16 (122.51)
Post	221.11 (147.26)	185.08 (110.00)	202.63 (129.06)
Change†	23.92 (48.01)	25.01 (35.54)	24.47 (41.51)
AF Bite Force, mean(sd)			
Pre	99.42 (51.16)	114.43 (94.47)	107.12 (75.89)
Post	119.13 (73.16)	147.58 (147.65)	133.72 (116.80)
Change†	19.71 (45.66)	33.15 (106.32)	26.60 (81.77)
Delta Value, mean(sd)			
Pre	-97.77 (123.24)	-45.65 (51.16)	-71.04 (98.99)
Post	-101.97 (114.08)	-37.51 (73.16)	-68.91 (116.51)
Change†	-4.21 (71.20)	8.15 (109.21)	2.13 (91.67)
Palp, mean(sd)			
Pre	0.74 (0.45)	0.40 (0.50)	0.56 (0.50)
Post	0.47 (0.51)	0.35 (0.49)	0.41 (0.50)
Change†	-0.26 (0.45)	-0.05 (0.22)	-0.15 (0.37)
Perc, mean(sd)			
Pre	1.05 (0.40)	1.10 (0.31)	1.08 (0.35)
Post	0.89 (0.46)	1.00 (0.46)	0.95 (0.46)
Change†	-0.16 (0.50)	-0.10 (0.31)	-0.13 (0.41)
Cold, mean(sd)			
Pre	2.53 (1.47)	2.65 (1.27)	2.59 (1.35)
Post	2.53 (1.61)	2.95 (1.00)	2.74 (1.33)
Change†	0.00 (1.15)	0.30 (0.92)	0.15 (1.04)

† Two group t-test p-values are 0.94, 0.61, and 0.68 respectively. Exact Wilcoxon test p-values for Palp, Perc, and Cold, respectively (0.09, 0.54, and 0.22). No statistically significant differences were found between the groups.

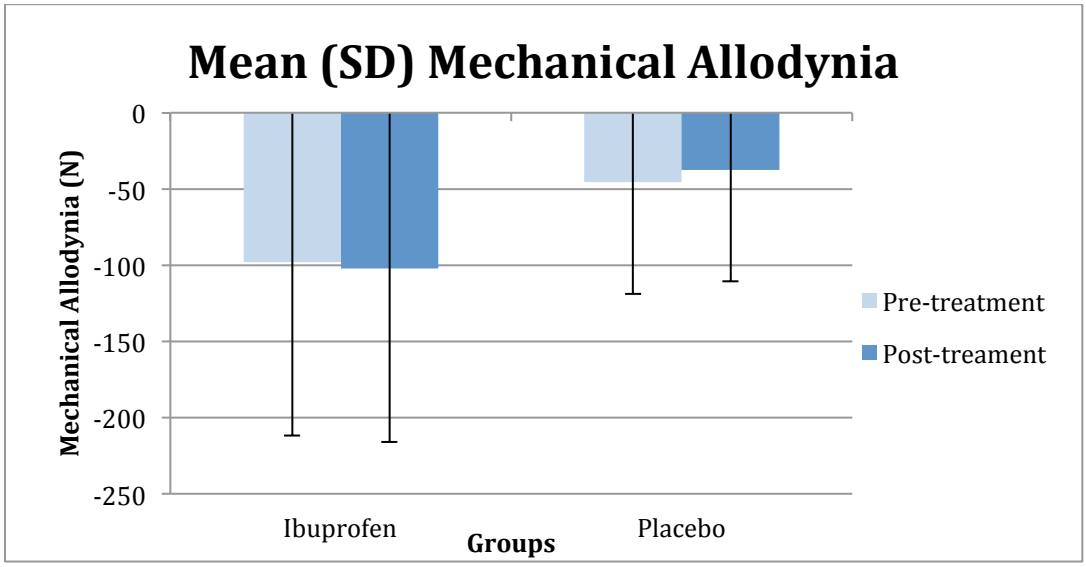


Figure 3. Mean Mechanical Allodynia By Treatment Groups

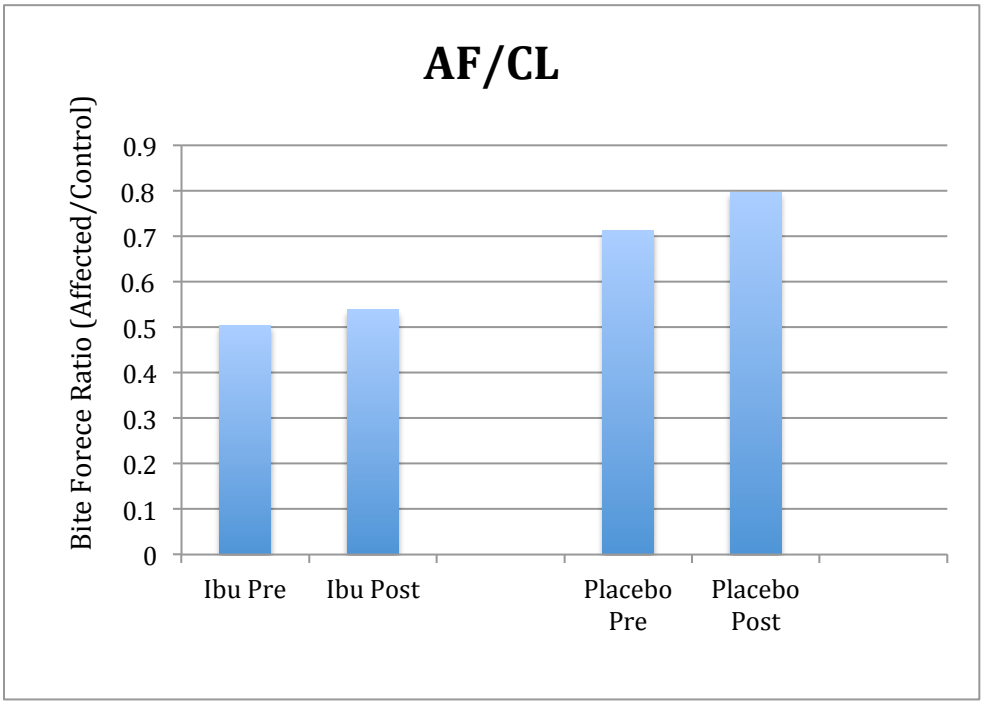


Fig 4. Bite force ratio gives fairly consistent readings between pre and post drug so affected tooth is identified by difference in bite force compared to control tooth, whether before or after treatment.

When analyzing the data of a subset diagnosis (SIRP/SAP) on Table 4, we observed that affected teeth mechanical pain thresholds preoperatively and post operatively were relatively the same, and contralateral mechanical pain thresholds increased an average of 33 N. Therefore, the mechanical allodynia increased in both ibuprofen and placebo treatment groups (31.36 N and 42.66 N, respectively). However, statistical analysis revealed no significant difference for contralateral and affected teeth mechanical pain thresholds or delta values (Refer to bottom of Table 4). The preoperative mechanical pain thresholds of affected teeth were reduced 23% compared with contralateral control teeth in patients with a diagnosis of SIRP/SAP. This appears to have no masking after ibuprofen, as a larger reduction of 37% in preoperative mechanical pain thresholds was observed compared to the contralateral teeth for all the patients in this study (Refer to Table 3).

Ibuprofen did appear to affect palpation and percussion values by masking palpation 40% (.38/.63=40%) and percussion 25% (.75/1.00=25%) on the affected teeth in patients with a diagnosis of SIRP/SAP. The minimal change with mechanical pain thresholds, or bite force, in both the ibuprofen and placebo groups in patients with a diagnosis of SIRP/SAP suggests little masking with bite force measurement (Refer to Table 4 and Figure 4). When comparing the masking effects of ibuprofen on all diagnostic groups versus subset of SIRP/SAP, ibuprofen masked palpation the most (36.5% vs 40%) and ibuprofen masked percussion less (15.2% vs 25%) (Refer to Table 3

and 4) on affected teeth. During this clinical trial, there was no observed masking effect in the placebo treatment group on palpation and percussion values (Table 4).

Table 4. Outcomes by Treatment Group (SIRP/SAP subset)

	Ibuprofen n=8	**Placebo n=9**	**Total n=17**
CL Bite Force, mean(sd)			
Pre	140.53 (81.63)	136.98 (44.26)	138.65 (62.44)
Post	168.70 (97.40)	174.24 (48.78)	171.64 (73.13)
Change†	28.18 (55.21)	37.27 (42.01)	32.99 (47.30)
AF Bite Force, mean(sd)			
Pre	109.75 (46.98)	103.78 (52.11)	106.59 (48.30)
Post	106.56 (43.78)	97.39 (46.10)	101.71 (43.86)
Change†	-3.19 (36.85)	-6.39 (63.29)	-4.88 (50.99)
Delta Value, mean(sd)			
Pre	-30.78 (96.84)	-33.20 (69.37)	-32.06 (80.69)
Post	-62.14 (84.34)	-76.86 (58.88)	-69.93 (70.02)
Change†	-31.36 (74.48)	-43.66 (47.20)	-37.87 (59.84)
Palp, mean(sd)			
Pre	0.63 (0.52)	0.33 (0.50)	0.47 (0.51)
Post	0.38 (0.52)	0.33 (0.50)	0.35 (0.49)
Change	-0.25 (0.46)	0.00 (0.00)	-0.12 (0.33)
Perc, mean(sd)			
Pre	1.00 (0.53)	1.00 (0.00)	1.00 (0.35)
Post	0.75 (0.46)	1.00 (0.00)	0.88 (0.33)
Change	-0.25 (0.71)	0.00 (0.00)	-0.12 (0.49)
Cold, mean(sd)			
Pre	2.00 (0.00)	2.11 (0.33)	2.06 (0.24)
Post	1.50 (0.93)	2.11 (0.33)	1.82 (0.73)
Change†	-0.50 (0.93)	0.00 (0.00)	-0.24 (0.66)

† Two group t-test p-values are 0.71, 0.90, and 0.69 respectively. Exact Wilcoxon test p-values for Palp, Perc, and Cold, respectively (0.21, 0.15, and 0.21).

According to Pearson's correlation coefficients, there is no statistically significant differences between mechanical pain thresholds and palpation or percussion, nor is there between palpation and percussion. For that reason, there is no correlation when comparing these three groups preoperatively (Refer to Table 5). As one would expect,

the mechanical pain thresholds were highest among normal un-inflamed teeth (RNL) and lowest among the most symptomatic teeth (S++L++). Refer to Table 6 for mechanical pain thresholds of cold responses preoperatively.

Table 5. Pearson's correlation coefficients (Pre-treatment)

BF vs. Palp	r=-0.02
BF vs. Perc	r=-0.03
BF vs. Cold	r=-0.11
Palp vs. Perc	r=-0.05

These are very small and are not statistically significantly different than 0 ($p > 0.05$).

Table 6. Pearson's correlation coefficients (Post-treatment/Ibuprofen group)

Ibuprofen

BF vs. Palp	r=-0.36
BF vs. Perc	r=0.05
BF vs. Cold	r=-0.24
Palp vs. Perc	r=0.22

Table 7. Pearson's correlation coefficients (Post-treatment/Placebo Group)

Placebo

BF vs. Palp	r=-0.31
BF vs. Perc	r=0.04
BF vs. Cold	r=-0.42
Palp vs. Perc	r=0.23

These are a little bigger but are not statistically significantly different than 0 ($p > 0.05$).

Table 8. Mean (SD) Bite Force of Cold Responses (Pre-treatment)

NR	103.75 (88.12)
RNL	150.63 (127.31)
S+NL	51.50 (50.20)
S+L+	111.19 (45.88)
S++L++	33.00 (-)

Table 9. Delta Values By Gender, Mean (SD)

	Ibuprofen n=19	Placebo n=20	Total n=39
Females, n=21			
Pre	-106.08 (109.67)	-45.24 (63.55)	-59.72 (78.36)
Post	-51.62 (72.78)	-35.17 (124.98)	-39.09 (113.25)
Chg	54.46 (53.98)	10.07 (115.38)	20.64 (104.61)
Males, n=18			
Pre	-94.80 (131.51)	-47.30 (63.05)	-84.24 (119.75)
Post	-119.96 (122.74)	-46.85 (46.11)	-103.71 (113.46)
Chg	-25.16 (65.78)	0.45 (94.20)	-19.47 (70.67)

T-tests comparing Males and Females
Pre: 0.45
Post: 0.08
Chg: 0.18

After reviewing t-tests, there was not a significant difference of mechanical allodynia between males and females preoperatively or post operatively (p = 0.45 and p =0.08, respectively). This data can be found in Table 9 and Figure 5.

