Examining the Relationship between Anticipated Pain and Actual Pain Associated with
Periodontal Surgery

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Abstract

Patients cite fear of pain as a reason for avoiding necessary dental treatment. The relationship between expected pain and actual pain, nor the factors that influence actual pain experienced following periodontal surgery have been well characterized. To measure anticipated pain, patients completed a visual analog scale (VAS) prior to surgery and a 7-day diary that included a VAS for actual pain and a record of pain medication and nutritional supplement use. Linear regression was used for statistical analysis. A positive correlation was found between anticipated pain and actual pain. Factors that influenced pain experienced after surgery included anticipated pain, age, sedation during surgery, and number of pain pills used. Patients who anticipated more pain experienced more pain following surgery. Older patients and patients who take less pain pills reported experiencing less pain. Recognizing factors that influence the amount of pain experienced can help practitioners provide appropriate accommodations for patients.
Acknowledgements

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<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
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<tr>
<td>CNS</td>
<td>Central nervous system</td>
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<td>COX</td>
<td>Cyclooxygenase</td>
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<td>CTG</td>
<td>Connective tissue graft</td>
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<td>DALY</td>
<td>Daily adjusted life year</td>
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<td>DAS</td>
<td>Dental anxiety scale</td>
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<td>DHA</td>
<td>Docosahexaenoic acid</td>
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<td>EPA</td>
<td>Eicosapentaenoic acid</td>
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<td>FFQ</td>
<td>Food frequency questionnaire</td>
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<td>HEI</td>
<td>Healthy eating index</td>
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<td>IDAF</td>
<td>Index of dental anxiety and fear</td>
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<tr>
<td>IV</td>
<td>Intravenous</td>
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<td>mg</td>
<td>Milligram</td>
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<td>MGG</td>
<td>Mucogingival graft</td>
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<tr>
<td>mm</td>
<td>Millimeter</td>
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<tr>
<td>NHANES</td>
<td>National health and nutrition examination survey</td>
</tr>
<tr>
<td>NSAID</td>
<td>Nonsteroidal anti-inflammatory drug</td>
</tr>
<tr>
<td>PCS</td>
<td>Pain catastrophizing scale</td>
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<tr>
<td>PNS</td>
<td>Peripheral nervous system</td>
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<tr>
<td>POP</td>
<td>Posterior occluding pair</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>rm ANOVA</td>
<td>Repeated measures analysis of variance</td>
</tr>
<tr>
<td>TNF</td>
<td>Tumor necrosis factor</td>
</tr>
<tr>
<td>VAS</td>
<td>Visual analog scale</td>
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<td>VIF</td>
<td>Variance inflation factor</td>
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Introduction

To maintain optimal overall health, it is essential to maintain oral health. In 2009, it was reported in the Canadian Health Measures Survey that 74.5% of Canadians had visited the dentist in the previous 12 months (Health Canada, 2009). This was higher than the 49.5% attendance reported by Nutrition Canada (Health Canada, 2009). The Canadian Health Measures Survey data regarding dental attendance included those patients who went for preventive care and for treatment (Health Canada, 2009). Based on the data collected, it cannot be determined if those who attended for preventive care would seek treatment if more invasive therapy, such as periodontal surgery, was required. It is encouraging to see higher numbers of Canadians attending the dentist because dental anxiety remains a barrier to treatment. Dental anxiety affects between 4.4% and 16.4% of Canadians (Chanpong, Haas, & Locker, 2005). One concern for patients with dental anxiety is the pain associated with dental treatment. One objective of the current study was to determine how the pain patients experience as a result of periodontal surgery compares to the pain they anticipated prior to dental surgery. Identifying factors that influence the amount of pain a patient experiences is another objective. It was hypothesized that patients expect more pain than they actually experience and this expectation of pain is one factor that causes dental anxiety. Factors including sex, type of surgery, nervousness toward dental treatment, supplement use, whether the patient had sedation during the surgery, age, smoking status, and anticipated pain were hypothesized to influence the amount of pain the patient would experience. If it is demonstrated that anticipated pain is overestimated, this could encourage more patients to seek necessary dental treatment. It is important for individuals to maintain their oral health because it is
essential for being able to consume a healthy and varied diet. The Canadian Health Measures Survey found that 12.2% of Canadians avoided certain foods because of impaired oral health (Health Canada, 2009). Edentulous adults comprised the largest percentage (25.5%) of those avoiding certain foods (Health Canada, 2009). The way people perceive dental treatment needs to change so individuals are not afraid of the treatment required to maintain an adequate dentition or repair an impaired dentition. This study will elucidate how anticipated pain compares to actual pain experienced as a result of two types of periodontal surgery—implant placement and soft tissue grafting. It will also examine what individual characteristics might cause an individual to experience more or less pain, for example, if age plays a role and how it affects the amount of pain experienced. This information will allow practitioners to inform patients using evidence based data as to the amount of pain they can expect as a result of surgery.
Chapter 1: Review of Literature

1.1 Oral Health and Dentition Status of Canadians

Oral health is an integral aspect of overall health. A complex relationship exists between an individual’s dental status, their food choices and, therefore, their overall nutritional status. The Oral Health Module of the Canadian Health Measures Survey revealed that 6.4% of Canadian adults (aged 20-79) are edentulous; meaning they have no natural teeth (Health Canada, 2009). The highest rate of edentulism was among older adults (aged 60-79) at 21.7% compared to the 40-59 year old age group with a rate of 4.4%. A full complement of teeth is considered to be 28 teeth, although an individual can have up to 32 teeth if there is no tooth loss and all four third molars are present. The average number of teeth that Canadian adults have is 24.53 teeth. Of the 93.6% of dentate Canadian adults, 42.3% have all 28 teeth, 36.7% have between 28 and 21 teeth, and 14.6% have fewer than 21 teeth (Health Canada, 2009). Thus, 57.7% of Canadian adults are missing one or more teeth and an impaired dentition can lead to negative health outcomes (Health Canada, 2009).
Figure 1.1: Dentition Status of Canadian Adults

1.1.1 Why Does Tooth Loss Occur?

People can lose their teeth for a variety of reasons including trauma and dental disease. In some cases, tooth loss can be due to extraction of a diseased tooth. A study performed in Ontario that examined the reasons for tooth extraction in general dental practices found periodontal disease accounted for more extractions of permanent teeth than dental caries (Murray, Locker, & Kay, 1996). Periodontal disease was the reason for 35.9% of extractions while dental caries only accounted for 28.9% of extractions (Murray et al., 1996). As age increased, periodontal disease became a larger contributor to the number of extractions. Periodontal disease was the reason for 60.6% of extractions in individuals between the ages 40 to 59 and 46.5% of extractions for those aged 60 and older (Murray et al., 1996). Based on a study from Brazil, improved access to oral health care has led to an overall decline in tooth loss, but dental caries and periodontal disease remain the primary reasons for tooth mortality (Montandon, Zuza, & Toledo, 2012). For adults between the ages of 45 and 81 years old, the primary reason for tooth extraction was due to periodontal disease (Montandon et al., 2012).

The periodontium is the foundation for teeth. The periodontium is comprised of the root cementum, periodontal ligament, alveolar bone, and the gingiva (Nanci & Bosshardt, 2006). Uncontrolled periodontitis, characterized by inflammation of the periodontium, is a major cause of tissue breakdown that leads to tooth loss because it can result in destruction of the connective tissues that hold the teeth in place (Nanci & Bosshardt, 2006). Maintaining the health of the periodontium is critical for retaining natural teeth. Other common reasons for tooth loss are dental caries, endodontic concerns
such as inflammation of the dental pulp, trauma resulting in fractured or missing teeth, extraction of impacted teeth, and removal of diseased teeth prior to prosthetic placement (Montandon et al., 2012).

Data from the Global Burden of Disease study showed that in 2010, 3.9 billion people were affected by oral health conditions (Marcenes et al., 2013). With all ages combined, untreated dental caries of permanent teeth was the most prevalent of these conditions; affecting 35% of the global population. Severe periodontitis had a global prevalence of 11% and severe tooth loss (defined as having fewer than 9 teeth remaining) had a global prevalence of 2% (Marcenes et al., 2013). In the US, the prevalence of periodontitis was assessed by the National Health and Nutrition Examination Survey (NHANES) (Eke et al., 2015). Beginning in 2009 a full-mouth periodontal examination was done as opposed to the partial-mouth examination that has previously been used. NHANES 2011-2012 found that 44.7% of adults aged 30 and older had periodontitis, which is a similar rate to the 47.2% found in the 2009-2010 survey (Eke et al., 2015). The highest prevalence of periodontitis was found among those living below the federal poverty line, who had less than a high school education, and who were current smokers (Eke et al., 2015). Using disability adjusted life years (DALYs), it was found that oral health conditions contributed to 224 years of healthy living lost per 100 000 people (Marcenes et al., 2013). Based on the oral health component of the Canadian Health Measures Survey, 16% of the adult population were found to have moderate periodontal disease (Health Canada, 2009). Thus, it is imperative to understand how oral health can be improved.
1.2 Food Choice Based on Dental Status

Missing teeth can limit an individual’s food choices and thereby alter overall health. For example, foods that are harder to masticate, particularly for older adults, include fruits, raw vegetables including root vegetables, tough meats, and hard breads like rye that have a healthier nutrient profile than white bread. Missing teeth can impact how food is prepared prior to consumption. Differences in dietary intake due to dentition were shown in a study of Finnish dental patients aged 30 years and older (n=7190) (Ranta, Tuominen, Paunio, & Seppanen, 1988). These patients were divided based on their dental status of dentate or edentate. The dentate group was further divided into those who had removable prosthetics and those who did not. The edentate group was divided into those who had both an upper and lower denture, which was considered adequate rehabilitation and those who had only one denture (either upper or lower) or no dentures, which was considered inadequate rehabilitation. It was found that the dentate population ate more fruits and vegetables, including root vegetables, than the edentate population. Among the dentate group, having a higher number of natural teeth increased the probability of the participant eating fruits, vegetables (including root vegetables), and meat. Analysis of the edentate group showed that having adequate rehabilitation was significantly associated with eating more fruits, vegetables, and root vegetables. In both the dentate and edentate groups, females were more likely to eat fruits, vegetables, and roots than males (Ranta et al., 1988). No statistical difference was found between the adequacy of dental rehabilitation and the likelihood that they consumed an easy to chew food like porridge within either the dentate or edentate group (Ranta et al., 1988). It can be inferred that individuals who lack adequate rehabilitation for their missing teeth avoid foods that are
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harder to chew like fruits and raw vegetables. This is a common theme that had been found among individuals who are missing teeth (Joshipura, Willett, & Douglass, 1996; Ranta et al., 1988; Sahyoun, Lin, & Krall, 2003; Sheiham, Steele, Marcenes, Finch, & Walls, 1999).

Using the oral health survey of the British National Diet and Nutrition Survey, the relationship between dentition status and food choice was examined for adults aged 65 years and older (Sheiham et al., 1999). An oral examination was performed for each participant. The number of contact points between opposing teeth (top and bottom) was recorded for dentate individuals; anyone with some remaining natural teeth, as this affects one’s ability to chew effectively. All the edentate participants had dentures. Data on food choice was gathered by giving participants a list of sixteen food items that ranged in masticatory difficulty from bread to foods like carrots or steak. Participants were asked to indicate the amount of difficulty they thought they would experience when eating the specific food item by whether they could eat it easily, with some difficulty, or not at all. Within the dentate group, 28% of participants reported having difficulty eating apples or not being able to eat apples at all. That number increased to 50% within the edentate group. The difference between the dentate compared to the edentulous groups’ ability to eat tomatoes, raw carrots, apples, and nuts were significant with more individuals in the edentulous group reporting difficulty with these foods. For example, with regards to eating tomatoes, the edentulous group was 3.6 times more likely to report having difficulty. However, the ability to eat softer and less nutrient dense foods like bread, toast, cheese, roasted potatoes, cooked greens, and chocolate did not differ significantly between groups. It was also found that the number of natural teeth remaining affected the
ability to eat certain foods within the dentate group. Of the participants with 1 to 10 teeth, 45% reported that they had difficulty eating or could not eat apples whereas of the participants with 21 or more teeth, only 12% reported difficulty or inability to eat apples. 26% of participants with 11 to 20 teeth reported difficulty or inability to eat apples (Sheiham et al., 1999).

A longitudinal survey was performed to investigate how tooth loss affects dietary intake (Joshipura et al., 1996). Over a four-year follow-up period of over 30,000 participants, 279 participants lost five or more teeth and these individuals significantly reduced their intake of apples and pears during this time period. Moreover, both groups (those who lost teeth and those who did not) reduced their cholesterol intake. The group who lost teeth reduced cholesterol intake by 11 mg while the group who did not lose teeth reduced their cholesterol intake by 29 mg (Joshipura et al., 1996). This could be an indication that although both groups decreased cholesterol intake, possibly due to public education regarding the risks of a high cholesterol diet, those who lost teeth were unable to decrease their intake as much because foods that they are able to chew easily were higher in cholesterol. Similar to other studies, it was found that intake of pears, apples, and carrots increased as number of teeth increased (Joshipura et al., 1996).