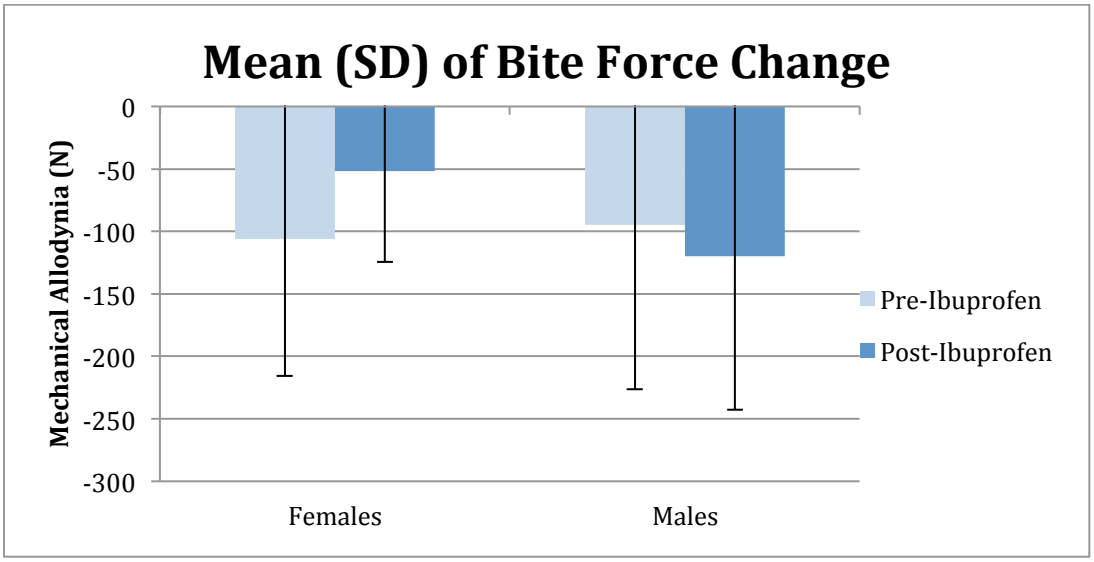


Figure 5. Comparison of Pre- and Post-Ibuprofen on Bite Force change in Males and Females.

It should be noted that of the 39 symptomatic patients that participated in this study, only one patient's preoperative (before drug administration) diagnosis was different from their post operative (post drug administration) diagnosis. The change in preoperative diagnosis (SIRP/SAP) to post operative diagnosis (Normal/Normal) would have changed the advised treatment from proceeding with root canal therapy to monitoring the previous symptomatic tooth for future treatment. Therefore, this patient would have been instructed go home and to return to the dental clinic immediately when symptoms reappear and not to take any medication prior to the next dental visit. Hopefully, at this subsequent visit, the correct diagnosis could be made. Ibuprofen successfully masked the cold test, palpation test, and percussion test within one hour of administration on this patient.

In this present study, 19 changes from preoperative to 1-hour post operative drug administration were observed in combined cold test, palpation test, and percussion test. As stated above, in only one situation did this masking effect result in a change in the planned treatment from preoperative to post operative administration of the drug group (2.5% of the patients in the study. 5% of treatment group).

DISCUSSION

It has been hypothesized that analgesics taken prior to dental appointments could affect the endodontic diagnostic testing results; hence, this could affect diagnosis and endodontic treatment. According to the results of this study, the outcomes of diagnostic tests and mechanical pain threshold measurements (bite force) were not statistically different between the treatment groups of ibuprofen and placebo, suggesting that bite force is not masked by ibuprofen.

Kardelis found similar results, which he stated that 10 mg of hydrocodone/1000 mg of acetaminophen intake would not affect diagnostic pulp tests on healthy teeth in Caucasian women (Kardelis et al. 2002). One would expect such results since there was no pulpal or apical inflammation in the teeth being tested with EPT and cold. It would be interesting to see the results of similarly designed study analyzing the effects of a commonly prescribed narcotic (10 mg of hydrocodone/650 mg of acetaminophen) on cold and EPT in male and female subjects with symptomatic teeth.

Carnes researched the effect of a narcotic, NSAID, acetaminophen, and placebo on the pain thresholds measured by electric pulp testing (EPT) on symptomatic teeth. They concluded that acetaminophen was the only treatment drug that did have a statistically significant difference on EPT pain thresholds between preoperative administration and 45 minutes later (Carnes et al. 1998). Although there was a statistical difference in electric pulp tester readings, this cannot be considered clinically meaningful. The results from the electric pulp tests were 33.26 preoperatively and 36.99 forty-five minutes later (Carnes et al. 1998). Clinically, the results from the EPT are

diagnostically the same. The presence of a response indicates vital tissue is present, whereas the absence of such a response usually indicates pulp necrosis. The exact number of the reading is of no significance and does not detect subtle degrees of vitality, nor can any electrical pulp tester indicate inflammation (Walton and Torabinejad 2009).

Carnes and Kardelis demonstrated similar results when measuring the effects of 10mg of a narcotic on EPT pain thresholds (no significant difference). Even though, Kardelis measured the effect of the combined narcotic and acetaminophen drugs and Carnes measured the effect of acetaminophen and a narcotic (meperidine) separately, they both reported similar results with EPT pain thresholds increasing 3-4 points (Carnes et al. 1998; Kardelis et al. 2002). As stated above, this is not clinically significant and these results do not change the diagnoses of these teeth.

Unfortunately, there are few studies that measure the effect certain drugs could have on diagnostic tests. After a review of the literature, it can be concluded from the above studies, that limited administration of narcotics, NSAIDs, acetaminophen, or a combination of a narcotic and acetaminophen will not have a clinical effect on electric pulp testing on healthy and symptomatic patients (Carnes et al. 1998; Kardelis et al. 2002).

Khan reported the intraobserver reliability was substantial (0.63-0.68) for the bite force transducer, and suggested one examiner collect the mechanical pain thresholds values due to the fair to substantial inter-rater reliability (0.3-0.64) (Khan et al. 2007a). Therefore, only one examiner (the author) gathered the measurements for all diagnostic testing (cold, palpation, percussion, and mechanical pain thresholds). Khan's average contralateral mechanical pain thresholds preoperatively were almost 100 N higher than

those found in this study (277.1 ± 44.4 N versus 178.16 ± 122.51, respectively). In addition, the preoperative measurements of the affected teeth were almost 23 N lower in Khan's study versus this study (83.9 ± 16.7 N versus 107.12 ± 75.89 N). However, due to the previously mentioned inter-rater reliability, it could be inaccurate to compare mechanical pain thresholds obtained in this study with those measurements gathered by another examiner in previous studies (Khan et al. 2007a,b).

There were 10 premolars enrolled in this study compared to 3 in Khan's study. This could be one reason to explain the lower preoperative bite forces (mechanical pain thresholds) in this study compared to Khan's study. Empirically, the author observed higher preoperative bite forces on affected teeth in this study on first molars (137.7 N) compared to premolars (64.2 N) and second molars (85.5 N). Moreover, the author observed a difference in bite forces depending upon the placement of the bite force transducer. Higher mechanical pain thresholds were thought to be recorded when the long axis of the bite force transducer was aligned mesial to distal on the occlusal table (See Figure 6A). If the bite force transducer is positioned in a slight buccal to lingual orientation to the clinical crown then the device engaged a single cusp and resulted in slightly lower measurements (See Figure 6B).

Figure 6A. Mesial to Distal Alignment of the Bite Force Transducer.

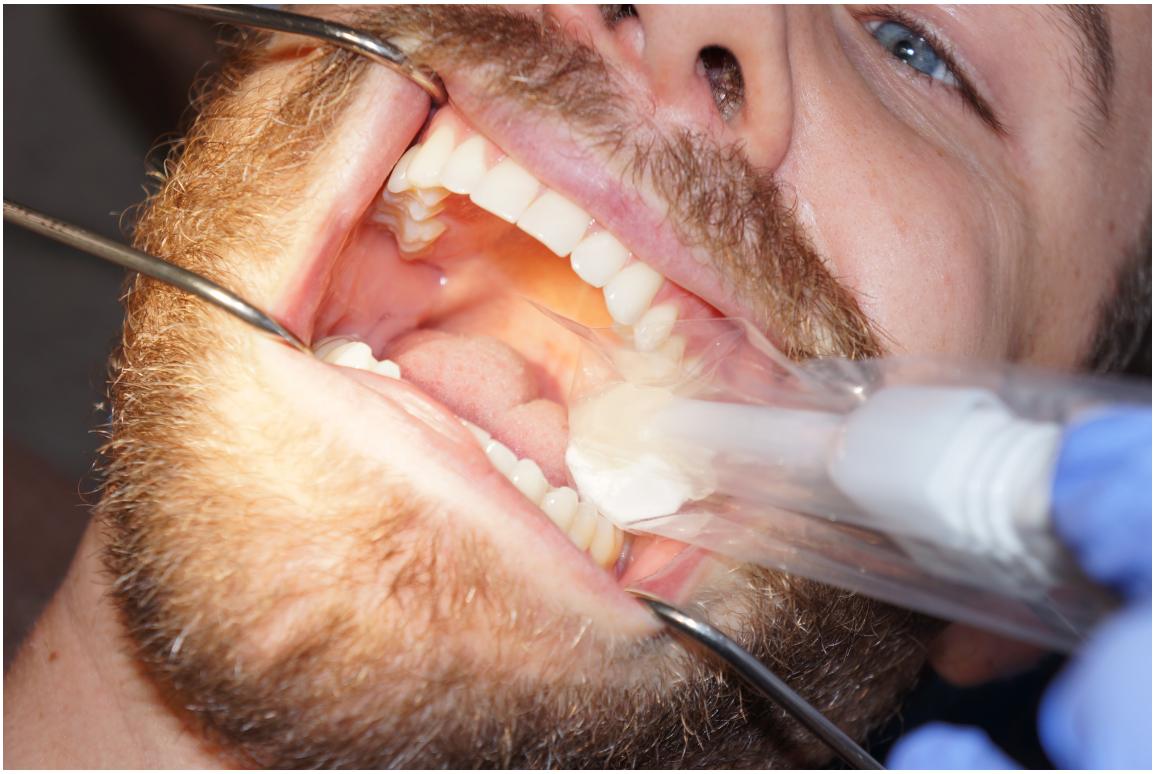


Figure 6B. Slight Buccal to Lingual Alignment of the Bite Force Transducer.

Previously, Khan reported that local anesthesia reduced mechanical allodynia by 62%. Interestingly, the un-inflamed, contralateral tooth's mechanical pain thresholds did not change 10 minutes after administering local anesthesia to the opposite affected side (Khan et al. 2007b). Pre-anesthesia contralateral mechanical pain threshold values were lower than volunteer healthy mechanical pain thresholds (Khan et al. 2007a). As a result, Khan stated there was a significant reduction in maximal bite force (mechanical pain thresholds) in the contralateral healthy control teeth compared with measurements from normal test subjects and was labeled as "contralateral allodynia". Since there was no evident inflammation on the contralateral teeth, this led Khan to believe central sensitization was present.

Like the results from Khan's study, the contralateral preoperative mechanical pain thresholds were higher than the affected, inflamed teeth. However, the results of this study differ from that of Khan's study in that the mechanical pain thresholds increase for both contralateral and affected teeth post operatively. Even though there was no statistical difference. In fact, both the contralateral and affected teeth's mechanical pain thresholds increased about the same (24.47 N and 26.6 N, respectively). Possibly ibuprofen could have reduce the concentration of peripheral inflammatory mediators which resulted in an increase in mechanical pain thresholds. These results cannot validate or deny the hypothesis of central sensitization resulting in contralateral allodynia. In order to validate that preoperative reduction in maximum bite force (contralateral allodynia) was present in this study, a clinical trial measuring the mechanical pain

thresholds of normal healthy volunteers would be needed (measured by the same examiner in this study).

Khan reported that the mechanical pain thresholds for teeth with a diagnosis of SIRP/SAP were reduced by 77% compared with contralateral control teeth (Khan et al. 2007b). In this study, the preoperative mechanical pain thresholds for teeth with a diagnosis of SIRP/SAP were reduced 23% compared with the contralateral control teeth. In addition, the preoperative mechanical pain thresholds for all the patients in this study were reduced by 40% compared with the contralateral control teeth. The comparison of preoperative mechanical pain thresholds between the affected tooth and the contralateral tooth do not coincide between the two studies using the same device and technique.

Khan reported to that it would take a sample size of 20 patients with irreversible pulpitis to detect an analgesic effect that reduced mechanical allodynia measurements by 130 N (Khan et al. 2007b). This study recruited 17 irreversible pulpitis participants (SIRP/SAP) and a total of 39 overall symptomatic participants with a variety of pulpal and apical diagnoses. Kardelis only had 16 healthy volunteer subjects participate in his study, but Carnes had a high number of subjects with moderate to severe dental pain take part in their study (n =80) (Kardelis et al. 2002; Carnes et al. 1998). There was a total of 30 subjects with irreversible pulpitis and symptomatic apical periodontitis partake in Khan's study (Khan et al. 2007b).

Khan reported a significant difference between the preoperative mechanical allodynia values of men compared to women. Yet, after the administration of local anesthesia, there was a similar percent reduction in mechanical allodynia in both groups, and therefore resulted in no significant difference. In this study, preoperative bite force

values were almost the same for males and females. Statistically there was no difference in preoperative or post-ibuprofen mechanical allodynia measurements for males and females. However, it should be noted that there was a statistically significant gender imbalance resulting in 14 males in the ibuprofen group and 16 females in the placebo group. There were 19 subjects in the ibuprofen group and 20 subjects in the placebo treatment group. Oddly, after the administration of ibuprofen, the bite force values in the male group increased slightly by 25 N, and the measurements for the females decreased 55 N ($p = 0.18$). This is opposite of what one would expect since only 5 females received ibuprofen compared to 14 males. According to Nusstein and Beck, more men than women received pain relief after taking analgesics for acute dental pain (Nusstein and Beck 2003). Therefore, the potential for ibuprofen to mask endodontic diagnoses would likely be higher in a group of men than women. However, this effect was not observed in this study.