Knowing that dental status affects an individual’s ability to eat certain nutritious foods like raw vegetables or various fruits and even some meats, there is concern that people with inadequate dental status can be at risk for nutritional deficiencies. Based on the dietary habits of the participants in the study by Sheiham et al., the authors suggested that having 20 or more teeth was usually adequate for eating most foods (Sheiham et al., 1999). It has also been suggested that perhaps a better proxy for measuring masticatory
ability is the number of posterior occluding pairs (POPs) that an individual has. POPs are the number of molars or premolars where both the opposing mandibular and maxillary teeth are present (Loney, 2007). In one study, individuals with five pairs of POPs, out of a possible eight, were considered to have adequate dentition (Sahyoun & Krall, 2003). Individuals with more POPs can chew more effectively and are therefore able to eat a wider variety of foods that are more nutrient dense such as fruit and raw vegetables. Individuals with fewer than five POPs were more likely to avoid certain foods and eat a less varied, nutritious diet. Because there is a pattern in the types of foods that people with impaired dentition tend to avoid (raw vegetables, fruit, well cooked meat) or based on the way they choose to prepare certain foods to make them easier to manage, they can become at risk of missing key nutrients from their diet.

1.2.2 Impaired Dentition Can Affect Nutrient Intake

It has been shown that missing natural teeth limits food choice because people avoid foods that they find difficult to masticate, but it has not been well established if these limitations lead to specific nutrient deficiencies (Ranta et al., 1988). However, there is an increasing body of evidence that suggest intakes of specific nutrients might be lower than recommended. In a study of male health professionals that determined food and nutrient intake via a questionnaire, edentulous participants were shown to consume significantly fewer vegetables and a lower amount of dietary fiber than their counterparts with 25 or more teeth (Joshipura et al., 1996). The edentulous participants’ intake of beta-carotene and crude fiber was also significantly lower, while total caloric intake, cholesterol, and saturated fat intake were significantly higher than those with 25 or more teeth. Using the questionnaire, there was no significant difference found between groups for fruit or
vitamin C intake (Joshipura et al., 1996). While dietary assessment using food intake
questionnaires provide useful information there are some limitations associated with this
method of data collection. Food frequency questionnaires are limited to the select foods
and methods of preparation on the form, 24-hour dietary recalls are limited by recall of
foods and quantities eaten, and individuals might alter the way they eat if they know they
have to record it in a food record (Subar et al., 2015).

To more accurately assess nutrient intake, hematological and biochemical markers
can be measured. One such study had participants aged 65 and older keep a four-day food
diary as well as have blood and urine samples analyzed to see how reported nutrient
intakes compared to those in the participants’ system (Sheiham et al., 2001). The sample
consisted of 407 dentate participants and 346 edentulous participants who had dentures.
Analysis of the food diaries showed that edentate people consumed less protein, intrinsic
sugars, milk sugars, fiber, calcium, non-heme iron, riboflavin, thiamin, niacin,
pantothenic acid, vitamin E, and vitamin C. These findings suggest that edentate
compared to dentate participants consumed a less varied diet and had a less nutrient diet.
Biochemical and hematological analysis was used to measure a number of nutrients,
which had previously been identified to be at risk due to food restrictions caused by poor
dental status (Sheiham et al., 1999). The biochemical analysis included such nutrients as
iron, ascorbate (vitamin C), vitamin D, retinol, α-tocopherol, and γ-tocopherol. However,
the analysis revealed that only plasma ascorbate and plasma retinol was statistically
different between the dentate and edentate participants (Sheiham et al., 2001). This shows
a discrepancy between information found using the food diaries versus the biological
analysis. This might be an indication that individuals underreport their intake in the food
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diaries and/or that edentulous individuals take nutritional supplements to account for the nutrients they are unable to obtain from their diet. In an analysis of the food diaries for the dentate where number of teeth was a cofactor, those with more teeth reported higher intake of protein, fat, and carbohydrate as well as fiber, intrinsic sugar, milk sugar, calcium, non-heme iron, pantothenic acid, vitamin C, and vitamin E (Sheiham et al., 2001). Intake of these nutrients as well as vitamin A, thiamin, riboflavin, and niacin was significantly associated with number of posterior occluding pairs. When analyzing the biological measurements of the dentate participants based on number of teeth remaining, only plasma ascorbate was significant (Sheiham et al., 2001). Plasma retinol was lower in the edentate group than the dentate group, but was not associated with number of teeth remaining or posterior occluding pairs (Sheiham et al., 2001). Dentate participants reported higher intake of most nutrients, but biological analytes revealed that plasma ascorbate and plasma retinol were significantly lower in edentate participants. This shows that although there are some discrepancies between reported intake and that found biologically, edentate participants had lower levels of specific nutrients than dentate participants did.

A similar study was conducted using data from the third National Health and Nutrition Examination Survey (NHANES III) (Sahyoun et al., 2003). The aim was to assess diet quality by looking at a battery of data including dietary intake, Healthy Eating Index (HEI), serum nutrient levels, and BMI (Sahyoun et al., 2003). Dietary intake was evaluated using a 24-hr recall. The HEI was a measure used to evaluate NHANES data and determine how closely the diet met the federal recommended guidelines (Center for Disease Control and Prevention). Serum levels of vitamin C, vitamin E, folate, and beta-
carotene were selected as indicators of nutritional status. The nutrient intake reported by the 24-hr recall indicated that carotenes (including beta-carotene), folate, and ascorbic acid were significantly lower for people with 1 to 4 posterior occluding pairs than people with 5 to 8 posterior occluding pairs. Vitamin A was significantly lower for edentulous participants and participants who wore full dentures, and dietary fiber was highest for those with 5 to 8 posterior occluding pairs and lowest in the edentulous group. When serum levels of these nutrients were measured, it was found that only beta-carotene and vitamin C were significantly associated with number of posterior occluding pairs. There was a positive relationship between a higher number of posterior occluding pairs and higher serum levels of vitamin C or beta carotene. Serum folate was lower in denture wearers than it was in people with 5 to 8 posterior occluding pairs (Sahyoun & Krall, 2003). HEI scores were higher for those with 5 to 8 posterior occluding pairs, but all groups fell between 51 and 80 indicating that their diet needs improvement (Sahyoun & Krall, 2003). This data suggests that the number of posterior occluding pairs might be more important for maintaining diet quality over number of teeth alone as having occluding pairs makes mastication easier.

In both of the previously discussed studies, vitamin C status was associated with number of teeth or posterior occluding pairs remaining (Sahyoun & Krall, 2003; Sheiham et al., 2001). One possible explanation for this is that many of the foods that are good sources of vitamin C like broccoli, brussels sprouts, and carrots must be cooked and softened to make them more manageable by people who are missing teeth. Depending on the method of cooking, this can decrease the amount of vitamin C available by up to 38% (Yuan, Sun, Yuan, & Wang, 2009). It is important to note that the intake of vitamin C
reported in food diaries in the two studies also indicates decreased overall consumption of vitamin C, likely because rich sources of vitamin C are deemed difficult to chew by those who are missing teeth (Sahyoun & Krall, 2003; Sheiham et al., 2001).

Poor nutritional status and/or consuming nutrients at lower than recommended levels, which can originate from compromised dental status, can put an individual at risk for chronic disease. Vitamin C and carotenoids were nutrients that repeatedly appeared to be affected by dental status. Fruits and vegetables are excellent sources of vitamin C and carotenoids. Dark leafy greens and broccoli are a high source of both nutrients. Common sources of vitamin C include citrus fruits, berries, and kiwi fruit and good sources of carotenoids include sweet potatoes and carrots. There is epidemiological evidence that a diet high in fruits and vegetables is protective against oral cancer (Pavia, Pileggi, Nobile, & Angelillo, 2006). A meta-analysis of observational studies on the topic revealed a reduced risk of oral cancer in men and women based on fruit and vegetable intake. The effect did not change when green vegetables were compared to overall vegetable consumption, whereas citrus fruit revealed a greater protective effect compared to overall fruit consumption (Pavia et al., 2006). This points to the potential role of vitamin C specifically and the importance of individuals being able to continue to access foods that provide adequate levels of this nutrient. Epidemiological evidence is also available that suggests a diet high in fruits, vegetables, and whole grains can decrease the risk of coronary heart disease and all-cause mortality (Steffen et al., 2003). There was also an association found between vitamin C and decreased probing depth following scaling and root planning in patients with chronic generalized periodontitis (Dodington, Fritz,
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Sullivan, & Ward, 2015). The decreased probing depth was an indicator of improved healing following the scaling and root planning procedure (Dodington et al., 2015).

Improving masticatory ability by either preserving natural teeth through soft tissue grafts or replacing missing teeth with dentals implants may reduce the risk of chronic disease by enabling individuals to eat a nutritious diet. As shown in Figure 1.2, when patients are missing teeth or are at risk of missing teeth they can become caught in a detrimental cycle that can ultimately set them on a trajectory for chronic disease development through inclination to choose soft, easy to chew, but often less nutritious foods. Unfortunately many people avoid seeking the treatment they need to preserve existing or replace missing teeth due to dental anxiety and fear.

Figure 1.2: Individuals can become stuck in this cycle of disease progression where poor nutritional status can lead to poor oral health and vice versa.
1.3 Dental Fear and Anxiety

Fear and anxiety toward dental procedures is widespread. Among Canadian adults, the prevalence of dental anxiety ranges from 4.4% to 16.4% (Chanpong et al., 2005). In a survey evaluating attitudes towards sedation and general anesthesia in dental practice, participants were asked about how often they attend dental clinics and reasons behind infrequent or missed appointments. It was found that 7.8% of participants had avoided the dentist in the past year because of fear or anxiety (Chanpong et al., 2005). Of all the participants, it was found that 5.5% had a high level of fear, indicating that they were either “very afraid” or “terrified.” An additional 30.5% of participants indicated lower levels of fear. 7.6% of participants had missed, cancelled, or avoided going to the dentist because of fear. Participants with high levels of fear were significantly more likely to miss, cancel, or avoid an appointment than those with lower levels or no fear (Chanpong et al., 2005). The avoidance of seeking dental treatment due to fear and anxiety is a problem because individuals might not receive necessary treatment to maintain or improve oral health. The importance of oral health on overall health has been clearly established with poor oral health being related to respiratory infections, cardiovascular disease, diabetes, low birth weight babies, and poor nutrition (King, 2012).

Understanding dental fear and anxiety related to the pain associated with dental surgery, specifically periodontal surgery, might allow dental professionals to reduce the anxiety and fear that a patient experiences. This would encourage more people to seek dental care and ultimately have better overall health.

When a patient is nervous or stressed about treatment, their anxiety can affect the way they experience or respond to the treatment (Eli, Schwartz-Arad, Baht, & Ben-
Pain associated with periodontal surgery

Tuvim, 2003). There are a number factors in addition to fear that can increase an individual’s nervousness about the treatment. When young adults were surveyed regarding their dental care practices, 36% of respondents reported “lack of time” as a reason for irregular visits. 34.1% reported that they did not have regular attendance because they felt that treatment was not needed, while 16.6% reported that cost of treatment limited their attendance, and 13.1% reported that fear kept them from the dentist (Quteish Taani, 2002). Among the young adults surveyed, those who had regular dental attendance (20.9%) reported lower dental anxiety than those who had irregular attendance (79.1%). In an Australian study, patients were divided into high dental anxiety and low dental anxiety groups based on responses to the Index of Dental Anxiety and Fear (IDAF-4C). All patients were asked if they were currently avoiding the dentist and the reason behind their avoidance. Patients in both the high dental anxiety and low dental anxiety groups reported cost as the reason for avoidance most frequently (72.5% and 70.0%, respectively). In the high dental anxiety groups, the next most common reasons for avoidance included fear or anxiety reported by 55.6%, not liking the dentist was reported by 41.2%, and their concern about the pain or having an unpleasant experience was reported by 41.1% of patients (Armfield & Ketting, 2015). In the low dental anxiety group, the second most common reason for avoidance following cost was lack of time reported by 38.8% (Armfield & Ketting, 2015). Patient concerns regarding dental visits differ greatly based on how they perceive the dentist and dental treatment. Some psychological aspects of dental treatment are the cause of a patients’ nervousness. Previous reports have shown that patients report more anxiety toward dental treatment when they have previously had a painful dental experience (Armfield & Ketting, 2015;
Bare & Dundes, 2004). For example, one study found that the severity of a previous negative experience was associated with higher dental anxiety and avoidance of dental treatment (Armfield & Ketting, 2015). Negative experiences included pain, discomfort, gagging, fainting or feeling light-headed, embarrassment, and having a personal problem with the dentist. There was a significant relationship between fainting and embarrassment among patients with high dental anxiety and avoidance of dental treatment. Participants characterized with low dental anxiety who were avoiding the dentist had a significant relationship with previous pain or fainting related to their dental visit (Armfield & Ketting, 2015). It has also been reported that some patients feel anxious when there is a perceived loss of control in their dental treatment (Bare & Dundes, 2004; Maggirias & Locker, 2002). It is important in these situations that the dental professional is able to identify a nervous patient and effectively communicate with them. This helps build trust between the patient and the dental professional, which can reduce anxiety and help the patient feel more in control of their treatment (Bare & Dundes, 2004). Fear of the pain associated with treatment is pervasive. Targeting this aspect of dental anxiety by determining how much pain patients actually experience following periodontal surgery through evidence-based data might help reduce avoidance of such treatment.