For patients with a diagnosis of SIRP/SAP, ibuprofen was able to mask palpation values by 40% and percussion values by 25% on the affected teeth. However, percussion and palpation test results remained unchanged for the placebo treatment group. In addition, there was very little change or masking effect of the affected teeth's mechanical pain thresholds, or bite force, in both the ibuprofen and placebo. Since mechanical pain thresholds did not change for the ibuprofen group, the bite force transducer has potential to be used as diagnostic aid in certain pulpal and apical diagnoses (i.e. SIRP/SAP). Yet, for the bite force transducer to be an accurate diagnostic tool, more clinical trials will be needed. Specifically, mechanical pain thresholds are needed for adjacent teeth to the inflamed, affected tooth. If the adjacent teeth's mechanical pain thresholds are similar,

then determining the symptomatic tooth or source of the inflammation could be difficult. Moreover, these values would need to be compared to normal, un-inflamed, healthy volunteers' mechanical pain thresholds to determine the diagnostic potential of this device. Moreover, only one clinician should gather all these information because of the fair to substantial inter-rater reliability.

In this clinical trial, it appears that ibuprofen has a greater ability to mask the results of diagnostic tests in patients with more pulpal and apical inflammation. This could be explained by ability of NSAIDs to be preferentially distributed into inflamed pulps (Bunczak-Reeh and Hargreaves 1998). NSAIDs have the ability to significantly suppress local production of prostaglandins by providing a significant analgesic effect (Roszkowski, Swift, and Hargreaves 1997). Moreover, there is 100-fold greater level of prostaglandins in an irreversibly inflamed pulp, such as one with a diagnosis of SIRP/SAP, than there is in normal control teeth (Nakanishi, Matsuo, and Ebisu 1995). This reduction in peripheral inflammatory mediators can produce a masking effect in diagnostic test results.

Although statistically there was not a significant difference between the two drug treatment groups for any of the diagnostic tests (cold, palpation, and percussion) or mechanical pain thresholds, the author believes the results of this study can show a clinical significance. Nineteen changes in diagnostic testing resulted from either administration of ibuprofen or placebo. For example, one subject with a S+L+ response to cold changed to RNL one hour after administration of 800 mg of ibuprofen. In addition, this subject's sensitive response to percussion and palpation also changed to non-sensitive response one hour later. In this particular instance, the pulpal and apical

diagnosis changed, and therefore would have result in a change of treatment provided. Although this rarely happens, fortunately this situation did present itself to be measured during this clinical trial. Even though this did not occur enough times to be statistically significant, one should still consider these results clinically significant.

The bite force transducer has exciting research potential and may be refined to improve endodontic diagnosis on teeth with a questionable diagnosis. The bite force transducer could be used to measure:

1. The extent of time of persistent central sensitization and allodynia after root canal therapy. Recently, it has been reported that 5.3% of patients have pain 6 months after root canal therapy (Nixdorf et al. 2010).
2. The extent of the zone of secondary allodynia, and this information could be correlated with patient's symptoms and the results of endodontic diagnostic testing.
3. The effect of various drugs taking preoperatively on mechanical allodynia, such as this current study. It would be interesting to observe if there is an inhibitory effect of pretreatment with an antagonist to the glutamate NMDA receptor on central sensitization (contralateral allodynia).
4. The effect of various drugs on persistent allodynia after root canal therapy. This could help develop new drugs for persistent chronic pain after endodontic therapy.

Knowledgeable clinicians should be confident in results obtained from their diagnostic tests regardless of the analgesic taken prior to the dental appointment. Results

from this study suggest that prior consumption of a high dose ibuprofen has the ability to effect pulpal and apical diagnoses on symptomatic patients, but this will not likely result in different recommended treatment (2.5% of this study population was affected). A maximum dose of 800mg ibuprofen can mask the results of cold, palpation, and percussion tests. A diagnosis cannot be fabricated after a single diagnostic test. Rather, a competent clinician should accumulate all possible information from multiple diagnostic tests, reproduction of the patient's chief compliant, and prior history of symptoms to derive an accurate diagnosis of the symptomatic patient's current pulpal and apical status. In this manner, the competent clinician can use the above data as a system of checks and balances to confirm his/her opinion about diagnoses and recommended treatment. If the gathered results from endodontic tests do not coincide to conclude a proper diagnosis, then the patient is advised to return to the dental office immediately when symptoms reappear. Since results from common endodontic testing can be masked by a high, single dose of ibuprofen, patients should be advised not to take ibuprofen prior to their return dental visit..

CONCLUSION

1. Preoperative administration of 800 mg of ibuprofen did not result in statistically significant different diagnostic testing results or mechanical pain thresholds over the placebo treatment group.
2. Although the results from this present study are not statistically significant, these results can be clinically significant and have impact on diagnosis and resulting treatment in certain instances.
3. In patients with SIRP/SAP, ibuprofen masked palpation values by 40% and percussion values by 25% with little change on mechanical pain thresholds. Therefore, the bite force transducer could have potential future use as a diagnostic aid.
4. There was not a statistically significant difference between male and female mechanical allodynia for either the ibuprofen or placebo treatment group.
5. The bite force transducer has great research potential to discover new drug treatment modalities, the extent of persistent central sensitization, and the zone of secondary allodynia, and unlike the common endodontic diagnostic tests of percussion and palpation, is not masked by analgesic treatment.
6. Competent clinicians should develop an accurate diagnosis after utilizing a variety of endodontic diagnostic tests using a system of checks and balances. If this information does not coincide, then patients are encouraged to return the dental office when their symptoms resume. Since results from common endodontic testing can be masked by a high, single dose of ibuprofen, patients should be

advised not to take ibuprofen prior to their return dental visit to aid in the proper diagnosis.

REFERENCES

Anon. 2009. “AAE Consensus Conference Recommended Diagnostic Terminology.” *Journal of Endodontics* 35 (12) (December): 1634–1634.

Arbuckle, JB, and RJ Docherty. 1995. “Expression of Tetrodotoxin-resistant Sodium Channels in Capsaicin-sensitive Dorsal Root Ganglion Neurons of Adult Rats.” *Neuroscience Letters* 185 (1) (February 6): 70–3.

Bunczak-Reeh, Mary Ann, and Kenneth M. Hargreaves. 1998. “Effect of Inflammation on the Delivery of Drugs to Dental Pulp.” *Journal of Endodontics* 24 (12) (December): 822–825.

Burgess, GM, I Mullaney, M McNeill, PM Dunn, and HP Rang. 1989. “Second Messengers Involved in the Mechanism of Action of Bradykinin in Sensory Neurons in Culture.” *Journal of Neuroscience* 9 (9) (September): 3314–25.

Byers, MR, PE Taylor, BG Khayat, and CL Kimberly. 1990. “Effects of Injury and Inflammation on Pulpal and Periapical Nerves.” *Journal of Endodontics* 16 (2) (February): 78–84.

Carnes, P. L., B. Cook, P. D. Eleazer, and J. P. Scheetz. 1998. “Change in Pain Threshold by Meperidine, Naproxen Sodium, and Acetaminophen as Determined by Electric Pulp Testing.” *Anesthesia Progress* 45 (4): 139.

Collins, S.L., R. A. Moore, H.J. McQuay, and P. J. Wiffen. 1998. “Oral Ibuprofen and Diclofenac in Postoperative Pain: a Quantitative Systematic Review.” *European Journal of Pain* 2: 285–291.

Cooper, SA, BP Schachtel, E Goldman, S Gelb, and P Cohn. 1989. “Ibuprofen and Acetaminophen in the Relief of Acute Pain: a Randomized, Double-blind, Placebo-controlled Study.” *Journal of Clinical Pharmacology* 29 (11) (November): 1026–30.

Cooper, Stephen A. 1990. “Treating Acute Pain: Do’s and Don’ts, Pros and Cons.” *Journal of Endodontics* 16 (2) (February): 85–91.

Derry, S., P. J. Wiffen, and R. A. Moore. 2011. “Relative Efficacy of Oral Analgesics After Third Molar Extraction – a 2011 Update.” *British Dental Journal* 211 (9): 419–420.

Dray, A. 1995. “Inflammatory Mediators of Pain.” *Journal of Anaesthesia* 75 (2) (August): 125–31.

Gage, Tommy W., and Frieda Pickett. 2005. *Mosby's Dental Drug Reference*. 7th ed. St. Louis, Missouri: Mosby Elsevier.

Gold, MS, DB Reichling, MJ Shuster, and JD Levine. 1996. "Hyperalgesic Agents Increase a Tetrodotoxin-resistant Na+ Current in Nociceptors." *Proceedings of the National Academy of Sciences of the United States of America* 93 (3) (February 6): 1108–12.

Gracely, Richard, Ronald Dubner, and Patricia A. McGrath. 1979. "Narcotic Analgesia: Fentanyl Reduces the Intensity but Not the Unpleasantness of Painful Tooth Pulp Sensations." *Science* 203 (March 23): 1261–63.

Hargreaves, Kenneth M., and Stephen Cohen. 2006. *Pathways of the Pulp*. 9th ed. St. Louis, Missouri: Mosby Elsevier.

Hargreaves, Kenneth M., and Harold E. Goodis. 2002. "Pain Mechanisms of the Pulpodentin Complex." In *Seltzer and Bender's Dental Pulp*. Chicago, IL: Quintessence Publishing Co., Inc.

Hargreaves, Kenneth M., Harold E. Goodis, Franklin Tay, Anibal Diogenes, and Michael Henry. 2012. "Pain Pathways and Mechanisms of the Pulpodentin Complex." In *Seltzer and Bender's Dental Pulp*, 166–80. 2nd ed. Chicago, IL: Quintessence Publishing Co., Inc.

Hargreaves, Kenneth M., Asma A. Khan, Harold E. Goodis, and Franklin Tay. 2012. "Pharmacologic Control of Dental Pain." In *Seltzer and Bender's Dental Pulp*, 190–200. 2nd ed. Chicago, IL: Quintessence Publishing Co., Inc.

Hargreaves, KM, and K Keiser. 2004. "New Advances in the Management of Endodontic Pain Emergencies. [Review] [36 Refs]." *Journal of the California Dental Association* 32 (6) (June): 469–73.

Ingle, John, Leif Bakland, and J. Craig Baumgartner. 2008. *Ingle's Endodontics*. 6th ed. Shelton, CT: People's Medical Pulblishing House.

Ingle, John, Leif Bakland, J. Craig Baumgartner, Kenneth M. Hargreaves, and Jennifer Gibbs. 2008. "Mechanisms of Odontogenic and Non-Odontogenic Pain." In *Ingle's Endodontics*, 376–87. 6th ed. Shelton, CT: People's Medical Pulblishing House.

Jeske, Arthur, and James Zahrowski. 2010. "Good Evidence Supports Ibuprofen as an Effective and Safe Analgesic for Postoperative Pain." *The Journal of the American Dental Association* 141 (5) (May 1): 567–568.

Jones, David M. 1999. “Effect of the Type Carrier Used on the Results of Dichlorodifluoromethane Application to Teeth.” *Journal of Endodontics* 25 (10) (October): 692–694.

Kardelis, Anthony C., Trudy A. Meinberg, Heather R. Sulte, Tom G. Gound, David B. Marx, and Richard A. Reinhardt. 2002. “Effect of Narcotic Pain Reliever on Pulp Tests in Women.” *Journal of Endodontics* 28 (7) (July): 537–539.

Khan, Asma A., Bryce McCreary, Christopher B. Owatz, William G. Schindler, Scott A. Schwartz, Karl Keiser, and Kenneth M. Hargreaves. 2007a. “The Development of a Diagnostic Instrument for the Measurement of Mechanical Allodynia.” *Journal of Endodontics* 33 (6) (June): 663–666.

Khan, Asma A., Christopher B. Owatz, William G. Schindler, Scott A. Schwartz, Karl Keiser, and Kenneth M. Hargreaves. 2007b. “Measurement of Mechanical Allodynia and Local Anesthetic Efficacy in Patients With Irreversible Pulpitis and Acute Periradicular Periodontitis.” *Journal of Endodontics* 33 (7) (July): 796–799.

McCarthy, Patrick J., Scott McClanahan, James Hodges, and Walter R. Bowles. 2010. “Frequency of Localization of the Painful Tooth by Patients Presenting for an Endodontic Emergency.” *Journal of Endodontics* 36 (5) (May): 801–805.

Mehlisch, DR, S Aspley, SE Daniels, and DP Bandy. 2010. “Comparison of the Analgesic Efficacy of Concurrent Ibuprofen and Paracetamol with Ibuprofen or Paracetamol Alone in the Management of Moderate to Severe Acute Postoperative Dental Pain in Adolescents and Adults: a Randomized, Double-blind, Placebo-controlled, Parallel-group, Single-dose, Two-center, Modified Factorial Study.” *Clinical Therapeutics* 32 (5) (May): 882–95.

Mehlisch, DR, S Aspley, SE Daniels, KA Southerden, and KS Christensen. 2010. “A Single-tablet Fixed-dose Combination of Racemic Ibuprofen/paracetamol in the Management of Moderate to Severe Postoperative Dental Pain in Adult and Adolescent Patients: a Multicenter, Two-stage, Randomized, Double-blind, Parallel-group, Placebo-controlled, Factorial Study.” *Clinical Therapeutics* 32 (6) (June): 1033–49.