1.4 Methods for Evaluation of Dental Anxiety

Cortisol is a steroid hormone that is produced by the adrenal glands. It is part of the sympathetic nervous system’s response to stress. It is often used as a biomarker for psychological stress (Hellhammer, Wust, & Kudielka, 2009). In one study, salivary cortisol levels were measured in each patient at four different time points (one week before surgery, day of surgery, 3 days post-surgery, and 6 days post-surgery) to try and
capture the physiological response to the stress and anxiety of impending periodontal surgery (Hashem, Claffey, & O'Connell, 2006). Saliva samples were collected between 8:00 and 10:00 AM to try and control for the significant diurnal variation that occurs with cortisol levels, however, no significant changes in cortisol levels were found over time (Hashem et al., 2006). The relationship between salivary cortisol levels and dental anxiety has been examined in different ways (Brand, 1999). Prior to dental treatment, patients completed a dental anxiety scale (DAS) and a visual analog scale (VAS) for dental anxiety and urine and saliva samples were collected to measure cortisol levels (Brand, 1999). The scale used to measure pain in dental clinic settings is usually a VAS. This is a 100mm line with anchors that read something comparable to “no pain” at one end and “worst pain imaginable” at the other. The scale used to measure anxiety varies with some researchers opting for the DAS, which is a questionnaire that evaluates patients’ anxiety, developed by Corah in 1969. Patients answer a series of questions that are scored and totaled for a score out of twenty. A score between 9 and 12 indicates moderate anxiety, 13 to 14 indicates high anxiety, and a score between 15 and 20 indicates severe anxiety or dental phobia. Other researchers opt to use a VAS with anchors such as ‘not nervous’ to ‘terrified’ at either end to measure dental anxiety (Eli et al., 2003; Fardal & McCulloch, 2012; S. Kim, Lee, Lee, Moon, & Chung, 2013). Patients were classified as having high or low dental anxiety based on their DAS score and there was no significant difference in salivary cortisol levels between groups. Urinary cortisol levels were significantly higher in the high versus the low dental anxiety group. When patients were divided into high and low anxiety groups using the VAS rating there was no relationship found between salivary cortisol and anxiety, but urinary cortisol was
higher in the high anxiety group (Brand, 1999). The conflicting results between saliva and urine cortisol could be a result of the dynamic release of cortisol in the face of stressful events. For example, salivary and urinary cortisol levels did not correlate (Brand, 1999). Salivary cortisol levels are susceptible to acute changes while urinary cortisol levels are more stable. However, these results must be interpreted cautiously because all cortisol samples were collected between 9:00 and 11:00 AM to control for diurnal variation, but this could also mean that they did not accurately capture the cortisol levels resulting from dental anxiety alone (Hashem et al., 2006). The relationship between high dental anxiety scores and urinary cortisol levels could be confounding. Because urinary cortisol levels are more stable over time, it is possible that people with high dental anxiety also experience high anxiety in other aspects of their life. Both urinary and salivary cortisol measures have their limitations as chronic stress, long-term exercise, and sex hormones can all affect cortical release and therefore confound the level of cortisol in response to a short-term stressor like dental surgery (Hellhammer et al., 2009). Cortisol levels were not measured in this thesis study because of the significant diurnal variation that occurs and the previous insignificant relationship between salivary cortisol and dental anxiety. In my thesis study, it was not practical to collect urine samples from these patients or to control for diurnal variation by having a patient visit at a predetermined time. Furthermore, other methods can be used to measure or interpolate an individual’s anxiety toward dental treatment, including DAS, VAS for anxiety, and even whether or not an individual chooses to have sedation during their surgery can be an indication of their anxiety. The current study used a VAS pain score to measure anticipated and actual pain because it was a user-friendly, unbiased measure of pain.
Using the VAS allowed patients to complete the VAS at home for each of the seven days. This minimized the encumbrance involvement in the study had on their lives, encouraging more people to participate.

1.5 Compromised Periodontal Health Due to Dental Fear and Anxiety

It can be interpolated that an individual wishes to have sedation or general anesthesia during dental treatment because they experience dental fear or anxiety. When asked about various dental procedures including: routine cleaning, fillings or caps, root canal, periodontal surgery, and extraction; 68.2% of respondents indicated that they would prefer to have sedation or general anesthesia during periodontal surgery than go without (Chanpong et al., 2005). Of the five dental procedures that were included in the survey, periodontal surgery (68.2%) had the highest preference for sedation or general anesthesia followed by root canal (54.7%) and tooth extraction (46.5%) (Chanpong et al., 2005). The fear of pain and associated anxiety can be a barrier to seeking periodontal treatment. What remains to be answered is if the anticipated amount of pain is comparable to the actual amount of pain experienced. If dental fear inhibits patients from seeking the appropriate treatment they may remain in the cycle of disease progression (Figure 1.2).

1.6 Impact of Anxiety on Pain Perception

There is currently limited research available that investigates the relationship between periodontal surgery (implants and soft tissue grafts) and associated pain. Studies have primarily focused on anxiety related to periodontal surgery and the impact of dental anxiety on pain experienced, and specifically implant surgery (Eli et al., 2003; Fardal & McCulloch, 2012). Therefore, there needs to be further research done on the pain
Pain associated with periodontal surgery

experienced as a result of soft tissue graft surgery, an important step in preserving natural teeth. Findings from these studies have shown how anxiety can influence the amount of pain experienced following surgery. For example, one study found that the best predictor of expected pain following surgery was anxiety toward dental surgery and it remained the best predictor for amount of actual pain reported immediately after surgery (Eli et al., 2003). Thus, patients who were most anxious and anticipated higher pain in fact experienced greater pain. A different study also found that those with the highest pretreatment anxiety had significantly higher pain scores than those with the lowest pretreatment anxiety (Fardal & McCulloch, 2012). Using a VAS to measure pain and both the DAS and VAS for anxiety, it was found that both anxiety and pain scores were highest before surgery (Eli et al., 2003). Both anxiety and pain immediately after surgery were significantly lower than immediately before. There was an additional decrease from immediately after surgery to four-weeks post-surgery in the amount of anxiety they reported. Also, patients recalled a higher amount of pain at the 4-week follow-up appointment than they reported immediately after surgery (Eli et al., 2003). This could be because the analgesic in used in sedation would have provided pain relief on the day of surgery, but inflammation and swelling would have been a source of pain post-surgery following the clearance of anesthetic. The time points where pain VAS were completed did not capture the amount of pain patients experienced in the days immediately after surgery.

A similar study was conducted to investigate the relationship between dental anxiety and pain experienced with additional assessment times (S. Kim et al., 2013). Pain and anxiety was recorded at four time points: immediately before surgery, immediately after
Pain associated with periodontal surgery

surgery, 1 day post-surgery, and 1 week post-surgery. Pain score was shown to be the highest on day 1 post-operatively, which is a time point not captured in the study previously discussed (Eli et al., 2003; S. Kim et al., 2013). At day 1 post-surgery, the pain score was significantly associated with the dental anxiety score. This was determined by DAS score and VAS pain score increasing at this time (S. Kim et al., 2013). It was also found that females reported significantly more pain and were more anxious than males at each time point measured (S. Kim et al., 2013). However, in a different study there was no statistically significant difference between males and females in mean pain score, but females did have higher mean anxiety scores than males (Fardal & McCulloch, 2012). Another study examined the relationship between dental anxiety and pain where patients recorded their average pain and worst pain on a VAS for 6 days post-operatively (Hashem et al., 2006). It was found that both average pain and worst pain decreased significantly over time. The Spielberger self-evaluation questionnaire was used to assess anxiety in this group of patients. The anxiety questionnaire was analyzed at three time points: 1 week before surgery, the day of surgery, and 6 days post-surgery. When compared to the other two time points, they found that anxiety on the day of surgery was significantly higher (Hashem et al., 2006). Interestingly, they did not find a strong correlation for those reporting high anxiety and those reporting the worst pain scores (Hashem et al., 2006). This insignificant finding could be a result of the small (18 patients) sample size (Hashem et al., 2006). A study needs to be conducted in the field of periodontal pain related to surgery with a larger sample size to increase the reliability of the relationships that have been found thus far. Additionally, the relationship between anticipated pain and actual pain experienced should be further investigated in a larger
population with consideration of potential influences such as sex and age and the extent to which different periodontal surgeries may predict pain experienced.

For clinical application, having a large sample of evidence regarding how much pain patients experience following surgery will allow dentists to accurately inform future patients about pain expectations. This study will also contribute to the field because it will explore the relationship between many factors and how they affect the amount of pain a patient experiences. There are no studies currently available that explore the relationship between nutritional supplement use and pain following periodontal surgery.
Figure 1.3: Cycle of Disease Progression. Individuals might avoid seeking necessary treatment for periodontal disease because they fear the pain associated with surgery. This traps them in a disease cycle that puts them at risk for poorer oral health status and increased risk of chronic disease. If periodontists can guide individuals about the actual pain associated with periodontal surgery, patients will be better informed and may be more inclined to seek the treatment and end the cycle.
1.7 Pain Medication and Nutritional Supplement Use May Modify Pain Experience

Moderate inflammation tends to follow periodontal surgeries including soft tissue grafts and placement of dental implants (Santana et al., 2005). The five cardinal signs of acute inflammation are redness, heat, pain, swelling, and loss of function. Because inflammation causes increased pain in the affected area, anti-inflammatory drugs are often prescribed following periodontal surgery to suppress the inflammatory response. The cyclooxygenase enzyme (COX) is an important enzyme in the inflammatory process. It is responsible for the synthesis of prostaglandins, which are associated with many of the signs of inflammation: redness, heat, pain, and swelling (Ricciotti & FitzGerald, 2011). Prostaglandins also make nerve endings more sensitive, meaning that pain is felt more intensely (Brenner and Stevens, 2010). Managing pain and inflammation is an important part of the recovery process following surgery. As seen in Figure 1.2, patients might avoid seeking periodontal treatment because they fear the associated pain. Pain medication is a method used to manage pain following periodontal surgery. Acetaminophen is a nonsteroidal anti-inflammatory drug (NSAID). Its mechanism of action is to decrease the synthesis of prostaglandins by competitively inhibiting COX. Acetaminophen is effective at relieving pain because it helps reduce inflammation (Brenner and Stevens, 2010).

Some individuals might seek nutritional supplements to help control or reduce pain following surgery. Others might take supplements on a regular basis, but those supplements could inadvertently help with the pain following surgery. Some supplements may exert anti-inflammatory effects. One study investigated if choline supplementation attenuates postoperative pain (Sidhu et al., 2013). Choline was of interest because it is a
selective activator of α7 nicotinic acetylcholine receptors (Sidhu et al., 2013). These receptors are part of the central and peripheral nervous system. When they are activated, the production of pro-inflammatory cytokines is reduced. Although preclinical studies were in favour of an analgesic effect caused by choline supplementation, a double-blind randomized trial of choline supplementation found no difference in pain reported between those who had taken choline supplements and those who had not (Sidhu et al., 2013). Tumor necrosis factor (TNF) was also measured as it is a cytokine that can be used as a marker of inflammation, but there was no difference in TNF levels between the two groups (Sidhu et al., 2013). The study concluded that the level of choline was not sufficient to exert the hypothesized anti-inflammatory effect and that IV administration may be required (Sidhu et al., 2013). Glucosamine is another supplement that may exert anti-inflammatory effects. Some studies have shown it to be an effective treatment for the pain associated with osteoarthritis, and its potential analgesic effects have been reported in a dental model (Kaida, Yamashita, Toda, & Hayashi, 2014). Pulpalgia is pain arising from dental pulp, which is the connective tissue at the centre of the tooth. An in vitro rat model was used to execute the study. Nociceptive sensitivity of the pulpal nerve was used as a measure of pain (Kaida et al., 2014). Bradykinin was used as a nerve stimulant. The rate of nerve firing was measured after application of glucosamine and after a physiological saline control (Kaida et al., 2014). The nerve firing was significantly lower in the glucosamine group indicating that pain signals are not being sent as rapidly. This indicates that glucosamine might help reduce dental pain (Kaida et al., 2014). Given the vast array of nutritional supplements and their various anti-inflammatory mechanisms, patients recorded their supplement use so it could be taken into account when looking at
how much pain they experienced or how many pain pills they used. It is novel for this study to quantify pain pill usage and to examine nutritional supplement use in this population.

1.8 Factors that May Influence Actual Pain and Pain Pill Usage Following Periodontal Surgery

There are a number of factors that may influence actual pain and pain pill usage following periodontal surgery. In the table below, I have summarized the specific factors to be used in my analyses. The specific rationale for including each factor in these analyses is based on existing literature.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>There have been some sex-differences in reporting of pain perception and willingness to report pain experienced (Heft, Meng, Bradley, &amp; Lang, 2007). For example, women report expecting less pain prior to surgery, but recall more pain four weeks post-surgery compared to men (Eli, Baht, Kozlovsky, &amp; Simon, 2000).</td>
</tr>
<tr>
<td>Type of Surgery</td>
<td>A difference in pain post-surgery was found among three types of periodontal surgeries: implant placement, crown lengthening and open flap debridement (Tan, Krishnaswamy, Ong, &amp; Lang, 2014). Duration of surgery was a factor that modulated pain post-surgery.</td>
</tr>
<tr>
<td>Nervousness</td>
<td>Anxiety toward dental treatment can result in greater perceived pain following treatment (Eli et al., 2003; Fardal &amp; McCulloch, 2012).</td>
</tr>
<tr>
<td>Anticipated Pain</td>
<td>Although anxiety predicts pain experienced, the relationship between anticipated pain and actual pain has not been determined. There is evidence that anticipated pain is greater than actual pain, but this relationship requires further investigation (Eli et al., 2003).</td>
</tr>
</tbody>
</table>
### Sedation

Dexamethasone is routinely administered to patients undergoing IV conscious sedation. Because dexamethasone reduces synthesis of various pro-inflammatory cytokines, it has analgesic effects that can modulate the pain experienced (Musba et al., 2015).

### Age

Pain perception changes with age. One study showed that older patients entering the emergency department reported lower amounts of pain for certain conditions, such as migraine, than younger patients. However, no age difference was found for other conditions such as extremity fractures (Daoust et al., 2016). It is therefore of interest to determine if age modulates the amount of pain patients experience following periodontal surgery.

### Smoking Status

Smoking following third molar extraction led to increased pain (Larrazabal, Garcia, Penarrocha, & Penarrocha, 2010). It was therefore hypothesized that smoking would also lead to increased pain following periodontal surgery.

### Nutritional Supplement Use

Many nutritional supplements such as DHA and EPA exert anti-inflammatory effects, and are associated with improved healing following sanative therapy, a routine periodontal procedure (Dodington et al., 2015).

### Actual Pain (for predicting pain pill use)

It is hypothesized that individuals who experience more pain will take more pain pills (ibuprofen) because they are instructed to take ibuprofen every 6 hours as needed.

### Pain Pills (for predicting actual pain)

It is hypothesized that those who take more pain pills will experience less pain because the ibuprofen will reduce inflammation and swelling (H. J. Kim, Lee, Im, Kim, & Lee, 2010).

### 1.9 Summary and Rationale

Oral health is important for overall health and reduced risk of chronic disease. A barrier to treatment for many oral health conditions including periodontal concerns is dental fear or anxiety (Figure 1.4). Knowing the amount and duration of actual pain
Pain associated with periodontal surgery

experienced by patients following dental implant and soft tissue graft surgeries will allow for development of evidence-based guidelines for how much pain they can expect to experience following surgery. This might help attenuate the anxiety they experience prior to periodontal surgery because it is hypothesized that anticipated pain will be less than actual pain. It is desirable to decrease patient anxiety prior to surgery because in previous studies, anxiety has been shown to predict the amount of actual pain experienced immediately after surgery. Providing evidence for how much pain a patient actually experiences may remove the “unknown” that can promote fear and anxiety, and encourage them to undergo procedures to maintain or improve oral health. In turn, this supports optimal overall health and reduces the risk of chronic disease development.
Figure 1.4: The purpose of this study is to determine how actual pain experienced following periodontal surgery compares to anticipated pain. The fear of anticipated pain can be a barrier to seeking treatment. Gathering evidence-based accounts of how much pain is experienced might ease the anxiety and fear of surgery allowing patients to undergo the treatment and end the cycle and allow them to consume a more healthful and varied diet. The yellow circle indicates the critical point where patients can allow their fear to prevent them from seeking treatment, leaving them trapped in the cycle or where they can overcome their fear and seek treatment to end the cycle. It is this point in the cycle that this study will address.
Chapter 2: Objectives and Hypotheses

2.1 Objectives

To determine:

1. the relationship between anticipated pain and actual pain experienced following the periodontal surgery.
2. the factors that predict the amount of pain and the amount of pain medication use following periodontal surgery.

2.2 Hypotheses

1. Experienced pain will be significantly less than anticipated pain.
2. The following factors will affect pain: sex, type of surgery, nervousness, anticipated pain, sedation, age, smoking status, supplement use, and pain pill usage.
3. The following factors will affect pain pill usage: sex, type of surgery, nervousness, anticipated pain, sedation, age, smoking status, supplement use, and actual pain.
Chapter 3: Methods

3.1 Study Design

This was an experimental study. The intervention that applied was periodontal surgery. The outcomes of interest were the amount of pain experienced and pain medication use.

Patients were recruited from a periodontal clinic in Southern Ontario. Those who were in need of dental implant surgery or soft tissue graft surgery were eligible to participate. Exclusion criteria were the following:

- Patients could not participate if they regularly took pain medication for preexisting health conditions.
- Patients who previously had implant or soft tissue graft surgery because they knew approximately how much pain to expect.
- Patients had to be 19 years of age or older.

This study received ethics clearance from the human bioscience research ethics board of Brock University, St. Catharines, Ontario (File # 13- 172- WARD). Patients were presented with a letter of invitation by a dental assistant during their consultation prior to surgery. If patients were interested in participating in the study, written informed consent was obtained prior to surgery. Patients then filled out a 100mm VAS prior to surgery indicating the amount of pain they anticipated as a result of their surgery with 0 mm meaning no pain and 100 mm meaning worst pain imaginable (Figure 3.1).
On the line below, mark the level of pain you expect to experience due to your periodontal procedure with an “X”.

No Pain          Worst Pain Imaginable

**Figure 3.1**: Visual Analog Scale (VAS) for expected pain caused by periodontal procedure that is completed before procedure.

Patients were instructed on how to complete the 7 day diary before the surgery. Because they did not have the initial pain VAS they filled out prior to surgery, they were not able to compare their anticipated pain score with their score for actual pain experienced. The periodontal surgery (either the dental implant placement or the soft tissue graft) was then performed by the periodontist. The same periodontist performed all the surgeries. Patients are routinely instructed to take 600 mg ibuprofen preoperatively and every six hours following as needed. This was the same instruction given to patients in this study. Patients completed Day 1 of the diary on the same day they had the surgery and for each consecutive day following for a total of seven days. Each day in the diary, the patients completed a VAS indicating the amount of pain they were currently experiencing, the number of pain pills they took to manage their pain, the number of alcohol servings they had, and the number of cigarettes or cigars they smoked. Patients were also asked to list any non-prescription medication or supplements they used. Part of routine care following surgery for patients includes a phone call from a nurse 24 hours postoperatively. For patients involved in the study, part of this call included a reminder to complete their diary and gave them an opportunity to ask any questions they might have had about how to complete the diary. Patients had a follow-up appointment two weeks after their surgery. It was during this follow-up visit that patients returned their completed
Pain associated with periodontal surgery

diary. When the receptionist called to remind the patient of their two week appointment, the patient was reminded them to bring their completed diary with them. If a patient forgot to bring their completed diary to their follow-up appointment, they were given an envelope with prepaid postage to mail the diary to the clinic.

Figure 3.2: Study Timeline for Each Patient

3.2 Periodontal Procedures

The type of surgery the patient had was recorded from their patient record. The two procedures of interest were dental implant placement and soft tissue grafts. The number of implants or teeth that needed tissue grafting and their location were recorded. Whether the patient was sedated was recorded because they were concomitantly given dexamethasone. Dexamethasone is a glucocorticoid, which exerts anti-inflammatory effects by inhibiting the synthesis of prostaglandin E2 and reduces swelling (Musba et al., 2015). These actions could mask the pain and discomfort the patient experiences.

3.2.1 Dental Implant Surgery

Dental implants serve as a replacement for natural teeth. An implant serves as an artificial tooth root. There are three parts of a complete dental implant: a fixture, an abutment, and a prosthesis (Pleasance, 2014). The fixture resembles a screw; it is made of
titanium and is inserted in the jaw. Over time the bone surrounding the implant will bond
to the titanium through a process called osseointegration. When the fixture is
osseointegrated it is stabilized by the bone and can support the crown or bridge
prosthesis. In between the fixture and the prosthesis is the abutment, which is placed on
the fixture to connect the fixture and the prosthesis. The crown is the replacement tooth.
It is custom made to match an individual’s natural teeth. In cases where multiple teeth are
being replaced beside each other, a bridge can be made that is anchored by implants
(Canadian Dental Association, 2015).

3.2.2 Soft Tissue Graft Surgery

Gum recession occurs when the gums pull away from the teeth. Periodontal
disease is one cause of gum recession, but brushing too vigorously, ill-fitting partial
dentures, genetics, and smoking are also potential causes of gum recession (Kassab &
Cohen, 2003). When recession occurs, it leaves the tooth root exposed. The tooth root is
not protected by enamel like the crown of a tooth is so when it is exposed it causes
increased sensitivity and is at greater risk of decay. To protect the root when recession
occurs, a periodontist can perform a soft tissue graft. If it is a connective tissue graft
(CTG), a thin piece of tissue is taken (usually from the palate) and sutured over the
exposed root. This protects the root and thickens the gum that has receded to prevent
further recession. Mucogingival grafts (MGG) are performed if patients’ gums are very
thin and there is a risk of the root becoming exposed. A piece of tissue is taken from the
palate and sutured over the thinning gums. This helps protect the gums from abrasion
caused by chewing and prevents further recession.
3.3 Pain Medication Use

The amount of pain medication used by the patient served as an alternative way of assessing the amount of pain a patient experienced compared to the VAS. This data was collected to gauge how much pain medication the patient felt was necessary to control the pain following surgery. The primary pain medication of interest is the 600 mg ibuprofen that was prescribed by Dr. Fritz. Use of other pain relieving medication (including alcohol) was recorded by the patient as well as any use of supplements that could potentially alter healing and/or pain.

3.4 Medical History

Basic medical histories were gathered from patient records. Information gathered included patient sex, age, prescription medication, allergies, preexisting health conditions, and smoking history. The patient history form also included a nervousness scale for patients to indicate how nervous they are about dental treatment. The scale is a numerical rating scale from 1 to 5.

3.5 Supplement Use

Supplement use was recorded in the patient diary. This was recorded to determine if there are correlations between the use of supplements and the amount of pain experienced. Because many supplements exert anti-inflammatory effects it could decrease the amount of pain a patient experiences. It is possible that patients might choose to use nutritional supplements as analgesics instead of using the pain pills prescribed by the periodontist. Supplement use was included in the regression as a yes/no dichotomous variable.
3.6 Statistical Analysis

A bivariate correlation was used to test if there was a significant relationship between the amount of pain anticipated and the amount of pain actually experienced. Assumptions of normality and homogeneity of variance were tested. The factors that influenced pain experienced and pain medication used were examined using linear regression. Predictor variables for the two models included: sex, type of surgery, nervousness, supplement use, use of sedation, age, and smoking status as well as anticipated pain. In the regression for pain, pain pill use was also included and vice versa.

Prior to the regression analysis, a repeated measures ANOVA was performed examine how pain changed over time. This informed which day pain was greatest and, therefore, which day to use for pain rating in the regression. The regression models used were as follows:

1. $\text{Pain}_i = \beta_0 + \beta_1 \text{sex}_i + \beta_2 \text{surgery}_i + \beta_3 \text{nervousness}_i + \beta_4 \text{anticipated pain}_i + \beta_5 \text{sedation}_i + \beta_6 \text{age}_i + \beta_7 \text{smoking}_i + \beta_8 \text{supplement use}_i + \beta_9 \text{pain pills}_i + \varepsilon_i$

2. $\text{Pills}_i = \beta_0 + \beta_1 \text{sex}_i + \beta_2 \text{surgery}_i + \beta_3 \text{nervousness}_i + \beta_4 \text{anticipated pain}_i + \beta_5 \text{sedation}_i + \beta_6 \text{age}_i + \beta_7 \text{smoking}_i + \beta_8 \text{supplement use}_i + \beta_9 \text{pain pills}_i + \varepsilon_i$

These models predicted how much each variable affected either the pain experienced or the amount of pain pills the patient used to control pain. Similar models were used for both the amount of pain experienced and the amount of pain pills used because in theory it should be the same variables that affect each outcome variable; when someone is experiencing pain they will take pain pills and if they experience more pain one would expect them to use more pills. The only change between the two models was
that pain pill use was included in the “Pain” regression model and actual pain was included in the “Pills” model.
Chapter 4: Results

4.1 Patient Demographics

Patient recruitment occurred from May 2014 through March 2016. A total of 256 patients were recruited. Of these patients, 213 had complete expected pain scale ratings and 7 day pain diaries. This was a completion rate of 83%.