Menhinick, KA, JL Gutmann, JD Regan, SE Taylor, and PH Buschang. 2004. “The Efficacy of Pain Control Following Nonsurgical Root Canal Treatment Using Ibuprofen or a Combination of Ibuprofen and Acetaminophen in a Randomized, Double-blind, Placebo-controlled Study.” *International Endodontic Journal* 37 (8) (August): 531–41.

Merrill, RL. 2007. “Central Mechanisms of Orofacial Pain.” *Dental Clinics of North America* 51 (1) (January): 45–59.

Meyer, RA, and JN Campbell. 1981. “Myelinated Nociceptive Afferents Account for the Hyperalgesia That Follows a Burn to the Hand.” *Science* 213 (4515) (September 25): 1527–9.

Mickel, André K., Andrew P. Wright, Sami Chogle, Jefferson J. Jones, Igor Kantorovich, and Francis Curd. 2006. “An Analysis of Current Analgesic Preferences for Endodontic Pain Management.” *Journal of Endodontics* 32 (12) (December): 1146–1154.

Moore, R. Andrew, Sebastian Straube, Jocelyn Paine, Sheena Derry, and Henry J. McQuay. 2011. “Minimum Efficacy Criteria for Comparisons Between Treatments Using Individual Patient Meta-analysis of Acute Pain Trials: Examples of Etoricoxib, Paracetamol, Ibuprofen, and Ibuprofen/paracetamol Combinations After Third Molar Extraction.” *PAIN* 152 (5) (May): 982–989.

Mumford, JM. 1965. “Pain Perception Threshold and Adaptation of Normal Human Teeth.” *Archives of Oral Biology* 10 (6) (December): 957–68.

Mumford, JM. 1967. “Pain Perception Threshold on Stimulating Human Teeth and the Histological Condition of the Pulp.” *British Dental Journal* 123 (9) (November 7): 427–33.

Nakanishi, T, H Shimizu, Y Hosokawa, and T Matsuo. 2001. “An Immunohistological Study on Cyclooxygenase-2 in Human Dental Pulp.” *Journal of Endodontics* 27 (6) (June): 385–8.

Nakanishi, Tadashi, Takashi Matsuo, and Shigeyuki Ebisu. 1995. “Quantitative Analysis of Immunoglobulins and Inflammatory Factors in Human Pulpal Blood from Exposed Pulps.” *Journal of Endodontics* 21 (3) (March): 131–136.

Narhi, M, T Hirvonen, and T Huopaniemi. 1984. “The Function of Intradental Nerves in Relation to the Sensations Induced by Dental Stimulation.” *Acupuncture & Electro-Therapeutics Research* 9 (2): 107–13.

Nixdorf, DR, EJ Moana-Filho, AS Law, LA McGuire, JS Hodges, and MT John. 2010. “Frequency of Persistent Tooth Pain After Root Canal Therapy: a Systematic Review and Meta-analysis.” *Journal of Endodontics* 36 (2) (February): 224–30.

Nusstein, JM, and M Beck. 2003. “Comparison of Preoperative Pain and Medication Use in Emergency Patients Presenting with Irreversible Pulpitis or Teeth with Necrotic Pulps.” *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* 96 (2) (August): 207–14.

Owatz, Christopher B., Asma A. Khan, William G. Schindler, Scott A. Schwartz, Karl Keiser, and Kenneth M. Hargreaves. 2007. "The Incidence of Mechanical Allodynia in Patients With Irreversible Pulpitis." *Journal of Endodontics* 33 (5) (May): 552–556.

Peters, JA, and JJ Lambert. 1989. "Electrophysiology of 5-HT3 Receptors in Neuronal Cell Lines." *Trends in Pharmacological Sciences* 10 (5) (May): 172–5.

Roszkowski, Mark T, James Q Swift, and Kenneth M Hargreaves. 1997. "Effect of NSAID Administration on Tissue Levels of Immunoreactive Prostaglandin E2, Leukotriene B4, and (S)-flurbiprofen Following Extraction of Impacted Third Molars." *Pain* 73 (3) (December): 339–345.

Rowe, A. H. R., and T. R. Pitt Ford. 1990. "The Assessment of Pulpal Vitality." *International Endodontic Journal* 23 (2): 77–83.

Roy, ML, and T Narahashi. 1992. "Differential Properties of Tetrodotoxin-sensitive and Tetrodotoxin-resistant Sodium Channels in Rat Dorsal Root Ganglion Neurons." *Journal of Neuroscience* 12 (6) (June): 2104–11.

Ryan, Jeffrey L., Badri Jureidini, James S. Hodges, Michael Baisden, James Q. Swift, and Walter R. Bowles. 2008. "Gender Differences in Analgesia for Endodontic Pain." *Journal of Endodontics* 34 (5) (May): 552–556.

Stoller, Eleanor Palo, Gregg H. Gilbert, Marsha A. Pyle, and R. Paul Duncan. 2001. "Coping with Tooth Pain: a Qualitative Study of Lay Management Strategies and Professional Consultation." *Special Care in Dentistry* 21 (6): 208–215.

Vane, JR. 1971. "Inhibition of Prostaglandin Synthesis as a Mechanism of Action for Aspirin-like Drugs." *Nature - New Biology* 231 (25) (June 23): 232–5.

Walton, Richard E., and Mahmoud Torabinejad. 2009. *Principles and Practice of Endodontics*. 4th ed. St. Louis, Missouri: W.B. Saunders Company.

Woolf, CJ. 1996. "Windup and Central Sensitization Are Not Equivalent." *Pain* (August): 2–3.

Woolf, CJ, and SW Thompson. 1991. "The Induction and Maintenance of Central Sensitization Is Dependent on N-methyl-D-aspartic Acid Receptor Activation; Implications for the Treatment of Post-injury Pain Hypersensitivity States." *Pain* 44 (3) (March): 293–9.

APPENDIX 1

Consent Form

The Effects of Ibuprofen on Masking Endodontic Diagnosis

You are invited to be a part of a study that will investigate the ability of an analgesic (Ibuprofen) to mask your tooth pain. Ibuprofen can reduce symptoms such as pain to biting and pain to cold and hot. These are the very symptoms that motivate one to seek out emergency dental care. Typical care involves pain management with Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) such as Ibuprofen. We would like to measure the effect that Ibuprofen has on your tooth pain when biting down. Using a bite-force measuring device, I will measure the amount of biting force as you bite down on both the tooth that hurts and a normal tooth on the other side. You will be given either Ibuprofen or a placebo to take orally and one hour later, I will re-measure how much force you can bite down with on the sore tooth and the normal tooth on the other side. A placebo is a harmless pill that does not contain any medicine. Then we will follow the usual protocol for providing dental treatment for the sore tooth. You were selected as a possible participant for this study because you are in need of emergency root canal treatment. We ask that you read this form and ask any questions that you may have before agreeing to be in the study. 50 patients will be needed for the completion of this study.

This study is being conducted by Dr. Walter Bowles DDS MS PhD, and a graduate student of the Division of Endodontics at the University of Minnesota, School of Dentistry, Dr. Jason Read, DMD.

PROCEDURES:
If you agree to be in the study, your root canal treatment will be performed in the standard way. We will complete tooth testing and measure your biting force on both the sore tooth and a normal tooth on the other side of your mouth. Then you will receive two oral capsules to take consisting of either Ibuprofen or placebo (no medication), and one hour later we will retest the tooth for bite force measurements on the sore tooth and normal tooth along with the tooth tests. Patients will be randomized to either the treatment or placebo group with a flip of a coin. Then you will receive standard emergency root canal treatment. Standard treatment consists of either complete root canal therapy of the affected tooth or doing the root canal in two visits, with cleaning the root canal and placing medication in the root canal at the first visit and completing the root canal treatment at the second visit.

RISKS:
Ibuprofen presents several possible risks to you. There is a potential for gastrointestinal bleeding associated with the use of aspirin and other NSAID's such as ibuprofen. The risk for bleeding is low for those who take the product intermittently. For those who take the products on a regular basis, the risk is increased, particularly for those over 65 years old.

NSAID's may cause an increased risk of serious cardiovascular events such as heart attack and stroke. This risk may increase with duration of use. Patients with heart disease may be at greater risk.

Other less frequent adverse effects can include kidney toxicity, severe allergic reactions, anemia, nausea, abdominal pain, constipation, dizziness, rash, fluid retention, and sensitivity to light. You will be asked if you have a drug allergy to ibuprofen or NSAIDs. If you do, you should not take part in this study. Ibuprofen is the drug most commonly used for dental pain. After your treatment, if you feel that your discomfort and pain are not being adequately treated, you should notify the dentist who performed the root canal treatment and to receive pain medication. If you are having side effects, you should notify the dentist who performed the root canal treatment or the investigator (Dr. Read) with this contact number (612-624-2661).

BENEFITS:
There may be no direct benefit to you from being in this study. It is also possible that you may have less discomfort and pain after your root canal treatment than you otherwise would have had.
Your participation in this study could serve to provide information that may aid in improving treatment methods used for future patients.

ALTERNATIVES TO PARTICIPATING IN THIS STUDY:
You would receive the same root canal treatment, most commonly completed with the use of Ibuprofen, being investigated in this study. A mild analgesic (pain medication) normally may or may not be prescribed for your potential discomfort after treatment depending on the nature of your root canal procedure and dental care provider.

COMPENSATION:
Compensation will only be in the form of treatment fee reduction ($75) off the root canal therapy fee upon completion of testing and root canal therapy treatment. Root canal therapy fees must be charged and root canal therapy completed (emergency treatment or non-surgical root canal therapy treatment) before the participants can receive a treatment fee reduction of $75.

RESEARCH RELATED INJURY:
In the event that this research activity results in an injury, treatment will be available, including first aid, emergency treatment and follow-up care as needed. Care for such treatment will be billed in the ordinary manner to you or your insurance company. If you think that you have suffered a research related injury, let the study dentists know right away.

CONFIDENTIALITY:
The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Your

public health information (PHI) created or received for the purposes of this study is protected under the federal regulation known as HIPAA. Refer to the attached HIPAA authorization for details concerning the use of this information.

VOLUNTARY NATURE OF THE STUDY:
Your decision whether or not to participate is voluntary and will not affect your current or future relations with the University of Minnesota, The University of Minnesota Dental Clinics, or your own dentist. If you decide to participate, you are free to withdraw at any time without affecting those relationships. Furthermore, if at any point following your root canal treatment or before, you may voluntarily withdraw from the study and the same dental treatment will be provided.

NEW INFORMATION:
If during the course of this research study, there are significant new findings discovered which might influence your willingness to continue, the researchers will inform you of those developments.

CONTACTS AND QUESTIONS:
The researchers conducting this study are Dr. Walter Bowles D.D.S, M.S.PhD, and Dr. Read, D.M.D. You may ask any questions you have now. If you have questions later, you may contact them at the University of Minnesota Dental School at (612) 624-2661. If you have any questions or concerns regarding the study and would like to talk to someone other than the researcher(s), contact the Fairview Research Helpline at telephone number 612-672-7692 or toll free at 866-508-6961. You may also contact this office in writing or in person at Fairview Research Administration, 2433 Energy Park Drive, St Paul, MN 55108. You will be given a copy of this form to keep for your records.

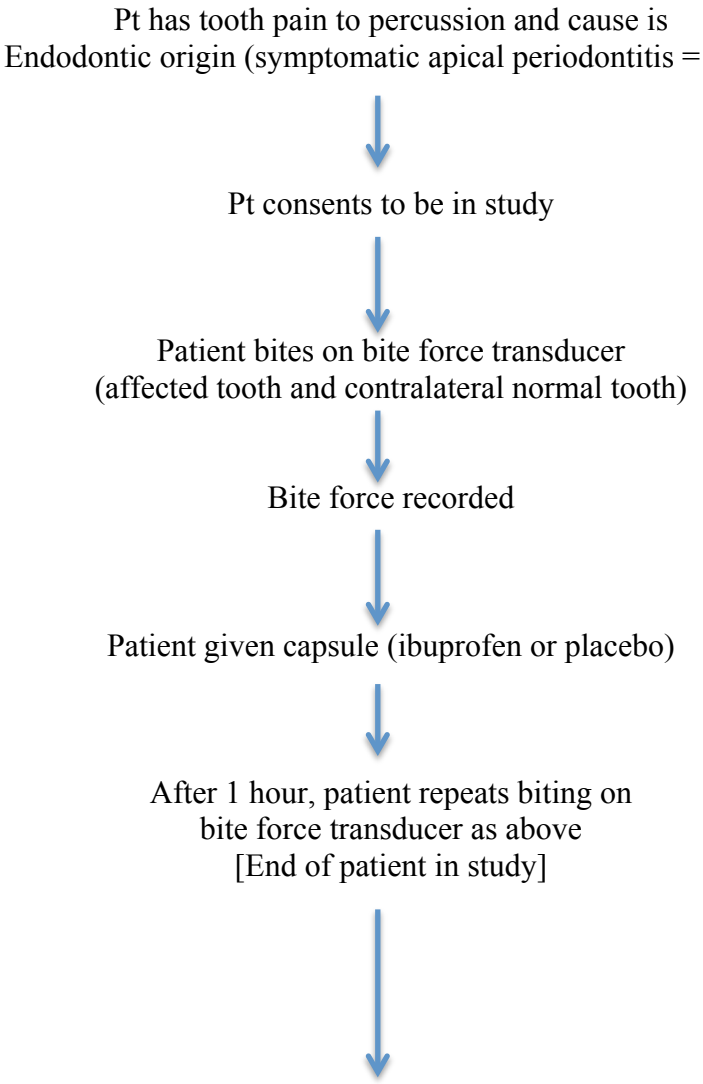
STATEMENT OF CONSENT:
I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature of Subject: _____ Date: _____

Signature of Investigator: _____ Date: _____

APPENDIX 2

Jason Read Research Study
Title: The Masking Effects of Ibuprofen on Endodontic Diagnosis



APPENDIX 3

Jason Read Research Study
Title: The Masking Effects of Ibuprofen on Endodontic Diagnosis

Exclusions criteria:

1. American Society of Anesthesiologists' physical status of 3 to 5
2. Periodontal pockets greater than 6 mm
3. Persistent (>7 days) use of medication that might alter their pain report (such as steroids and antidepressants)
4. Participants that have taken analgesics in the previous 12 hours
5. Absence of contralateral (control) tooth
6. Sensitivity to percussion on the contra lateral tooth

GRAD ENDO RESIDENTS/DENTAL STUDENTS: If you have a pt that you complete a **CONSULT** with that has **percussion** sensitivity (**SAP**), then you can offer them to participate in my study on Tuesday or Thursday afternoons and they can get **$75** off their RCT. If the pt agrees to participate in my study, keep a sticker with their cell on it and I will contact them. You can give them my cell number to contact me also.

It will take 1 hr and 15 min of their time. I will measure their biting force, give them either placebo or Ibuprofen (800mg), then wait 1 hr to measure their biting force again. Refer to flow chart. Then we can appoint them back to you for RCT.

What questions do I ask the patient?

1. Do you have biting sensitivity?
2. Do you have allergy to NSAIDs such as Ibuprofen, Advil, Aspirin?
3. Have you taken NSAIDS in the past 12 hours?
4. Have taken steroids or antidepressants > 7days?

APPENDIX 4

Patient Name:
Treatment/Packet #:
Chart #:
Ethnicity:
DOB: / / Age:
VNRS: (0-10) Currently: _____ Max: _____
Sex: M/F
Dx: Pulpal:
PA:
Comments:

Pre-Medication:

Contralateral **Unaffected** Tooth (**5** bite force measurements)

Tooth					
Palpation					
Percussion					
Cold					
Mobility					
Bite Force					

Affected Tooth (**2** bite force measurements)

Tooth					
Palpation					
Percussion					
Cold					
Mobility					
Bite Force					

1 Hour Post-Medication:

Contralateral **Unaffected** Tooth (**5** bite force measurements)

Tooth					
Palpation					
Percussion					
Cold					
Mobility					
Bite Force					

Affected Tooth (**2** bite force measurements)

Tooth					
Palpation					
Percussion					
Cold					
Mobility					
Bite Force					

APPENDIX 5

Statistical Analysis

Descriptive statistics were used to summarize the demographics, patient characteristics, and outcome measures. Two group t-tests were used to compare the mean change in the outcomes from pre-treatment to post-treatment between the groups. P-values less than 0.05 were considered statistically significant. SAS V9.1.3 (SAS Institute Inc, Cary, NC) was used for the analysis.

Results

Table 1. Demographics by Treatment Group

	Ibuprofen n=19	**Placebo n=20**	**Total n=39**
Age, mean(sd)	45.47 (15.63)	50.35 (19.56)	47.97 (17.69)
range	24-72	19-77	19-77
Sex†, n (%)			
Female	5 (26)	16 (80)	21 (54)
Male	14 (74)	4 (20)	18 (46)
Ethnicity, n (%)			
AA	2 (11)	4 (20)	6 (15)
Asian	2 (11)	0	2 (5)
White	14 (74)	14 (70)	28 (72)
Hispanic	1 (5)	1 (5)	2 (5)
Middle Eastern	0	1 (5)	1 (3)
Diagnosis, n (%)			
ASIRP/SAP	1 (5)	0	1 (3)
Nec/AAA	0	1 (5)	1 (3)
Nec/CAA	0	1 (5)	1 (3)
Nec/SAP	5 (26)	4 (20)	9 (23)
PI/SAP	1 (5)	0	1 (3)
PT/SAP	4 (21)	3 (15)	7 (18)
RP/SAP	0	2 (10)	2 (5)
SIRP/SAP	8 (42)	9 (45)	17 (44)
Current VNRS, mean(sd)	1.58 (1.74)	1.15 (1.81)	1.36 (1.77)
Max VNRS, mean(sd)	6.37 (2.11)	7.05 (3.17)	6.72 (2.69)

† p=0.0012 (Fisher's exact test comparing treatment groups). There was a statistically significant gender imbalance between the groups.

Table 2. Summary of Palp, Perc and Cold tests by Treatment Group

	Ibuprofen n=19		Placebo n=20		Total n=39	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Palp, n (%)						
NS=0	5 (26)	10 (53)	12 (60)	13 (65)	17 (44)	23 (59)
S+=1	14 (74)	9 (47)	8 (40)	7 (35)	22 (56)	16 (41)
Perc, n (%)						
NS=0	1 (5)	3 (16)	0	2 (10)	1 (3)	5 (13)
S+=1	16 (84)	15 (79)	18 (90)	16 (80)	34 (87)	31 (79)
S++=2	2 (11)	1 (5)	2 (10)	2 (10)	4 (10)	3 (8)
Cold, n (%)						
NR=4	8 (42)	9 (47)	8 (40)	9 (45)	16 (41)	18 (46)
RNL=0	3 (16)	4 (21)	1 (5)	0	4 (10)	4 (10)
S+NL=1	0	0	2 (10)	0	2 (5)	0
S+L+=2	8 (42)	6 (32)	8 (40)	10 (50)	16 (41)	16 (41)
S++L++=3	0	0	1 (5)	1 (5)	1 (3)	1 (3)

Table 3. Outcomes by Treatment Group

	Ibuprofen n=19	Placebo n=20	Total n=39
CL Bite Force, mean(sd)			
Pre	197.19 (133.94)	160.08 (110.97)	178.16 (122.51)
Post	221.11 (147.26)	185.08 (110.00)	202.63 (129.06)
Change†	23.92 (48.01)	25.01 (35.54)	24.47 (41.51)
AF Bite Force, mean(sd)			
Pre	99.42 (51.16)	114.43 (94.47)	107.12 (75.89)
Post	119.13 (73.16)	147.58 (147.65)	133.72 (116.80)
Change†	19.71 (45.66)	33.15 (106.32)	26.60 (81.77)
Delta Value, mean(sd)			
Pre	-97.77 (123.24)	-45.65 (51.16)	-71.04 (98.99)
Post	-101.97 (114.08)	-37.51 (73.16)	-68.91 (116.51)
Change†	-4.21 (71.20)	8.15 (109.21)	2.13 (91.67)
Palp, mean(sd)			
Pre	0.74 (0.45)	0.40 (0.50)	0.56 (0.50)
Post	0.47 (0.51)	0.35 (0.49)	0.41 (0.50)
Change†	-0.26 (0.45)	-0.05 (0.22)	-0.15 (0.37)
Perc, mean(sd)			
Pre	1.05 (0.40)	1.10 (0.31)	1.08 (0.35)
Post	0.89 (0.46)	1.00 (0.46)	0.95 (0.46)
Change†	-0.16 (0.50)	-0.10 (0.31)	-0.13 (0.41)
Cold, mean(sd)			
Pre	2.53 (1.47)	2.65 (1.27)	2.59 (1.35)
Post	2.53 (1.61)	2.95 (1.00)	2.74 (1.33)
Change†	0.00 (1.15)	0.30 (0.92)	0.15 (1.04)

† Two group t-test p-values are 0.94, 0.61, 0.68, 0.07, 0.66, and 0.37 respectively. No statistically significant differences were found between the groups. Palp was close to 0.05.

Exact Wilcoxon test p-values for Palp, perc, and cold, respectively (0.09, 0.54, and 0.22). Both tests should not be reported.

Table 4. Outcomes by Treatment Group (SIRP/SAP subset)

	Ibuprofen n=8	Placebo n=9	Total n=17
CL Bite Force, mean(sd)			
Pre	140.53 (81.63)	136.98 (44.26)	138.65 (62.44)
Post	168.70 (97.40)	174.24 (48.78)	171.64 (73.13)
Change†	28.18 (55.21)	37.27 (42.01)	32.99 (47.30)
AF Bite Force, mean(sd)			
Pre	109.75 (46.98)	103.78 (52.11)	106.59 (48.30)
Post	106.56 (43.78)	97.39 (46.10)	101.71 (43.86)
Change†	-3.19 (36.85)	-6.39 (63.29)	-4.88 (50.99)
Delta Value, mean(sd)			
Pre	-30.78 (96.84)	-33.20 (69.37)	-32.06 (80.69)
Post	-62.14 (84.34)	-76.86 (58.88)	-69.93 (70.02)
Change†	-31.36 (74.48)	-43.66 (47.20)	-37.87 (59.84)
Palp, mean(sd)			
Pre	0.63 (0.52)	0.33 (0.50)	0.47 (0.51)
Post	0.38 (0.52)	0.33 (0.50)	0.35 (0.49)
Change	-0.25 (0.46)	0.00 (0.00)	-0.12 (0.33)
Perc, mean(sd)			
Pre	1.00 (0.53)	1.00 (0.00)	1.00 (0.35)
Post	0.75 (0.46)	1.00 (0.00)	0.88 (0.33)
Change	-0.25 (0.71)	0.00 (0.00)	-0.12 (0.49)
Cold, mean(sd)			
Pre	2.00 (0.00)	2.11 (0.33)	2.06 (0.24)
Post	1.50 (0.93)	2.11 (0.33)	1.82 (0.73)
Change†	-0.50 (0.93)	0.00 (0.00)	-0.24 (0.66)

† Two group t-test p-values are 0.71, 0.90, 0.69, 0.12, 0.30, and 0.12 respectively.

Exact Wilcoxon test p-values for Palp, perc, and cold, respectively (0.21, 0.15, and 0.21).

Both tests should not be reported.

Pearson's correlation coefficients (Pre-treatment)

BF vs. Palp: r= -0.02
BF vs. Perc: r= -0.03
BF vs. Cold: r= -0.11
Palp vs. Perc: r= 0.05

These are very small and are not statistically significantly different than 0 ($p > 0.05$).

Pearson's correlation coefficients (Post-treatment)

Ibuprofen

BF vs. Palp: r= -0.36
BF vs. Perc: r= 0.05
BF vs. Cold: r= -0.24
Palp vs. Perc: r= 0.22

Placebo

BF vs. Palp: r= -0.31
BF vs. Perc: r= 0.04
BF vs. Cold: r= 0.42
Palp vs. Perc: r= 0.23

These are a little bigger but are not statistically significantly different than 0 ($p > 0.05$).

Mean (SD) Bite Force of Cold Responses (Pre-treatment)
NR: 103.75 (88.12)
RNL: 150.63 (127.31)
S++L++: 33.00 (-)
S+L+: 111.19 (45.88)
S+NL: 51.50 (50.20)

Delta Values By Gender, Mean (SD)

	Ibuprofen n=19	**Placebo n=20**	**Total n=39**
Females, n=21			
Pre	-106.08 (109.67)	-45.24 (63.55)	-59.72 (78.36)
Post	-51.62 (72.78)	-35.17 (124.98)	-39.09 (113.25)
Chg	54.46 (53.98)	10.07 (115.38)	20.64 (104.61)

Males, n=18			
Pre	-94.80 (131.51)	-47.30 (63.05)	-84.24 (119.75)
Post	-119.96 (122.74)	-46.85 (46.11)	-103.71 (113.46)
Chg	-25.16 (65.78)	0.45 (94.20)	-19.47 (70.67)