The final sample included 133 (62.4%) females and 80 (37.6%) males. The mean age was 51 ± 15 years (range: 19-80 years). Of the 213 patients, 115 (54%) patients had soft tissue graft surgeries; this included those who had CTGs (90 patients), those who had mucogingival grafts (23 patients), and those who had both types of graft (2 patients) while there were 98 (46%) patients who had dental implant surgery. All patients had the option of sedation during their procedure. There were 49 (23.0%) patients who had IV sedation and 3 (1.4%) who had nitrous sedation. The remaining 161 patients (75.6%) elected to go without sedation during their surgery. Patients also reported their smoking status. It was found that 147 (69.0%) had never smoked, 54 (25.4%) were former smokers, and 12 (5.6%) were current smokers. There were 82 patients (38.5%) who reported using nutritional supplements during their 7 day recovery period and 131 (61.5%) did not use supplements. Nervousness toward dental treatment was gauged using a scale from 1 through 5 (1 being not nervous and 5 being very nervous). This information was missing from 4 patients’ charts; for the remaining 209 patients the mean nervousness reported was 2.5 ± 1.3. See Table 4.1 for further detail. Statistical analysis was performed using IBM SPSS statistics 22.
Table 4.1: Patient Characteristics

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>51± 15 (Range: 19-80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex [n (%)]</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>80 (37.6)</td>
</tr>
<tr>
<td>Female</td>
<td>133 (62.4)</td>
</tr>
<tr>
<td>Type of Surgery [n (%)]</td>
<td></td>
</tr>
<tr>
<td>Graft</td>
<td></td>
</tr>
<tr>
<td>- CTG</td>
<td>115 (54)</td>
</tr>
<tr>
<td>- MGG</td>
<td>- 90 (78)</td>
</tr>
<tr>
<td>- CTG + MGG</td>
<td>- 23 (20)</td>
</tr>
<tr>
<td>Implant</td>
<td>98 (46)</td>
</tr>
<tr>
<td>Sedation [n (%)]</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>49 (23)</td>
</tr>
<tr>
<td>Nitrous</td>
<td>3 (1.4)</td>
</tr>
<tr>
<td>None</td>
<td>161 (75.6)</td>
</tr>
<tr>
<td>Smoking Status [n (%)]</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>147 (69)</td>
</tr>
<tr>
<td>Former</td>
<td>54 (25.4)</td>
</tr>
<tr>
<td>Current</td>
<td>12 (5.6)</td>
</tr>
<tr>
<td>Nutritional Supplement User [n (%)]</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>82 (38.5)</td>
</tr>
<tr>
<td>No</td>
<td>131 (61.5)</td>
</tr>
<tr>
<td>Use ≥2 supplements</td>
<td>59 (27.7)</td>
</tr>
<tr>
<td>Nervousness [mean± SD]</td>
<td></td>
</tr>
<tr>
<td>1 [n (%)]</td>
<td>64 (30.6)</td>
</tr>
<tr>
<td>2</td>
<td>45 (21.5)</td>
</tr>
<tr>
<td>2.5</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>3</td>
<td>52 (24.9)</td>
</tr>
<tr>
<td>3.5</td>
<td>2 (1.0)</td>
</tr>
<tr>
<td>4</td>
<td>24 (11.5)</td>
</tr>
<tr>
<td>4.5</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>5</td>
<td>20 (9.6)</td>
</tr>
<tr>
<td>Expected Pain [mean± SD]</td>
<td></td>
</tr>
</tbody>
</table>
| CTG: connective tissue graft
| MGG: mucogingival graft
4.2 Anticipated and Actual Pain

Day 1 post-surgery was selected to be the primary day for comparison between anticipated and actual pain. This day was selected because repeated measures ANOVA (rm-ANOVA) showed that pain was highest on this day and the desire for the study was to capture pain at its worst. Prior to performing the rm-ANOVA, the assumptions of the test were checked.

1. The dependent variable (pain) is a continuous measure.
2. The independent variable (day) has \( \geq 2 \) groups: 7 days + anticipated pain rating.
3. There are no outliers.
4. Distribution of the dependant variable is approximately normal.
5. Sphericity, which assumes that variances of the differences between each day are equal, was tested using Mauchly’s test. Mauchly’s test was significant (\( p<0.01 \)), which means sphericity was violated. To account for this the Greenhouse-Geisser estimate was used to test the within-subject effects of time on the amount of pain a patient reported.

The Greenhouse-Geisser test statistics was significant (\( p<0.01 \)) therefore pairwise comparisons were performed. It was found that the actual pain experienced by patients was significantly lower (\( p<0.01 \)) than anticipated pain. It was also found that actual pain decreased continuously each day post-surgery (\( p\leq 0.01 \)). This provided the justification to conduct further statistical analysis using actual pain on day 1 as the comparator because it was confirmed to be the time point at which patients experienced the most pain.
A bivariate correlation was done to determine the relationship between anticipated pain and actual pain (on day 1). The mean anticipated pain was 4.46\pm 2.37. The mean for actual pain experienced on day 1 was 3.20\pm 2.47. The Pearson correlation coefficient (r) was 0.274 and the R square value was 0.075. This correlation was significant at the 0.01 level in a 2-tailed test.
Figure 4.2: Scatter plot showing the positive correlation between patients’ anticipated pain and the actual pain they reported on day 1 after surgery.

4.3 Predictors of Pain Experienced

A linear regression was performed to elucidate if there were certain characteristics that could be used to predict how much pain a patient can expect to experience. The following regression equation was used:

$$\text{Pain}_i = \beta_0 + \beta_1 \text{sex}_i + \beta_2 \text{surgery}_i + \beta_3 \text{nervousness}_i + \beta_4 \text{anticipated pain}_i + \beta_5 \text{sedation}_i + \beta_6 \text{age}_i + \beta_7 \text{smoking}_i + \beta_8 \text{supplement use}_i + \beta_9 \text{pain pills}_i + \varepsilon_i$$

All variables were entered into the regression simultaneously. $\beta_0$ is the constant. $\beta_1 \text{sex}$ was the indicator variable for the sex of the patient. $\beta_2 \text{surgery}$ was the indicator variable for the type of surgery they had (implant or graft). $\beta_3 \text{nervousness}$ was the indicator variable used for the patients’ self-rated nervousness toward dental treatment on a scale of 1 through 5; 1 being not nervous and 5 being very nervous. $\beta_4 \text{anticipated pain}$ was the value measured on the VAS of anticipated pain they completed before surgery.
β5 sedation was the indicator variable for ether or not the patient was sedated during surgery. β6 age was the indicator variable for the age of the patient in years. It was a continuous variable. β7 smoking was the indicator variable for the patients’ smoking status; whether they identified themselves as a current smoker, former smoker, or never smoker. β8 supplement use was the indicator variable for whether or not they used nutritional supplements during the 7 days post-surgery. β9 pain pills was the indicator variable used for the number of pain pills the patients reported taking post-surgery.

With respect to the regression analysis, patients who used pain medication other than the 600 mg ibuprofen that was prescribed by the periodontist to manage pain (21 patients) were excluded. Age was missing for 1 patient, nervousness was missing for 4 patients, and sedation was missing for 3 patients. The final sample was therefore 184 patients.

Assumptions were checked prior to running the regression analysis.

1. The outcome was linearly related to the predictor variables. This was tested using a matrix scatterplot (Appendix 7.8) and examining the relationship between the outcome and the predictors.

2. To test that the errors were independent, a Durbin-Watson test was performed. When the results of this test are close to 2 (between 1 and 3) it indicates that the errors are uncorrelated. The Durbin-Watson value obtained for this regression was 1.994, which indicates this assumption was met and the errors are independent (Appendix 7.11).
3. Homoscedasticity was met meaning that the variance between the errors were constant. This assumption was checked using a scatterplot of standardized residuals against the standardized predicted values (Appendix 7.9).

4. Errors were normally distributed. This is ensured because of the large sample size, but a histogram of the residuals was made to confirm this assumption was met (Appendix 7.10).

5. The predictor variables were not correlated with any external variables that were not included in the analysis.

6. All the variables in the regression were either quantitative or categorical. The outcome variable (pain) was quantitative, continuous and unbounded.

7. There was no perfect multicollinearity between the predictor variables meaning that none of the predictors had a perfect linear relationship. This was tested by looking at a correlation matrix of all the predictor variables. None of the correlations were considered substantial (none of the r values were > 0.9). The variance inflation factor (VIF) was also used to ensure there was no multicollinearity. All VIF values were below 10, which ensures this assumption has been met (Appendix 7.11).

8. The variance of the predictor variables was not zero.

The model had an r of 0.474 and $r^2$ of 0.224. The adjusted $r^2$ was 0.184. The regression analysis is summarized in Table 4.2.
Table 4.2: Regression of actual pain experienced on day 1 post-surgery

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B± SE</th>
<th>t</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>-0.184±0.360</td>
<td>-0.037</td>
<td>-0.511</td>
</tr>
<tr>
<td>Surgery</td>
<td>-0.388±0.370</td>
<td>-0.080</td>
<td>-1.049</td>
</tr>
<tr>
<td>Nervousness</td>
<td>0.112±0.143</td>
<td>0.061</td>
<td>0.785</td>
</tr>
<tr>
<td>Anticipated Pain</td>
<td>0.228±0.074</td>
<td>0.222</td>
<td>3.059</td>
</tr>
<tr>
<td>Sedation</td>
<td>-0.996±0.423</td>
<td>-0.177</td>
<td>-2.354</td>
</tr>
<tr>
<td>Age</td>
<td>-0.029±0.013</td>
<td>-0.176</td>
<td>-2.131</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.245±0.284</td>
<td>0.061</td>
<td>0.861</td>
</tr>
<tr>
<td>Supplement Use</td>
<td>-0.124±0.373</td>
<td>-0.025</td>
<td>-0.331</td>
</tr>
<tr>
<td>Pain Pills</td>
<td>0.573±0.140</td>
<td>0.287</td>
<td>4.094</td>
</tr>
</tbody>
</table>

4.4 Predictors of Prescribed Pain Medication Use

A second regression was performed to determine the influence of the characteristics in the model on predicting the amount of pain medication an individual would need to manage their pain. The same model was used for this regression as the one in section 4.3 except pain on day one was substituted for the pain pill use on day one. The following regression equation was used: \( \text{Pills}_i = \beta_0 + \beta_1 \text{sex}_i + \beta_2 \text{surgery}_i + \beta_3 \text{nervousness}_i + \beta_4 \text{anticipated pain}_i + \beta_5 \text{sedation}_i + \beta_6 \text{age}_i + \beta_7 \text{smoking}_i + \beta_8 \text{supplement use}_i + \beta_9 \text{pain}_i + \epsilon_i \)

All assumptions were checked for this regression analysis.
1. The outcome was linearly related to the predictor variables. This was tested using a matrix scatterplot (Appendix 7.8) and examining the relationship between the outcome and the predictors.

2. Durbin-Watson test was performed to ensure that errors are independent. The Durbin-Watson value obtained for this regression was 2.149, which indicates this assumption was met because it is very close to 2 (Appendix 7.14).

3. The assumption of homoscedasticity was checked using a scatterplot of standardized residuals against the standardized predicted values (Appendix 7.12). Based on the scatterplot this assumption was not met. This means that the confidence intervals in the regression might not be trustworthy.

4. Errors were normally distributed. Although the large sample size should ensure this assumption is met, a histogram of the residuals was used as confirmation (Appendix 7.13).

5. The predictor variables were not correlated with any external variables that were not included in the analysis.

6. All the variables in the regression were either quantitative or categorical. The outcome variable (pain pills) was quantitative and unbounded, but not continuous which could have lead to the heteroscedasticity of residuals.

7. There was no perfect multicollinearity between the predictor variables. VIF was used to ensure this assumption was met. All VIF values were below 10, which confirms there was no multicollinearity (Appendix 7.14).

8. The variance of the predictor variables was not zero.
The sample size for this regression was 184 patients. The R for the model was 0.413. It had an R² of 0.170, the adjusted R² was 0.128. Results of the regression are summarized in Table 4.3.