T-tests comparing Males and Females
Pre: 0.45
Post: 0.08
Chg: 0.18

APPENDIX 6

Packet #	Pt #	Ethnicity	Age	VNRS Current	VNRS Max	Tx Group	Sex	Tooth	Diagnosis
1	60466964	Causasian	74	3	9	PLACEBO	F	28	RP/SAP
2	97555018	Causasian	47	2	7	PLACEBO	M	30	PT/SAP
3	97557652	Asian	67	3	6	IBUPROFEN	F	12	PI/SAP
4	97557280	Causasian	48	2	8	IBUPROFEN	M	19	Nec/SAP
5	97556274	Causasian	29	0	7	PLACEBO	F	18	RP/SAP
6	97557129	Causasian	53	1	4	PLACEBO	F	3	SIRP/SAP
7	97558190	AA	26	3	3	PLACEBO	F	30	PT/SAP
8	97550222	Causasian	70	0	3	IBUPROFEN	M	15	ASIRP/SAP
9	20511139	Causasian	65	0	10	PLACEBO	F	4	SIRP/SAP
10	20464086	Causasian	40	2	6	IBUPROFEN	M	12	Nec/SAP
11	97557541	Causasian	27	4	9	IBUPROFEN	M	20	Nec/SAP
12	Not included					PLACEBO			
13	97559071	Causasian	65	0	0	PLACEBO	F	3	PT/SAP
14	Not included					PLACEBO			
15	97559056	Causasian	31	1	8	IBUPROFEN	F	14	PT/SAP
16	30166898	Causasian	72	0	7	IBUPROFEN	M	19	SIRP/SAP
17	10186777	Asian	60	0	9	IBUPROFEN	M	17	SIRP/SAP
18	97544895	AA	47	3	5	IBUPROFEN	M	14	PT/SAP
19	97560034	Hispanic	57	5	9	PLACEBO	F	4	Nec/AAA
20	97554925	Causasian	30	0	3	IBUPROFEN	F	13	PT/SAP
21	97560281	AA	24	3	10	IBUPROFEN	M	18	SIRP/SAP
22	70524399	Causasian	57	0	3	IBUPROFEN	M	31	SIRP/SAP
23	97560392	AA	19	5	10	PLACEBO	F	19	SIRP/SAP
24	40540920	Causasian	40	0	10	PLACEBO	F	15	SIRP/SAP
25	97560625	Hispanic	35	0	6	IBUPROFEN	F	3	SIRP/SAP
26	97559326	Causasian	60	0	4	IBUPROFEN	M	5	PT/SAP
27	Not included					IBUPROFEN			
28	97560190	Causasian	66	0	1	PLACEBO	F	14	Nec/CAA
29	97558182	Causasian	72	0	4	PLACEBO	F	30	SIRP/SAP
30	40441251	AA	26	0	10	PLACEBO	F	3	SIRP/SAP
31	97560947	Causasian	59	4	10	PLACEBO	F	18	SIRP/SAP
32	10382052	Causasian	58	0	5	PLACEBO	M	5	Nec/SAP
33	97559621	Causasian	53	2	7	IBUPROFEN	F	14	SIRP/SAP
34	97562397	Causasian	30	3	7	IBUPROFEN	M	31	SIRP/SAP
35	522170	Causasian	77	0	8	PLACEBO	M	31	Nec/SAP
36	60225031	Causasian	77	0	8	PLACEBO	F	14	Nec/SAP
37	60540539	AA	33	0	10	PLACEBO	M	30	SIRP/SAP
38	97563108	Causasian	33	6	8	IBUPROFEN	M	31	Nec/SAP
39	97555591	Causasian	21	0	9	PLACEBO	F	5	Nec/SAP
40	97563310	Causasian	31	0	5	IBUPROFEN	M	19	Nec/SAP
41	97559132	Causasian	49	1	7	IBUPROFEN	M	31	SIRP/SAP
42	50465332	Middle	43	0	7	PLACEBO	F	3	SIRP/SAP

Eastern

Packet #	Contra Cold Pre-Op	Affected Cold Pre-Op	Contra Cold Post-Op	Affected Cold Post-Op
1	RNL	S+NL	RNL	**S+L+**
2	RNL	RNL	RNL	**NR**
3	RNL	RNL	RNL	**NR**
4	RNL	NR	RNL	NR
5	RNL	S+NL	RNL	**S+L+**
6	RNL	S+L+	RNL	S+L+
7	RNL	NR	RNL	NR
8	RNL	RNL	RNL	RNL
9	RNL	S+L+	RNL	S+L+
10	RNL	NR	RNL	NR
11	RNL	NR	RNL	NR
12				
13	RNL	NR	RNL	NR
14				
15	RNL	RNL	RNL	RNL
16	RNL	S+L+	RNL	S+L+
17	RNL	S+L+	RNL	S+L+
18	RNL	NR	RNL	NR
19	RNL	NR	RNL	NR
20	RNL	NR	RNL	NR
21	RNL	S+L+	RNL	S+L+
22	RNL	S+L+	RNL	S+L+
23	RNL	S+L+	RNL	S+L+
24	RNL	S+L+	RNL	S+L+
25	RNL	S+L+	RNL	S+L+
26	RNL	NR	RNL	NR
27				
28	RNL	NR	RNL	NR
29	RNL	S+L+	RNL	S+L+
30	RNL	S+L+	RNL	S+L+
31	RNL	S++,L++	RNL	S++,L++
32	RNL	NR	RNL	NR
33	RNL	S+L+	RNL	**RNL**
34	RNL	S+L+	RNL	**RNL**
35	RNL	NR	RNL	NR
36	NR	NR	NR	NR
37	RNL	S+L+	RNL	S+L+
38	RNL	NR	RNL	NR
39	RNL	NR	RNL	NR

40	RNL	NR	RNL	NR
41	RNL	S+L+	RNL	S+L+
42	NR	S+L+	NR	S+L+

Packet #	Contra Perc Pre-Op	Affected Perc Pre-Op	Contra Perc Post-op	Affected Perc Post-Op
1	NS	S+	NS	S+
2	NS	S+	NS	**NS**
3	NS	S+	NS	S+
4	NS	S+	NS	S+
5	NS	S+	NS	**NS**
6	NS	S+	NS	S+
7	NS	S+	NS	S+
8	NS	S+	NS	S+
9	NS	S+	NS	S+
10	NS	S+	NS	S+
11	NS	S+	NS	S+
12				
13	NS	S+	NS	S+
14				
15	NS	S+	NS	S+
16	NS	S+	NS	S+
17	NS	S++	NS	**S+**
18	NS	S++	NS	S++
19	NS	S++	NS	S++
20	NS	S+	NS	S+
21	NS	S+	NS	**NS**
22	NS	S+	NS	S+
23	NS	S+	NS	S+
24	NS	S+	NS	S+
25	NS	S+	NS	S+
26	NS	S+	NS	S+
27				
28	NS	S+	NS	S+
29	NS	S+	NS	S+
30	NS	S+	NS	S+
31	NS	S+	NS	S+
32	NS	S+	NS	S+
33	NS	S+	NS	**NS**
34	NS	NS	NS	**S+**
35	NS	S+	NS	S+
36	NS	S++	NS	S++
37	NS	S+	NS	S+

38	NS	S+	NS	**NS**
39	NS	S+	NS	S+
40	NS	S+	NS	S+
41	NS	S+	NS	S+
42	NS	S+	NS	S+

Packet #	**Contra Palp Pre-Op**	**Affected Palp Pre-Op**	**Contra Palp Post-Op**	**Affected Palp Post-Op**
1	NS	S+	NS	S+
2	NS	NS	NS	NS
3	NS	S+	NS	S+
4	NS	S+	NS	S+
5	NS	NS	NS	NS
6	NS	NS	NS	NS
7	NS	S+	NS	**NS**
8	NS	S+	NS	**NS**
9	NS	NS	NS	NS
10	NS	NS	NS	NS
11	NS	S+	NS	S+
12				
13	NS	S+	NS	S+
14				
15	NS	S+	NS	**NS**
16	NS	NS	NS	NS
17	NS	S+	NS	S+
18	NS	S+	NS	S+
19	NS	S+	NS	S+
20	NS	S+	NS	**NS**
21	NS	S+	NS	S+
22	NS	NS	NS	NS
23	NS	S+	NS	S+
24	NS	NS	NS	NS
25	NS	S+	NS	S+
26	NS	S+	NS	S+
27				
28	NS	S+	NS	S+
29	NS	S+	NS	S+
30	NS	S+	NS	S+
31	NS	NS	NS	NS
32	NS	NS	NS	NS
33	NS	S+	NS	**NS**
34	NS	S+	NS	**NS**
35	NS	NS	NS	NS

36	NS	NS	NS	NS
37	NS	NS	NS	NS
38	NS	NS	NS	NS
39	NS	NS	NS	NS
40	NS	S+	NS	S+
41	NS	NS	NS	NS
42	NS	NS	NS	NS

Packet #	BF Contra Pre-Op Avg	BF Affected Pre-Op Avg	BF Contra Post-Op Avg	BF Affected Post-Op Avg
1	0.051	0.016	0.064	0.013
2	0.4638	0.327	0.4384	0.421
3	0.0422	0.0235	0.0446	0.034
4	0.4372	0.164	0.5146	0.256
5	0.1324	0.087	0.1028	0.127
6	0.1018	0.0915	0.1572	0.1305
7	0.422	0.3845	0.4792	0.444
8	0.493	0.1175	0.5834	0.187
9	0.1666	0.089	0.1608	0.116
10	0.3532	0.1965	0.333	0.276
11	0.148	0.0675	0.1742	0.077
12				
13	0.0656	0.0745	0.0988	0.0705
14				
15	0.2262	0.1345	0.1952	0.2055
16	0.1202	0.1065	0.12	0.1325
17	0.0796	0.2035	0.2072	0.1415
18	0.1866	0.059	0.242	0.022
19	0.179	0.0345	0.192	0.056
20	0.312	0.0425	0.28	0.129
21	0.1524	0.0655	0.1378	0.057
22	0.052	0.129	0.0742	0.134
23	0.112	0.2025	0.1378	0.138
24	0.1852	0.0755	0.2854	0.1235
25	0.0464	0.0475	0.0576	0.058
26	0.0642	0.066	0.13	0.103
27				
28	0.266	0.1335	0.2796	0.1595
29	0.1496	0.127	0.2086	0.1455
30	0.1862	0.046	0.1934	0.0305
31	0.0558	0.033	0.1382	0.1085
32	0.104	0.0695	0.1218	0.12
33	0.2486	0.097	0.2382	0.131

34	0.2552	0.1255	0.3568	0.1505
35	0.0608	0.072	0.1108	0.0455
36	0.1427	0.1195	0.168	0.5495
37	0.1646	0.1355	0.1354	0.0325
38	0.0744	0.046	0.0724	0.043
39	0.0814	0.0365	0.078	0.069
40	0.2854	0.094	0.282	0.0785
41	0.1698	0.1035	0.1578	0.048
42	0.111	0.134	0.1514	0.0515

APPENDIX 7

PACKET 1

Pt# 60466964 **Avg**

Contra Pre-op

Tooth	20	21	22			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	P	P			
Bite Force	0.032	0.071	0.048	0.05	0.054	0.051

Affected Pre-op

Tooth	27	28	29			
Palp	NS	S+B	NS			
Percuss	NS	S+	NS			
Cold	RNL	S+NL	RNL			
Mobility	P	P	P			
Bite Force	0.015	0.017				0.016

Contra 1 hr Post-Op

Tooth	20	21	22			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	P	P			
Bite Force	0.045	0.07	0.071	0.06	0.074	0.064

Affected 1 hr Post-Op

Tooth	27	28	29			
Palp	NS	S+B	NS			
Percuss	NS	S+	NS			
Cold	RNL	**S+L+**	RNL			
Mobility	P	P	P			
Bite Force	0.012	0.014				0.013

PACKET 2

Pt # 97555018 Avg

Contra Pre-op

Tooth	20	19	18
Palp	NS	NS	NS
Percuss	NS	NS	NS
Cold	RNL	RNL	RNL
Mobility	P	P	P

	Bite Force	0.431	0.433	0.508	0.402	0.545	0.4638
	Affected Pre-op						
	Tooth	29	30	31			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	P	P			
	Bite Force	0.302	0.352				0.327
	Contra 1 hr Post-Op						
	Tooth	20	19	18			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.405	0.473	0.518	0.463	0.333	0.4384
	Affected 1 hr Post-Op						
	Tooth	29	30	31			
	Palp	NS	NS	NS			
	Percuss	NS	**NS**	NS			
	Cold	RNL	**NR**	NR			
	Mobility	P	P	P			
	Bite Force	0.405	0.437				0.421
PACKET 3	Pt #						Avg
	97557652						
	Contra Pre-op						
	Tooth	6	5	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.047	0.035	0.045	0.039	0.045	0.0422
	Affected Pre-op						
	Tooth	11	12	13			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.021	0.026				0.0235
	Contra 1 hr Post-Op						
	Tooth	6	5	4			

Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		P	P			
Bite Force		0.059	0.031	0.038	0.056	0.039	0.0446

Affected 1 hr Post-Op							
Tooth		11	12	13			
Palp	NS		S+B	NS			
Percuss	NS		S+	NS			
Cold	RNL		**NR**	RNL			
Mobility	P		P	P			
Bite Force		0.033	0.035				0.034

PACKET 4

Pt #	Packet #	Avg
97556274	4	

Contra Pre-op							
Tooth		29	30	31			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		P	P			
Bite Force		0.533	0.434	0.448	0.411	0.36	0.4372

Affected Pre-op							
Tooth		20	19	18			
Palp	NS		S+B	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	RNL			
Mobility	P		P	P			
Bite Force		0.153	0.175				0.164

Contra 1 hr Post-Op							
Tooth		29	30	31			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		P	P			
Bite Force		0.748	0.688	0.339	0.397	0.401	0.5146

Affected 1 hr Post-Op							
Tooth		20	19	18			
Palp	NS		S+B	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	RNL			
Mobility	P		P	P			

	Bite Force	0.298	0.214				0.256

PACKET 5

	Pt #	Packet #					Avg
	97556274	5					
	Contra Pre-op						
	Tooth	31	30	29			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.103	0.134	0.137	0.138	0.15	0.1324
	Affected Pre-op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	S+	NS	NS			
	Cold	S+NL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.095	0.079				0.087
	Contra 1 hr Post-Op						
	Tooth	31	30	29			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.072	0.106	0.115	0.14	0.081	0.1028
	Affected 1 hr Post-Op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	**NS**	NS	NS			
	Cold	**S+L+**	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.12	0.134				0.127

PACKET 6

	Pt #	Packet #					Avg
	97557129	6					
	Contra Pre-op						
	Tooth	11	13	14			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.042	0.161	0.19	0.04	0.076	0.1018