**Table 4.3:** Regression results for pain pills used on day 1 post-surgery

<table>
<thead>
<tr>
<th></th>
<th>B± SE</th>
<th>B</th>
<th>t</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>0.323± 0.416</td>
<td>0.131</td>
<td>1.748</td>
<td>0.082</td>
</tr>
<tr>
<td>Surgery</td>
<td>-0.080± 0.192</td>
<td>-0.033</td>
<td>-0.415</td>
<td>0.678</td>
</tr>
<tr>
<td>Nervousness</td>
<td>-0.075± 0.074</td>
<td>-0.081</td>
<td>-1.013</td>
<td>0.313</td>
</tr>
<tr>
<td>Anticipated pain</td>
<td>-0.013± 0.040</td>
<td>-0.026</td>
<td>-0.336</td>
<td>0.737</td>
</tr>
<tr>
<td>Sedation</td>
<td>0.206± 0.222</td>
<td>0.073</td>
<td>0.927</td>
<td>0.355</td>
</tr>
<tr>
<td>Age</td>
<td>-0.009± 0.007</td>
<td>-0.112</td>
<td>-1.300</td>
<td>0.195</td>
</tr>
<tr>
<td>Smoking</td>
<td>-0.036± 0.147</td>
<td>-0.018</td>
<td>-0.243</td>
<td>0.809</td>
</tr>
<tr>
<td>Supplement Use</td>
<td>-0.096± 0.193</td>
<td>-0.038</td>
<td>-0.496</td>
<td>0.620</td>
</tr>
<tr>
<td>Pain</td>
<td>0.153± 0.037</td>
<td>0.307</td>
<td>4.094</td>
<td><strong>0.000</strong></td>
</tr>
</tbody>
</table>

**4.5 Secondary Analysis: Predictors of Anticipated Pain**

Because anticipated pain was a significant predictor of the actual pain a patient experienced, the variables that influenced how much pain a patient anticipated were explored. The regression used for this analysis was: \( \text{Anticipated}_i = \beta_0 + \beta_1 \text{gender}_i + \beta_2 \text{surgery}_i + \beta_3 \text{nervousness}_i + \beta_4 \text{sedation}_i + \beta_5 \text{age}_i + \beta_6 \text{smoking}_i + \beta_7 \text{supplement use}_i + \epsilon_i \)
This model used variables that were hypothesized be factors that would influence how much pain an individual would anticipate. These variables appeared in the above regressions as well. Without having pain pills in the regression, the sample size was larger with 205 patients with complete datasets.

Assumptions for this regression were checked.

1. The outcome was linearly related to the predictor variables. This was tested using a matrix scatterplot (Appendix 7.8) and examining the relationship between the outcome and the predictors.

2. Durbin-Watson test was performed to ensure that errors are independent. The Durbin-Watson value was 2.217. This is very close to 2, which indicates this assumption was met (Appendix 7.17).

3. The assumption of homoscedasticity was checked using a scatterplot of standardized residuals against the standardized predicted values (Appendix 7.15). The points on the scatterplot appeared random indicating that this assumption was met and errors were constant.

4. Errors were normally distributed. A histogram of the residuals was used to confirm this (Appendix 7.16).

5. The predictor variables were not correlated with any external variables that were not included in the analysis.

6. All the variables in the regression were either quantitative or categorical. The outcome variable (anticipated pain) was quantitative, continuous, and unbounded.
7. There was no perfect multicollinearity between the predictor variables. All VIF values were below 10, which ensures this assumption has been met (Appendix 7.14).

8. The variance of the predictor variables was not zero.

The R for the above model was 0.394. The $R^2$ was 0.155 and the adjusted $R^2$ was 0.125. The regression results are summarized in Table 4.4.

**Table 4.4:** Regression results for predictors of anticipated pain

<table>
<thead>
<tr>
<th></th>
<th>β ± SE</th>
<th>β</th>
<th>T</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>0.457± 0.340</td>
<td>0.094</td>
<td>1.342</td>
<td>0.181</td>
</tr>
<tr>
<td>Surgery</td>
<td>-0.602± 0.349</td>
<td>-0.127</td>
<td>-1.724</td>
<td>0.086</td>
</tr>
<tr>
<td>Nervousness</td>
<td>0.422± 0.131</td>
<td>0.234</td>
<td>3.226</td>
<td>0.001</td>
</tr>
<tr>
<td>Sedation</td>
<td>0.755± 0.408</td>
<td>0.135</td>
<td>1.849</td>
<td>0.066</td>
</tr>
<tr>
<td>Age</td>
<td>0.005± 0.012</td>
<td>0.032</td>
<td>0.408</td>
<td>0.684</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.166± 0.274</td>
<td>0.042</td>
<td>0.607</td>
<td>0.544</td>
</tr>
<tr>
<td>Supplement Use</td>
<td>-0.292± 0.344</td>
<td>-0.060</td>
<td>-0.849</td>
<td>0.397</td>
</tr>
</tbody>
</table>

4.6 Nutritional Supplement Use

In the final sample of 213 participants, 82 participants (38.5%) reported using nutritional supplements post-surgery. Of those who reported using supplements, 59 participants (72%) were taking two or more supplements. Further analysis of the characteristics of those who used nutritional supplements showed that 51 (62.2%) were female and 31 (37.8%) were male. It was found that 43 (52.4%) of the supplement users
had implant surgery and the remaining 39 (47.6%) patients had soft tissue graft surgery. This shows a fairly equal distribution of supplement use between the two surgeries of interest and between the two sexes. As seen in Figure 4.3, the most commonly used supplements were vitamin D and a multivitamin.

**Figure 4.3:** The most commonly used nutritional supplements reported by patients following periodontal surgery. The data labels above the bars indicate the % of patients taking each supplement.
Chapter 5: Discussion

This study was designed to determine how a patient’s anticipated pain prior to periodontal surgery (graft or implant) is related to the actual pain they experience following their procedure. It was found that anticipated pain and actual pain are positively correlated. Individuals who anticipate more pain tend to experience more pain. Actual pain was found to be highest on day 1; the end of the day on the same day of surgery. Factors that were found to affect the amount of pain included the patient’s anticipated pain, whether or not they had sedation, their age, and how many pain pills they used. This study showed the effectiveness of sedation in reducing pain following surgery. It also showed that older patients experienced less pain. Factors that were found to predict a patient would experience more pain included higher anticipated pain and taking more pain pills. There was no relationship between actual pain experienced and the type of surgery an individual underwent, sex, nervousness, smoking status, or use of nutritional supplements (Figure 5.1).
Figure 5.1: Summary: Factors that did (blue arrows) or did not (red arrows) predict actual pain on day 1 post-surgery.

With regards to the factors influencing pain pill usage, only actual pain experienced was significant (Figure 5.2). When patients were experiencing more pain they took more pain pills. This suggests that individuals were taking the prescribed pain medication appropriately.
5.1 The Relationship Between Anticipated Pain and Actual Pain

A bivariate correlation showed that anticipated pain is significantly related to actual pain (Figure 4.2). Patients who anticipated a greater amount of pain subsequently reported experiencing a greater amount of pain. This is an interesting finding because it indicates that the pain experienced by patients is a self-fulfilling prophecy. Pain is not merely a physiological process; cognitive factors are involved (Lin, Niddam, Hsu, & Hsieh, 2013). Anxiety associated with the unpredictability of dental pain can increase the amount of pain experienced (Lin et al., 2013). “Pain Catastrophizing” is a term used to explain the negative perception of anticipated and actual pain and can be divided into three main areas (Lin et al., 2013). The first is rumination, where patients focus their attention on the painful experience. Magnification is the second aspect of pain
catastrophizing where patients exaggerate the potentially painful stimuli; in this case the pain associated with surgery. The third aspect is helplessness where patients lack the ability to effectively cope with pain (Lin et al., 2013). It has been found that individuals who have a higher score on the pain catastrophizing scale (PCS) have heightened awareness of signals indicating potential painful stimuli (Van Damme, Crombez, & Eccleston, 2002). The effect of the unpredictability of painful stimuli was examined in a dental pain model (Lin et al., 2013). The patients were in two conditions; one condition where the stimulus applied to the tooth remained the same the entire time and a second unpredictable condition where the patient did not know if it would be a high or low intensity stimulus (Lin et al., 2013). It was found that higher PCS score was associated with increased pain in the unpredictable model compared to the predictable model where patients were also experiencing increased anxiety (Lin et al., 2013). It is important to note that PCS score was not associated with the increased pain caused by the higher intensity stimuli alone; so the unpredictability of the condition was what caused the greater pain perception (Lin et al., 2013). Brain hippocampal activity was associated with PCS score in the unpredictable condition only. It was found that the posterior hippocampus, which is responsible for fear conditioning was the area that was activated as opposed to the anterior hippocampus, which is generally associated with anxiety and fear. This indicates that those with higher PCS scores process the threat of fear differently in an anxiety inducing situation like the unpredictable stimulus condition (Lin et al., 2013). With regards to the finding of the current study, those who anticipated more pain could experience some level of pain catastrophizing such as rumination or magnification. This
could then cause them to experience a greater amount of pain based on the way they process the painful stimuli caused by the periodontal surgery.

5.2 How Pain Experience Changes Over Time

A repeated measures ANOVA performed to determine how pain changed over the course of the study showed that anticipated pain was significantly greater than actual pain experienced on any day (Figure 4.1). This finding is in agreement with that found by Eli et al. (2003). When they had patients complete a VAS of expected pain before surgery and actual pain immediately after surgery it was found that there was a significant decrease between the expected pain and the actual pain (Eli et al., 2003).

The repeated-measures ANOVA also showed that pain on day 1, which was recorded by patients on the same day of surgery, was significantly higher than any other day. Pain continued to decrease significantly each consecutive day (Figure 4.1). This finding varies from that of other studies (S. Kim et al., 2013). Pain was recorded at three time points in their study: immediately after surgery, one day after surgery, and one week after surgery and they found that pain was highest on the day after surgery, which in comparison to this study would be day 2 of the patient diary (S. Kim et al., 2013). A potential explanation for this difference is that patients in the current study were instructed to complete their pain VAS at the end of each day. Therefore, they completed day 1 on the day of surgery, but at the end of the day at which point any analgesic effects of anesthetic would not be present. In contrast, the other study measured the pain immediately after surgery when local anesthetic would still be exerting its effects (S. Kim et al., 2013). Kim et al. did find that pain one week after surgery was the lowest, which is in accordance with the finding in the current study that pain was lowest by day 7.
4.1) (S. Kim et al., 2013). A larger study consisting of 234 patients who were all undergoing implant placement surgery, found that of the time points measured (during surgery, 24 hours post-surgery, and 1, 6, and 12 weeks post-surgery) the highest pain was reported 24 hours post-surgery (Al-Khabbaz, Griffin, & Al-Shammari, 2007). They found that 80.3% of patients reported experiencing pain at the 24 hour time point, but the majority (69.7%) reported this pain to be mild. In this study, patients indicated their pain on a numerical scale ranging from 0 through 10 and were told that choosing 1 through 3 indicated they were experiencing mild pain, 4 through 6 was indicative of moderate pain, and 7 through 10 indicated severe pain (Al-Khabbaz et al., 2007). Using this type of scale instead of an unnumbered VAS meant that the scale was not continuous, nor was it as objective with patients knowing how severe their pain would be interpreted as when selecting within the range of numbers.

5.3 The Amount of Pain Experienced is Modulated by Different Factors

Factors that were hypothesized to have a role in the amount of pain a patient experienced were investigated using linear regression analysis. The variables entered in the regression were selected based on previous research that suggested a role for these variables in the pain experience of patients and the clinical expertise of the periodontist who performed the surgeries (P. F.). Table 4.2 shows that of the nine variables entered in the regression, four were significant. It was found that anticipated pain, sedation, age, and pain pill use helped predict how much pain an individual experienced. Based on the unstandardized coefficients, for every one unit increase in anticipated pain, the amount of actual pain reported increases by 0.228. Those who had IV sedation reported experiencing 0.996 units less pain than those who did not have sedation during their
procedure. For every one year older a patient was, they reported having 0.029 units less pain. With each 1 pain pill increase, individuals reported experiencing 0.573 units more pain. Interestingly, the type of surgery the patient had, their sex, their nervousness toward dental surgery, their smoking status, and whether or not they used supplements did not significantly predict how much pain they would actually experience following surgery.

5.4 Manifestation of Pain

Given the results of the bivariate correlation and the regression, there was a reason to explore why having a greater amount of anticipated pain led to a greater amount of actual pain. Pain is a complex experience involving physiological, psychological, and neurological processes. Post-operative pain plays an important role in protecting the surgical site from further tissue damage and allowing it to heal (Coulthard et al., 2014). The type of pain that results from oral surgery is referred to as inflammatory pain, which results from the peripheral tissue damage incurred as a result of the surgery (Coulthard et al., 2014). This pain subsides as healing occurs (Coulthard et al., 2014). Nociception is the term used to describe the process of the peripheral and central nervous system sending information about noxious stimuli to the brain stem and cerebral cortex (National Research Council, 2009). The perception of pain develops when the signals are processed in the cerebral cortex (National Research Council, 2009). Hyperalgesia can occur following surgery; this is when there is an increased response to noxious stimuli because of increased excitability of the nociceptors, resulting in increased pain sensitivity (National Research Council, 2009). There is evidence that neonatal injury can affect the development of pain receptors and thus lead an individual to have higher or lower pain sensitivity (National Research Council, 2009). This is one explanation for individual
differences in pain perception. What many periodontists need to be particularly concerned with is how psychological factors can modulate pain perception. Because anxiety influences pain perception, it is important to manage anxiety in a periodontal setting. As shown in Figure 4.2 anticipated pain and actual pain are correlated; perhaps if the patient anticipates a lower amount of pain the actual pain will also decrease. If the higher anticipated pain is due to patient anxiety or causing the patient anxiety, being able to show the anxious patient a figure like Figure 4.1 where the actual pain is significantly lower than anticipated, it could help reduce anxiety.

5.5 Sedation Modifies the Pain Experienced Following Surgery

Patients who had IV sedation during surgery reported experiencing significantly less pain. One possible explanation for this finding is that the dexamethasone adjuvant provided in IV helps decrease the acute pain a patient experiences. Dexamethasone is a glucocorticoid that is sometimes used to reduce post-operative pain because it is anti-inflammatory (Waldron, Jones, Gan, Allen, & Habib, 2013). A meta-analysis showed that individuals who were administered dexamethasone pre- or intra-operatively had lower VAS pain ratings at two and 24-hours post-operatively (Waldron et al., 2013). It was also found that the 24-hour pain reduction was greater when dexamethasone was given pre-surgery compared to during surgery. Also, patients who were administered dexamethasone had lower opioid use to manage pain at 2- and 24-hours post-operatively, they required less “rescue analgesia” to manage intolerable pain, and they had a longer time to their first dose of analgesic (Waldron et al., 2013). Thus, the decreased pain experienced by the patients receiving IV sedation may be due to dexamethasone administered. There is also evidence that conscious sedation affects a patient’s recall of
the surgery and the pain experienced (Wilson, McNeil, Kyle, Weaver, & Graves, 2014). To look at the effects of moderate sedation on recall of pain and anxiety, patients were analyzed based on whether they had conscious sedation plus local anesthesia during tooth extraction surgery or local anesthesia alone (Wilson et al., 2014). Pain and anxiety were measured for three time points: state or current, predicted, and recalled at 1 month post-surgery. It was found that there was a significant interaction between group and time with regards to the pain ratings. Those who underwent conscious sedation reported less pain in their current state before surgery (Wilson et al., 2014). The conscious sedation group also recalled less pain than the local anesthesia only group (Wilson et al., 2014). The predicted pain levels were similar between two groups, but the conscious sedation group predicted that they would experience more pain than their state or recalled pain while the local anesthesia alone group predicted less pain than their current state (Wilson et al., 2014). These results suggest that conscious sedation favourably affected the recall of pain related to oral surgery. Because those patients who had sedation recall less pain following surgery, they might be more apt to seek oral care in the future.

5.6 The Effect of Age on Pain Perception

The present study also found that older individuals reported experiencing significantly less pain. There is clinical evidence to support the finding that pain perception decreases with age. A clinical investigation investigating how pain perception differs with age used an 11-point numerical rating scale for patients who presented with conditions that are often associated with acute pain during an emergency department visit (Daoust et al., 2016). Pain intensity was reported by the patient at the time of triage in the emergency department and these records were used for the study (Daoust et al., 2016).
Six common diagnoses that are considered painful were the focus of the study: renal colic, pancreatitis, appendicitis, headache/migraine, dislocation, or extremity fracture, but if patients presented with two or more of these conditions they were excluded from the study. Patients were divided into four age groups for analyses: young adults (18-44 years), middle-aged (45-64 years), early seniors (65-74), and late seniors (>75). It was found that pain decreased linearly with age for renal colic, pancreatitis, appendicitis, and headache/migraine, but there were no age differences found for dislocation or extremity fractures (Daoust et al., 2016). As one ages, there are physiological changes that occur within the central nervous system (CNS) and peripheral nervous system (PNS) that have been hypothesized to have an effect on pain perception (Gibson & Farrell, 2004). It has been noted that by the age of 60 years old, there is a noticeable reduction in the number of myelinated and unmyelinated nerve fibers (Gibson & Farrell, 2004). There are also a greater number of nerve cells that are damaged (Verdu, Ceballos, Vilches, & Navarro, 2000). These changes can lead to slower conduction velocity (Verdu et al., 2000). There are significant changes that occur in the human brain, including the cerebral cortex, as one ages (Gibson & Farrell, 2004). Changes including neuronal death, a decrease in the branching of dendrites, and a decrease in neurochemical transmission could be responsible for reduced pain processing (Gibson & Farrell, 2004). As previously mentioned, the pain associated with tissue injury is primarily to protect the site during the healing process. The inflammatory response is responsible for the pain reported following surgery. Topical capsaicin can be used to experimentally induce a neurogenic flare response, which is a way of measuring stimulation of axon reflexes to mimic the inflammatory response (Helme, Littlejohn, & Weinstein, 1987). It was established that
the flare response to capsaicin decreased as age increased indicating that the pain response could be diminished among older adults (Gibson & Farrell, 2004). Another possible explanation is that the VAS used anchors of “no pain” to “worst pain imaginable;” rather than numbers. Older adults might have reported less pain because they have more life experiences to use for comparison and can imagine greater pain than a younger adult. Older adults could have a higher pain tolerance due to the fact that they have potentially had more exposure to painful experiences over the course of their life (Daoust et al., 2016).

5.7 Relationship Between Pain Experienced and Pain Pill Use

Patients who used more pain medication reported experiencing significantly more pain. This makes sense logically; if an individual is experiencing more pain, they will take more pain medication to relieve said pain. Patients were prescribed 600 mg ibuprofen four times daily for pain relief. Patients were excluded from the study if they reported using an alternative mechanism of pain relief. This resulted in the exclusion of 21 patients. Ibuprofen is in the non-steroidal anti-inflammatory (NSAID) class of drugs. Ibuprofen is a non-specific COX inhibitor and is thus able to inhibit both COX-1 and COX-2 (H. J. Kim et al., 2010). COX-1 is constitutively expressed, meaning it is expressed at a fairly constant rate over time, and it is expressed on most cells (H. J. Kim et al., 2010; Bailey, Patel, & Coulthard, 2014). It has several functions including regulating platelet function, and protecting the gastrointestinal mucosal lining and kidneys (Bailey et al., 2014). COX-2 is inducibly expressed, meaning its expression is upregulated to be expressed at greater levels by cells in response to stimuli (H. J. Kim et al., 2010). COX-2 is activated by a complex signaling cascade of pro-inflammatory
cytokines including interleukin-1α (IL-1α) (Ogata et al., 2007). COX is the rate limiting enzyme in the synthesis of prostaglandins therefore when COX is inhibited, the inflammatory response is reduced (H. J. Kim et al., 2010). Ibuprofen is absorbed primarily in the small intestine, but some absorption also occurs in the stomach, it reaches its peak plasma concentration at approximately 45 minutes on an empty stomach or 1-2 hours if taken with food, and its half-life is 2 hours (Bailey et al., 2014). A Cochrane systematic review was published, which looked at the effects of oral ibuprofen for post-operative pain management compared to placebo (Derry, Derry, Moore, & McQuay, 2009). Of the 72 studies included in the review, 57 were related to dental pain (Derry et al., 2009). It was clear from the results of the review that ibuprofen is an effective method for providing post-operative analgesia (Derry et al., 2009). The primary outcome was 50% reduction in pain over 4 to 6 hours (Derry et al., 2009). Studies using a range of doses of ibuprofen from 50 mg up to 800 mg showed a dose-response trend between 100 mg to 400 mg (Derry et al., 2009). There was limited data available for 600 mg and 800 mg, but the trend appeared consistent with these higher doses (Derry et al., 2009). The efficacy of different doses was significant when only the dental studies were included: 400 mg was significantly better at achieving 50% pain relief than 200 mg, and 600 or 800 mg was significantly better at achieving 50% pain relief than 400 mg (Derry et al., 2009). This is an important clinical finding for the current study because 600 mg ibuprofen, which is what was prescribed to the patients, was found to be most efficacious. This review also found a dose response with regards to the time before rescue medication was needed (Derry et al., 2009). Patients who received 400 mg ibuprofen had a median time of 5.6 hours before more medication was required compared to those who took 200 mg
ibuprofen whose median time until rescue medication was required was 4.7 hours (Derry et al., 2009). Dosages greater than 400 mg were not included in the comparison (Derry et al., 2009). In the current study, patients were told to complete the diary at the end of each day. This would allow them to record the total number of pain pills taken throughout the day. Based on the regression model, patients who took more pain pills experienced more pain. This seems counterintuitive, but it is likely because patients were asked to report the greatest amount of pain they experienced throughout the day. They would have reported their pain and then relieved it by taking more of the prescribed pain medication, which was totaled at the end of the day.

5.8 Factors That Did Not Predict Pain Experienced

There were a number of variables included in the regression that were hypothesized to predict the amount of pain an individual would experience, but were not found to be significant predictors. These factors included type of surgery, sex, nervousness toward dental treatment, smoking status, and whether they used nutritional supplements. Some of these factors were hypothesized to influence pain experienced because previous studies had found a relationship such as that between nervousness and pain experienced (Eli et al., 2003). One possible explanation for the insignificant findings between these factors and pain experienced is the large sample size of this study. With a large sample of 213 patients involved in the analysis, the results of this study are more likely to reflect that of the population than the smaller samples found in previous studies such as the sample of 60 patients (Eli et al., 2003) or 18 (Hashem et al., 2006). This large sample size was a strength of this study compared to the literature currently available.
5.8.1 Type of Surgery

It was hypothesized that the type of surgery would influence the amount of pain the patient experienced. Based on clinical observation, it was thought that soft tissue grafts would elicit a higher pain rating than dental implant surgery. The rationale behind this was that the area affected by a graft is greater than that of an implant because of the tissue taken from the palate and applied to the receding gingiva there are two sites disturbed by graft surgery compared to a single site affected by an implant placement. However, in the regression analysis there was no significant difference between the two surgeries.

5.8.2 Sex Differences

Surprisingly, there was no sex difference found in the pain ratings following surgery. It was hypothesized that females would report more pain than males. The literature supports this hypothesis (Heft et al., 2007), but due to our insignificant finding, sex differences in pain reported following dental surgery will need to be explored further. One study sought to explore the differences between men and women regarding dental fear (Heft et al., 2007). They hypothesized that the phrasing of the question about fear and anxiety causes men and women to respond differently because of societal expectations (Heft et al., 2007). They divided participants into 2 groups and asked one group how much they “dreaded” a particular aspect of dental treatment; receiving a root canal for example, and they asked the other group how much they “feared” that aspect of dental treatment. Men and women responded similarly. However, they found that females compared to males were more likely to report fear of pain to any of the aspects of dental treatment they inquired about. They also found that participants in the “dread” group
were more likely to report feelings of “dread” to any of the aspects asked about except “receiving an injection in your mouth” to which the wording of fear versus dread did not have an affect on the response. When asked about having a tooth drilled, they found that men were more willing to admit feeling “dread” than “fear”. They also found that the wording did not affect the way that females responded to the questions (Heft et al., 2007).

The design of our study was such that individuals reported how much pain they expected or were actually experiencing on the VAS ranging from “no pain” to “worst pain imaginable,” it is possible that no sex differences were found in the amount of pain reported because patients were not asked in a way that could potentially cause them embarrassment with regards to their response. Most studies that find sex differences in dentistry focus on the individuals feelings of fear or anxiety related to the pain associated with dentistry whereas this study focused on the actual amount of pain the patient was experiencing. Patients were able to scale their actual pain on the VAS based on the anchors so perhaps if the final anchor was not “worst pain imaginable,” but something more concrete, there could have been differences.

5.8.3 Nervousness

No significant difference was found between a patient’s reported nervousness toward dental treatment and their pain experienced. This is an interesting finding because there is evidence in the literature contrary to this (Eli et al., 2003; Fardal & McCulloch, 2012). This insignificant finding is perhaps attributable to the way nervousness was measured. The question “On a scale of 1 to 5, how nervous are you about dental treatment,” is standard on the patient information and medical history questionnaire (Appendix 4.6) completed by all patients at the periodontal clinic where this study took
Pain associated with periodontal surgery

place. This information was gathered at the patients’ first visit to the clinic, which may or may not have been directly related to the surgery they had that allowed them to participate in this study. Meaning, they might not have considered the dental surgery they received in this study when they filled out the initial nervousness scale regarding dental treatment. In previous studies in this field that have found a relationship between dental anxiety and pain experience, many have had patients complete a dental anxiety questionnaire such as the DAS developed by Corah or a VAS for anxiety with anchors such as “not afraid at all” to “terrified” or “not nervous” to “extremely nervous” (Corah, 1969; Eli et al., 2003; Fardal & McCulloch, 2012). In previous studies, the anxiety measures were taken at different time points than our nervousness rating was taken. For example, in one study, the DAS and anxiety VAS was completed prior to treatment (Eli et al., 2003). The anxiety VAS was then completed at two more time points: immediately after surgery and four weeks post-operatively (Eli et al., 2003). This gave the authors a more specific measure of state anxiety for the patients. The sample sizes in these studies were smaller than the current study; one study had 60 patients (Eli et al., 2003) and the other had 150 patients (Fardal & McCulloch, 2012), but these samples were large enough that sample size is not likely the reason for the differences found.