Affected Pre-op							
Tooth		2	3	4			
Palp	NS		NS	NS			
Percuss	NS		S+	NS			
Cold	RNL		S+L+	RNL			
Mobility	P		P	P			
Bite Force		0.078	0.105				0.0915
Contra 1 hr Post-Op							
Tooth		11	13	14			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		P	P			
Bite Force		0.086	0.162	0.159	0.158	0.221	0.1572
Affected 1 hr Post-Op							
Tooth		2	3	4			
Palp	NS		NS	NS			
Percuss	NS		S+	NS			
Cold	RNL		S+L+	RNL			
Mobility	P		P	P			
Bite Force		0.139	0.122				0.1305
PACKET 7	Pt #		Packet #				Avg
	97558190		7				
Contra Pre-op							
Tooth		20	19	18			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		1	1			
Bite Force		0.411	0.39	0.378	0.419	0.512	0.422
Affected Pre-op							
Tooth		29	30	31			
Palp	NS		S+	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	RNL			
Mobility	P		P	P			
Bite Force		0.456	0.313				0.3845
Contra 1 hr Post-Op							
Tooth		20	19	18			
Palp	NS		NS	NS			

	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	1	1			
	Bite Force	0.303	0.503	0.489	0.533	0.568	0.4792
	Affected 1 hr Post-Op						
	Tooth	29	30	31			
	Palp	NS	**NS**	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	NR	RNL			
	Mobility	P	P	P			
	Bite Force	0.434	0.454				0.444
PACKET 8	Pt #	Packet #					Avg
	97550222	8					
	Contra Pre-op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.421	0.455	0.488	0.534	0.567	0.493
	Affected Pre-op						
	Tooth	15	14	13			
	Palp	S+B	NS	NS			
	Percuss	S+	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.096	0.139				0.1175
	Contra 1 hr Post-Op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.562	0.578	0.577	0.611	0.589	0.5834
	Affected 1 hr Post-Op						
	Tooth	15	14	13			
	Palp	**NS**	NS	NS			
	Percuss	S+	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.183	0.191				0.187

PACKET 9

Pt #	Packet #					Avg
20511139	9					
Contra Pre-op						
Tooth	11	12	13			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	p	P			
Bite Force	0.102	0.137	0.202	0.196	0.196	0.1666
Affected Pre-op						
Tooth	4	6	7			
Palp	NS	NS	NS			
Percuss	S+	NS	NS			
Cold	S+L+	RNL	RNL			
Mobility	P	P	P			
Bite Force	0.135	0.043				0.089
Contra 1 hr Post-Op						
Tooth	11	12	13			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	P	P			
Bite Force	0.068	0.216	0.158	0.19	0.172	0.1608
Affected 1 hr Post-Op						
Tooth	4	6	7			
Palp	NS	NS	NS			
Percuss	S+	NS	NS			
Cold	S+L+	RNL	RNL			
Mobility	P	P	P			
Bite Force	0.136	0.096				0.116

PACKET 10

Pt #	Packet #					Avg
20464086	10					
Contra Pre-op						
Tooth	4	5	6			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	p	P			
Bite Force	0.387	0.325	0.304	0.359	0.391	0.3532

Affected Pre-op							
Tooth		9	12	15			
Palp	NS		NS	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	NR			
Mobility	P		P	P			
Bite Force		0.18	0.213				0.1965
Contra 1 hr Post-Op							
Tooth		4	5	6			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		p	P			
Bite Force		0.307	0.35	0.333	0.322	0.353	0.333
Affected 1 hr Post-Op							
Tooth		9	12	15			
Palp	NS		NS	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	NR			
Mobility	P		P	P			
Bite Force		0.253	0.299				0.276
PACKET 11	Pt #		Packet #				Avg
	97557541		11				
Contra Pre-op							
Tooth		30	29	28			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		p	P			
Bite Force		0.097	0.171	0.139	0.181	0.152	0.148
Affected Pre-op							
Tooth		19	20	21			
Palp	NS		S+B	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	RNL			
Mobility	P		1	1			
Bite Force		0.052	0.083				0.0675
Contra 1 hr Post-Op							
Tooth		30	29	28			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			

	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.122	0.196	0.093	0.216	0.244	0.1742
	Affected Post-op						
	Tooth	19	20	21			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	NR	RNL			
	Mobility	P	1	1			
	Bite Force	0.071	0.083				0.077
PACKET 12	Not included						
PACKET 13	Pt #	Packet #					Avg
	97559071	13					
	Contra Pre-op						
	Tooth	15	14	13			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.038	0.054	0.071	0.08	0.085	0.0656
	Affected Pre-op						
	Tooth	2	3	4			
	Palp	NS	S+B	S+B			
	Percuss	NS	S+	S+			
	Cold	RNL	NR	RNL			
	Mobility	P	1	1			
	Bite Force	0.066	0.083				0.0745
	Contra 1 hr Post-Op						
	Tooth	15	14	13			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.047	0.074	0.095	0.171	0.107	0.0988
	Affected Post-op						
	Tooth	2	3	4			
	Palp	NS	S+B	**NS**			
	Percuss	NS	S+	S+			
	Cold	RNL	NR	RNL			
	Mobility	P	1	1			

	Bite Force	0.057	0.084				0.0705

PACKET 14 Not included

PACKET 15

Pt #	Packet #					Avg
97559056	15					
Contra Pre-op						
Tooth	2	3	4			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	p	P			
Bite Force	0.19	0.196	0.225	0.278	0.242	0.2262
Affected Pre-op						
Tooth	15	14	13			
Palp	NS	S+B	NS			
Percuss	NS	S+	NS			
Cold	RNL	RNL	RNL			
Mobility	P	1	1			
Bite Force	0.133	0.136				0.1345
Contra 1 hr Post-Op						
Tooth	2	3	4			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	p	P			
Bite Force	0.18	0.213	0.18	0.158	0.245	0.1952
Affected Post-op						
Tooth	15	14	13			
Palp	NS	**NS**	NS			
Percuss	NS	S+	NS			
Cold	RNL	RNL	RNL			
Mobility	P	1	1			
Bite Force	0.208	0.203				0.2055

PACKET 16

Pt #	Packet #			Avg
30166898	16			
Contra Pre-op				
Tooth	30	29	28	
Palp	NS	NS	NS	
Percuss	NS	NS	NS	

	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.146	0.1	0.109	0.134	0.112	0.1202
	Affected Pre-op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	1	1			
	Bite Force	0.119	0.094				0.1065
	Contra 1 hr Post-Op						
	Tooth	30	29	28			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.109	0.108	0.131	0.124	0.128	0.12
	Affected Post-op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	1	1			
	Bite Force	0.138	0.127				0.1325
PACKET 17	Pt #	Packet #					Avg
	10186777	17					
	Contra Pre-op						
	Tooth	32	31	29			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.049	0.042	0.069	0.1	0.138	0.0796
	Affected Pre-op						
	Tooth	17	18	20			
	Palp	S+B	NS	NS			
	Percuss	S++	S+	NS			
	Cold	S+L+	RNL	RNL			
	Mobility	P	1	1			
	Bite Force	0.202	0.205				0.2035

	Contra 1 hr Post-Op						
	Tooth	32	31	29			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.11	0.78	0.047	0.07	0.029	0.2072
	Affected Post-op						
	Tooth	17	18	20			
	Palp	S+B	NS	NS			
	Percuss	**S+**	S+	NS			
	Cold	S+L+	RNL	RNL			
	Mobility	P	1	1			
	Bite Force	0.143	0.14				0.1415
PACKET 18	Pt #	Packet #					Avg
	97544895	18					
	Contra Pre-op						
	Tooth	3	4	5			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.249	0.146	0.15	0.139	0.249	0.1866
	Affected Pre-op						
	Tooth	15	14	13			
	Palp	NS	S+B	NS			
	Percuss	S+	S++	S+			
	Cold	RNL	NR	RNL			
	Mobility	P	1	1			
	Bite Force	0.044	0.074				0.059
	Contra 1 hr Post-Op						
	Tooth	3	4	5			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.235	0.247	0.223	0.33	0.175	0.242
	Affected Post-op						
	Tooth	15	14	13			
	Palp	NS	S+B	NS			
	Percuss	S+	S++	S+			

	Cold	**NR**	NR	RNL				
	Mobility	P		1	1			
	Bite Force		0.021	0.023				0.022
PACKET 19	Pt #	Packet #						Avg
	97560034		19					
	Contra Pre-op							
	Tooth		14	13	12			
	Palp	NS		NS	NS			
	Percuss	NS		NS	NS			
	Cold	RNL		RNL	RNL			
	Mobility	P		p	P			
	Bite Force		0.093	0.175	0.19	0.215	0.222	0.179
	Affected Pre-op							
	Tooth		3	4	5			
	Palp	NS		S+B/L	NS			
	Percuss	NS		S++	S+			
	Cold	RNL		NR	RNL			
	Mobility	P		2	1			
	Bite Force		0.036	0.033				0.0345
	Contra 1 hr Post-Op							
	Tooth		14	13	12			
	Palp	NS		NS	NS			
	Percuss	NS		NS	NS			
	Cold	RNL		RNL	RNL			
	Mobility	P		p	P			
	Bite Force		0.156	0.179	0.217	0.169	0.239	0.192
	Affected Post-op							
	Tooth		3	4	5			
	Palp	NS		S+B/L	NS			
	Percuss	**S+**		S++	**NS**			
	Cold	RNL		NR	RNL			
	Mobility	P		2	1			
	Bite Force		0.047	0.065				0.056
PACKET 20	Pt #	Packet #						Avg
	97554925		20					
	Contra Pre-op							
	Tooth		3	4	5			
	Palp	NS		NS	NS			
	Percuss	NS		NS	NS			
	Cold	RNL		RNL	RNL			

Mobility	P		p	P			
Bite Force		0.33	0.33	0.342	0.284	0.274	0.312
Affected Pre-op							
Tooth		12	13	14			
Palp	NS		S+B	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	RNL			
Mobility	P		P	P			
Bite Force		0.05	0.035				0.0425
Contra 1 hr Post-Op							
Tooth		3	4	5			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		p	P			
Bite Force		0.287	0.188	0.271	0.214	0.44	0.28
Affected Post-op							
Tooth		12	13	14			
Palp	NS		**NS**	NS			
Percuss	NS		S+	NS			
Cold	RNL		NR	RNL			
Mobility	P		P	P			
Bite Force		0.107	0.151				0.129

PACKET 21	Pt #	Packet #					Avg
	97560281	21					
	Contra Pre-op						
	Tooth		31	30	29		
	Palp	NS		NS	NS		
	Percuss	NS		NS	NS		
	Cold	RNL		RNL	RNL		
	Mobility	P		p	P		
	Bite Force		0.172	0.174	0.155	0.096	0.165	0.1524
	Affected Pre-op						
	Tooth		18	19	20		
	Palp	S+B/L		NS	NS		
	Percuss	S+		NS	NS		
	Cold	S+L+		RNL	RNL		
	Mobility	P		P	P		
	Bite Force		0.045	0.086				0.0655
	Contra 1 hr Post-Op						

	Tooth		31	30	29		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force		0.15	0.117	0.128	0.13	0.164	0.1378
	Affected Post-op						
	Tooth		18	19	20		
	Palp		S+B/L	NS	NS		
	Percuss		**NS**	NS	NS		
	Cold		S+L+	RNL	RNL		
	Mobility		P	P	P		
	Bite Force		0.086	0.028				0.057
PACKET 22	Pt #	Packet #					Avg
	70524399	22					
	Contra Pre-op						
	Tooth		18	19	20		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force		0.053	0.053	0.044	0.032	0.078	0.052
	Affected Pre-op						
	Tooth		31	30	29		
	Palp		NS	NS	NS		
	Percuss		S+	NS	NS		
	Cold		S+L+	RNL	RNL		
	Mobility		1	P	P		
	Bite Force		0.137	0.121				0.129
	Contra 1 hr Post-Op						
	Tooth		18	19	20		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force		0.084	0.092	0.051	0.077	0.067	0.0742
	Affected Post-op						
	Tooth		31	30	29		
	Palp		NS	NS	NS		
	Percuss		S+	NS	NS		
	Cold		S+L+	RNL	RNL		

	Mobility	1	P	P			
	Bite Force	0.131	0.137				0.134
PACKET 23	Pt #	Packet #					Avg
	97560392	23					
	Contra Pre-op						
	Tooth	31	30	29			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.105	0.185	0.067	0.094	0.109	0.112
	Affected Pre-op						
	Tooth	18	19	20			
	Palp	NS	S+B/L	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	1	P	P			
	Bite Force	0.194	0.211				0.2025
	Contra 1 hr Post-Op						
	Tooth	31	30	29			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.121	0.071	0.156	0.175	0.166	0.1378
	Affected Post-op						
	Tooth	18	19	20			
	Palp	NS	S+B/L	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	1	P	P			
	Bite Force	0.096	0.18				0.138
PACKET 24	Pt #	Packet #					Avg
	40540920	24					
	Contra Pre-op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	S+			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			

	Bite Force	0.161	0.205	0.191	0.154	0.215	0.1852
	Affected Pre-op						
	Tooth	15	14	13			
	Palp	NS	NS	NS			
	Percuss	S+	NS	NS			
	Cold	S+L+	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.09	0.061				0.0755
	Contra 1 hr Post-Op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	S+			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.194	0.117	0.34	0.369	0.407	0.2854
	Affected Post-op						
	Tooth	15	14	13			
	Palp	NS	NS	NS			
	Percuss	S+	NS	NS			
	Cold	S+L+	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.122	0.125				0.1235
PACKET 25	Pt #	Packet #					Avg
	97560625	25					
	Contra Pre-op						
	Tooth	15	14	13			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.049	0.04	0.068	0.052	0.023	0.0464
	Affected Pre-op						
	Tooth	2	3	4			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.069	0.026				0.0475
	Contra 1 hr Post-Op						
	Tooth	15	14	13			

	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.05	0.046	0.087	0.053	0.052	0.0576
	Affected Post-op						
	Tooth	2	3	4			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.052	0.064				0.058
PACKET 26	Pt #	Packet #					Avg
	97559326	26					
	Contra Pre-op						
	Tooth	11	12	14			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.032	0.05	0.08	0.062	0.097	0.0642
	Affected Pre-op						
	Tooth	3	5	6			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	NR	NR	NR			
	Mobility	1	1	P			
	Bite Force	0.048	0.084				0.066
	Contra 1 hr Post-Op						
	Tooth	11	12	14			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.114	0.116	0.152	0.129	0.139	0.13
	Affected Post-op						
	Tooth	3	5	6			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	NR	NR	NR			
	Mobility	1	1	P			

	Bite Force	0.121	0.085				0.103

PACKET 27 Not included

PACKET 28

Pt #	Packet #					Avg
97560190	28					
Contra Pre-op						
Tooth	2	3	4			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	NR			
Mobility	P	p	P			
Bite Force	0.302	0.281	0.23	0.253	0.264	0.266
Affected Pre-op						
Tooth	13	14	15			
Palp	NS	S+B	NS			
Percuss	NS	S+	NS			
Cold	RNL	NR	RNL			
Mobility	1	1	P			
Bite Force	0.137	0.13				0.1335
Contra 1 hr Post-Op						
Tooth	2	3	4			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	NR			
Mobility	P	p	P			
Bite Force	0.27	0.285	0.259	0.283	0.301	0.2796
Affected Post-op						
Tooth	13	14	15			
Palp	NS	S+B	NS			
Percuss	NS	S+	NS			
Cold	RNL	NR	RNL			
Mobility	1	1	P			
Bite Force	0.145	0.174				0.1595

PACKET 29

Pt #	Packet #			Avg
97558182	29			
Contra Pre-op				
Tooth	18	19	20	
Palp	NS	NS	NS	

	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.184	0.13	0.147	0.137	0.15	0.1496
	Affected Pre-op						
	Tooth	31	30	29			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	NR			
	Mobility	P	1	P			
	Bite Force	0.121	0.133				0.127
	Contra 1 hr Post-Op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.225	0.213	0.206	0.197	0.202	0.2086
	Affected Post-op						
	Tooth	31	30	29			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	NR			
	Mobility	P	1	P			
	Bite Force	0.145	0.146				0.1455
PACKET 30	Pt #	Packet #					Avg
	40441251	30					
	Contra Pre-op						
	Tooth	15	14	12			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	NR			
	Mobility	P	p	P			
	Bite Force	0.176	0.268	0.171	0.174	0.142	0.1862
	Affected Pre-op						
	Tooth	2	3	4			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.03	0.062				0.046

Contra 1 hr Post-Op

Tooth	15	14	12			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	NR			
Mobility	P	p	P			
Bite Force	0.222	0.161	0.194	0.18	0.21	0.1934

Affected Post-op

Tooth	2	3	4			
Palp	NS	S+B	NS			
Percuss	NS	S+	NS			
Cold	RNL	S+L+	RNL			
Mobility	P	P	P			
Bite Force	0.04	0.021				0.0305

PACKET 31

Pt #	Packet #	Avg
97560947	31	

Contra Pre-op

Tooth	31	30	29			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	p	P			
Bite Force	0.074	0.052	0.05	0.05	0.053	0.0558

Affected Pre-op

Tooth	18	19	20			
Palp	NS	NS	NS			
Percuss	S+	NS	NS			
Cold	S++,L++	RNL	RNL			
Mobility	P	P	P			
Bite Force	0.04	0.026				0.033

Contra 1 hr Post-Op

Tooth	31	30	29			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	RNL	RNL			
Mobility	P	p	P			
Bite Force	0.125	0.115	0.141	0.152	0.158	0.1382

Affected Post-op

Tooth	18	19	20
Palp	NS	NS	NS

	Percuss	S+	NS	NS			
	Cold	S++,L++	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.109	0.108				0.1085
PACKET 32	Pt #	Packet #					Avg
	10382052	32					
	Contra Pre-op						
	Tooth	13	12	11			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.117	0.086	0.08	0.116	0.121	0.104
	Affected Pre-op						
	Tooth	4	5	6			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	NR	RNL			
	Mobility	P	P	P			
	Bite Force	0.052	0.087				0.0695
	Contra 1 hr Post-Op						
	Tooth	13	12	11			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.109	0.132	0.121	0.115	0.132	0.1218
	Affected Post-op						
	Tooth	4	5	6			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	NR	RNL			
	Mobility	P	P	P			
	Bite Force	0.1	0.14				0.12
PACKET 33	Pt #	Packet #					Avg
	97559621	33					
	Contra Pre-op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			

	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.254	0.21	0.241	0.218	0.32	0.2486
	Affected Pre-op						
	Tooth	15	14	13			
	Palp	NS	S+B	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.048	0.146				0.097
	Contra 1 hr Post-Op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.237	0.194	0.234	0.265	0.261	0.2382
	Affected Post-op						
	Tooth	15	14	13			
	Palp	NS	**NS**	NS			
	Percuss	NS	**NS**	NS			
	Cold	RNL	**RNL**	RNL			
	Mobility	P	P	P			
	Bite Force	0.149	0.113				0.131
PACKET 34	Pt #	Packet #					Avg
	97562397	34					
	Contra Pre-op						
	Tooth	20	19	18			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.258	0.297	0.274	0.215	0.232	0.2552
	Affected Pre-op						
	Tooth	31	30	29			
	Palp	S+	NS	NS			
	Percuss	NS	NS	NS			
	Cold	S+L+	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.096	0.155				0.1255

	Contra 1 hr Post-Op						
	Tooth		20	19	18		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force	0.31	0.379	0.395	0.383	0.317	0.3568
	Affected Post-op						
	Tooth		31	30	29		
	Palp		**NS**	NS	NS		
	Percuss		**S+**	NS	NS		
	Cold		**RNL**	RNL	RNL		
	Mobility		P	P	P		
	Bite Force	0.149	0.152				0.1505
PACKET 35	Pt #	Packet #					Avg
	522170	35					
	Contra Pre-op						
	Tooth		18	20	21		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force	0.04	0.072	0.056	0.068	0.068	0.0608
	Affected Pre-op						
	Tooth		31	30	29		
	Palp		NS	NS	NS		
	Percuss		S+	NS	NS		
	Cold		NR	RNL	RNL		
	Mobility		1	P	P		
	Bite Force	0.081	0.063				0.072
	Contra 1 hr Post-Op						
	Tooth		18	20	21		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force	0.104	0.119	0.11	0.119	0.102	0.1108
	Affected Post-op						
	Tooth		31	30	29		
	Palp		NS	NS	NS		
	Percuss		S+	NS	NS		

	Cold	NR	RNL	RNL	
	Mobility	1	P	P	
	Bite Force	0.058	0.033		0.0455
PACKET 36	Pt #	Packet #			Avg
	60225031	36			
	Contra Pre-op				
	Tooth	2	3	4	
	Palp	NS	NS	NS	
	Percuss	NS	NS	NS	
	Cold	NR	NR	RNL	
	Mobility	P	p	P	
	Bite Force	0.131	0.138	0.159	0.14266 6667
	Affected Pre-op				
	Tooth	15	14	13	
	Palp	NS	NS	NS	
	Percuss	S+	S++	NS	
	Cold	NR	NR	NR	
	Mobility	P	P	P	
	Bite Force	0.063	0.176		0.1195
	Contra 1 hr Post-Op				
	Tooth	2	3	4	
	Palp	NS	NS	NS	
	Percuss	NS	NS	NS	
	Cold	NR	NR	RNL	
	Mobility	P	p	P	
	Bite Force	0.182	0.14	0.182	0.168
	Affected Post-op				
	Tooth	15	14	13	
	Palp	NS	NS	NS	
	Percuss	**NS**	S++	NS	
	Cold	NR	NR	NR	
	Mobility	P	P	P	
	Bite Force	0.109	0.99		0.5495
PACKET 37	Pt #	Packet #			Avg
	60540539	37			
	Contra Pre-op				
	Tooth	18	19	20	
	Palp	NS	NS	NS	
	Percuss	NS	NS	NS	

	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.146	0.088	0.173	0.172	0.244	0.1646
	Affected Pre-op						
	Tooth	29	30	31			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.096	0.175				0.1355
	Contra 1 hr Post-Op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.095	0.106	0.158	0.169	0.149	0.1354
	Affected Post-op						
	Tooth	29	30	31			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.037	0.028				0.0325
PACKET 38	Pt #	Packet #					Avg
	97563108	38					
	Contra Pre-op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.1	0.08	0.089	0.059	0.044	0.0744
	Affected Pre-op						
	Tooth	31	30	29			
	Palp	NS	NS	NS			
	Percuss	S+	NS	NS			
	Cold	NR	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.042	0.05				0.046

	Contra 1 hr Post-Op						
	Tooth		18	19	20		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force	0.03	0.085	0.065	0.054	0.128	0.0724
	Affected Post-op						
	Tooth		31	30	29		
	Palp		NS	NS	NS		
	Percuss		**NS**	NS	NS		
	Cold		NR	RNL	RNL		
	Mobility		P	P	P		
	Bite Force	0.042	0.044				0.043
PACKET 39	Pt #	Packet #					Avg
	97555591	39					
	Contra Pre-op						
	Tooth		11	12	13		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force	0.068	0.069	0.072	0.085	0.113	0.0814
	Affected Pre-op						
	Tooth		4	5	6		
	Palp		NS	NS	NS		
	Percuss		S+	S+	NS		
	Cold		S+NL	NR	S+NL		
	Mobility		P	P	P		
	Bite Force	0.045	0.028				0.0365
	Contra 1 hr Post-Op						
	Tooth		11	12	13		
	Palp		NS	NS	NS		
	Percuss		NS	NS	NS		
	Cold		RNL	RNL	RNL		
	Mobility		P	p	P		
	Bite Force	0.056	0.075	0.105	0.079	0.075	0.078
	Affected Post-op						
	Tooth		4	5	6		
	Palp		NS	NS	NS		
	Percuss		S+	S+	NS		

	Cold	S+NL	NR	S+NL			
	Mobility	P	P	P			
	Bite Force	0.077	0.061				0.069
PACKET 40	Pt #	Packet #					Avg
	97563310	40					
	Contra Pre-op						
	Tooth	30	29	28			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.234	0.227	0.287	0.356	0.323	0.2854
	Affected Pre-op						
	Tooth	19	20	21			
	Palp	S+B	NS	NS			
	Percuss	S+	NS	NS			
	Cold	NR	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.106	0.082				0.094
	Contra 1 hr Post-Op						
	Tooth	30	29	28			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			
	Mobility	P	p	P			
	Bite Force	0.252	0.322	0.338	0.239	0.259	0.282
	Affected Post-op						
	Tooth	19	20	21			
	Palp	S+B	NS	NS			
	Percuss	S+	NS	NS			
	Cold	NR	RNL	RNL			
	Mobility	P	P	P			
	Bite Force	0.052	0.105				0.0785
PACKET 41	Pt #	Packet #					Avg
	97559132	41					
	Contra Pre-op						
	Tooth	18	19	20			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	RNL	RNL			

Mobility	P		p	P			
Bite Force		0.223	0.137	0.169	0.149	0.171	0.1698
Affected Pre-op							
Tooth		31	29	28			
Palp	NS		NS	NS			
Percuss	S+		NS	NS			
Cold	S+L+		RNL	RNL			
Mobility	P		P	P			
Bite Force		0.146	0.061				0.1035
Contra 1 hr Post-Op							
Tooth		18	19	20			
Palp	NS		NS	NS			
Percuss	NS		NS	NS			
Cold	RNL		RNL	RNL			
Mobility	P		p	P			
Bite Force		0.178	0.124	0.177	0.135	0.175	0.1578
Affected Post-op							
Tooth		31	29	28			
Palp	NS		NS	NS			
Percuss	S+		NS	NS			
Cold	S+L+		RNL	RNL			
Mobility	P		P	P			
Bite Force		0.038	0.058				0.048

PACKET 42	Pt #	Packet #					Avg
	50465332	42					
	Contra Pre-op						
	Tooth	15	14	13			
	Palp	NS	NS	NS			
	Percuss	NS	NS	NS			
	Cold	RNL	NR	RNL			
	Mobility	P	p	P			
	Bite Force	0.066	0.108	0.143	0.083	0.155	0.111
	Affected Pre-op						
	Tooth	2	3	4			
	Palp	NS	NS	NS			
	Percuss	NS	S+	NS			
	Cold	RNL	S+L+	RNL			
	Mobility	P	P	P			
	Bite Force	0.141	0.127				0.134
	Contra 1 hr Post-Op						

Tooth	15	14	13			
Palp	NS	NS	NS			
Percuss	NS	NS	NS			
Cold	RNL	NR	RNL			
Mobility	P	p	P			
Bite Force	0.166	0.133	0.113	0.171	0.174	0.1514

Affected Post-op						
Tooth	2	3	4			
Palp	NS	NS	NS			
Percuss	NS	S+	NS			
Cold	RNL	S+L+	RNL			
Mobility	P	P	P			
Bite Force	0.056	0.047				0.0515