Interestingly, in the secondary analysis nervousness was a significant predictor of the amount of anticipated pain. As shown in table 4.4, a patients’ expected pain rating increased by 0.422 for every 1 unit increase on the 1 through 5 nervousness scale. While there was a significant relationship between nervousness and anticipated pain and anticipated pain significantly predicted actual pain, there was no significant relationship between nervousness and actual pain. The factors that a patient considered while
evaluating their anticipated pain is not known for certain, however the general consensus based on previous research is that both anticipated and experienced pain can be related back to a patient’s anxiety (Eli et al., 2000). Perhaps the measure of anticipated pain overwhelmingly encompassed factors that influence actual pain experience that our tool for measuring nervousness was not able to capture.

5.8.4 Smoking Status

Smoking status was included in the regression because smoking has been shown to have detrimental effects on oral health and the healing process following periodontal treatment (Dodington et al., 2015). Another study investigated how smoking influences the efficacy of scaling and root planing in individuals with chronic or generalized aggressive periodontitis (Darby, Hodge, Riggio, & Kinane, 2005). In agreement with the study previously discussed, they found a greater reduction in probing depth following scaling and root planing in non-smokers than in smokers (Darby et al., 2005). The microbiological profile was also examined between the smokers and non-smokers. It was found that there was a greater reduction in some types of bacteria in non-smokers than smokers. These bacteria included *Tannerella forsythensis*, *Prevotella intermedia*, and *Porphyromonas gingivalis* (Darby et al., 2005). It was hypothesized that this occurred because these are all anaerobic bacteria and the deeper pockets that remained in the smokers created a more favourable environment for the bacteria (Darby et al., 2005). The delayed healing in smokers has been attributed to imbalances in the subgingival flora, disruption of healthy immune functioning affecting neutrophils and cytokines, reduced circulation to the gingiva, or a depletion of antioxidants (Dodington et al., 2015; Heasman et al., 2006). Because smoking is a known predictor of periodontitis and it
Pain associated with periodontal surgery

delays the healing process, it was hypothesized that smokers would experience more pain as a result of surgery than non-smokers. This is not the result that was found; smoking status was not a significant predictor of pain. In the literature, there are mixed results with some studies reporting that smoking is associated with increased pain while others report no relationship (Larrazabal et al., 2010). In the current study, the insignificant relationship might be attributable to the small number of smokers included in the sample. In a study investigating the relationship between oral hygiene and smoking before third molar extraction and the pain and swelling following surgery, it was found that smoking before surgery did not relate to pain following surgery (Larrazabal et al., 2010). However, smoking following surgery resulted in more pain (Larrazabal et al., 2010). The inconsistent findings related to smoking and dental pain suggest that further research is needed to understand this relationship.

5.8.5 Nutritional Supplement Use

The use of nutritional supplements was recorded by the patients in this study. It was hypothesized that those who used nutritional supplements would experience less pain than those who did not use supplements because many supplements have physiological activities such as anti-inflammatory and antioxidant effects. For example, it has been hypothesized that vitamin D has beneficial effects on periodontal health and bone loss. A possible explanation for this improved periodontal health is the reduced gingival inflammation seen in those with higher levels of 25-hydroxyvitamin D (Dietrich, Nunn, Dawson-Hughes, & Bischoff-Ferrari, 2005). It was found that those in the highest vitamin D quintile were less likely to bleed upon gingival probing than those in the lowest vitamin D quintile (Dietrich et al., 2005). It is for this reason that it was
hypothesized that nutritional use might lead to decreased pain in the current study. Due to the small number of supplement users, supplement use was analyzed on a yes/no basis. Secondary analysis will be done to analyze specific nutrients. It was of interest to determine if the combination of nutritional supplementation with traditional analgesics (ibuprofen) would have an increased effect on reducing pain. It has previously been reported that specific nutrients may facilitate the healing process following scaling and root planing in individuals with chronic generalized periodontitis (Dodington et al., 2015). It was reported that, in nonsmokers, higher intakes of fruits and vegetables, β-carotene, vitamin C, α-tocopherol, EPA, and DHA was associated with reduced probing depth following scaling and root planing surgery (Dodington et al., 2015). A potential explanation for this improved healing seen among those with higher intakes of these nutrients was that they have high antioxidant activity (Dodington et al., 2015). Many of the nutrients such as EPA and DHA are also known to exert anti-inflammatory effects. The current study found that the most commonly used supplements were vitamin D, multivitamin, vitamin B12, omega 3, 6, 9, calcium, and vitamin C. This compares to another study where calcium, vitamin D, multivitamin, and vitamin C were the most commonly used supplements among periodontal patients (Johnston, Fritz, & Ward, 2013). Although patients did report taking supplements following surgery, data on whole food intake was not collected, nor were biological samples collected to measure levels of the different supplements in the blood. It is therefore difficult to comment on the insignificant results found with nutritional supplements and pain. It is possible that those people who were taking supplements were not taking adequate amounts to exert anti-
inflammatory effects that would reduce inflammation following an acute injury such as that associated with surgery.

5.9 Factors Influencing Pain Pill Use

The factors that influence the amount of pain medication a patient used to control their pain following surgery was also investigated using linear regression. The only factor that was found to be significant was the amount of pain they were experiencing. For every one unit increase in the amount of pain an individual experienced, they took an extra 0.15 pain pills. This number might not be clinically relevant, but it is reassuring that individuals are taking pain pills in conjunction with the amount of pain they are experiencing.

What might be of more interest from a clinical perspective regarding the use of pain medication, is the number of patients who chose to self-medicate instead of using the prescribed pain pills. There were 21 (9.86%) patients excluded from the regression analysis because they did not take the pain medication prescribed by the periodontist. In a study that looked at self-medication practices, 59% of respondents reported self-medicating for tooth pain (Baptist, Sharma, & Hegde, 2012). The survey question was broad asking “Do you self-medicate for tooth pain?” without specifying what type of pain and whether it is before or after surgery. The most common drugs used for self-medication found were paracetamol, ibuprofen, or a combination of the two (Baptist et al., 2012). It is important to be aware of self-medication practices among dental patients to be able to educate the patients about the risks of drug interactions.
Chapter 6: Conclusions

Anticipated pain is correlated with actual pain, therefore if a patient anticipates a greater amount of pain they will likely experience a greater amount of pain as a result. The greatest amount of pain experienced by patients occurs on the same day of surgery. Pain decreases each day following surgery. In additional to anticipated pain being a predictor of actual pain seen with the correlation, whether or not they had sedation, their age, and how many pain pills they used also affected the amount of pain the patient experienced. Sedation reduced pain following surgery. It was found that older patients experienced less pain. Increased anticipated pain and taking more pain pills were factors that predicted an individual would experience more pain. There was no relationship between actual pain experienced and the type of surgery, sex, nervousness, smoking status, or use of nutritional supplements by the patient. The actual pain experienced by the patient was the only factor that affected their pain pill usage. Type of surgery, sex, age, nervousness, sedation, smoking status, use of nutritional supplements, and anticipated pain did not affect pain pill use.

6.1 Implications

The results of this study may have important clinical implications. Nervousness towards dental treatment was a predictor of anticipated pain and knowing that anticipated pain is correlated with actual pain can guide periodontists to the importance of recognizing nervous patients and helping them feel at ease. There are many strategies in the literature to help alleviate dental anxiety. These strategies include effective communication between the dentist and dental staff to build a trusting relationship with
the patient, distraction of the patient using techniques such as virtual reality, as well as relaxation techniques, hypnosis, and sedation.

This study is important to improve patient experience regarding periodontal therapy. Using this data, periodontists will be able to inform their patients about the pain they expect following surgery using evidence based data from patients who underwent the two types of periodontal surgery. They will be able to show patients that the actual amount of pain experienced by these patients was less than they anticipated. For periodontists to be able to inform their patients of this, it might ease their anxiety toward treatment. Based on the correlation between anticipated pain and actual pain, if patients anticipate less pain before their surgery it can result in them experiencing a lower amount of actual pain.

6.2 Future Directions

Based on findings from this research, several areas have been identified for further study. Development of a more specific measure for nervousness would be useful. A limitation of this study was the generic nervousness questionnaire used. A more specific questionnaire such as the DAS or a VAS for anxiety used by others (Eli et al., 2003; Fardal & McCulloch, 2012) would strengthen the evidence to support whether or not anxiety influences actual pain experienced following surgery. The use of nutritional supplements and their role in pain following surgery could also be examined in more depth, particularly among regular users. While the relationship with supplements was not significant in this study, it is known that nutrition has an important role in periodontal health (Dodington et al., 2015; Lau, Johnston, Fritz, & Ward, 2013). A future study should have patients complete a food frequency questionnaire in addition to having them
report nutritional supplements they are taking. Taking blood draws to measure serum levels of known anti-inflammatory nutrients could also help determine whether having higher levels of these nutrients can affect the inflammation process following dental surgery and therefore affect the amount of pain experienced.

A clinical implication of this study is there is now evidence-based data from patients who experienced the surgeries first hand to be able to inform future patients about how much pain they can expect. A follow-up study to this could be to repeat a similar study, but prior to giving them the initial anticipated pain VAS, present the data from this study to educate them about how much pain patients experienced. Outcomes of interest in a study like this would be to examine how the knowledge of what previous patients experienced affects the anticipated and actual pain of future patients. It would determine if knowing what previous patients experienced can decrease anticipated pain and actual pain.

A second follow-up study to this would utilize patients who participated in this study who return to the clinic for a second implant of graft surgery. They would complete the same anticipated pain VAS and actual pain VAS they did in the current study. The outcome of interest would be to see how having experienced the surgery previously affects the anticipated pain. A comparison between the anticipated pain VAS from the current study and from a second visit for a similar periodontal surgery would be done to see how patients recall the pain they experienced the first time.

Another study that could be done to complement the current study would focus on nutrition and the implications of poor oral health and the ability to consume a healthy and
varied diet. Thus far, it has been hypothesized that improved oral health would allow an individual to have more choice with regards to their diet, but no studies have been done to examine how diet changes following oral rehabilitation. This would be a longitudinal study, where a food frequency questionnaire (FFQ) would be given to patients prior to implant surgery to determine their current nutritional status. There would then be a 6 month or 1 year follow-up where another FFQ was given to examine if and how their diet changed following surgery. The number of implants would also need to be taken into consideration for example, an individual’s diet might not change significantly if only one implant was place, but if two or more were placed it could have a more dramatic effect on diet.
References


Chapter 7: Appendices

7.1 Certificate of Ethics Clearance

Certificate of Ethics Clearance for Human Participant Research

DATE: 4/7/2014
PRINCIPAL INVESTIGATOR: WARD, Wendy - Kinesiology
CO-INVESTIGATOR: FRITZ, Peter
FILE: 13-172 - WARD
TYPE: Faculty Research
STUDENT:
SUPERVISOR:

TITLE: Use of Pain Medication Following Periodontal Procedures

Type of Clearance: NEW  Expiry Date: 4/30/2015

The Brock University Bioscience Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from 4/7/2014 to 4/30/2015.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before 4/30/2015. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavorable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Brian Roy, Chair
Bioscience Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of these facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.
7.2 Letter of Invitation

Faculty of Applied Health Sciences

Department of Kinesiology &
Department of Community Health Sciences

January 2014

Letter of Invitation

Project Title: Use of Pain Medication Following Periodontal Procedures

Faculty Investigator: Dr. Wendy E. Ward, Professor & Canada Research Chair in Bone and Muscle Development, Faculty of Applied Health Sciences, Brock University

Co-Investigator: Dr. Peter C. Fritz, Periodontist & Implant Surgeon, Reconstructive Periodontics and Implant Surgery Clinic, Fonthill, ON

Adjunct Assistant Professor, Department of Kinesiology, Brock University

I, Wendy Ward, Professor & Canada Research Chair in Bone and Muscle Development, from the Department of Kinesiology, Brock University, invite you to participate in a research project entitled, Use of Pain Medication Following Periodontal Procedures.

Please note that this study is in addition to your scheduled appointment. It is completely your choice to participate or not participate in this research study. Your decision will in no way impact the standard of care that you will receive. If you
choose not to participate there will be no further discussion of this study. You feeling comfortable with the care you receive is the priority of Dr. Fritz’s clinic. We appreciate your time for considering this request.

You are here today at Dr. Fritz’s clinic for a dental implant placement or soft tissue graft to improve your oral health. The purpose of this study is to determine the amount and duration of pain medication a patient requires after placement of a dental implant or a soft tissue graft. For some patients, they chose not to have these procedures done because of perceived pain that is much greater than actual pain they will experience. Thus, knowing this information will allow future patients to use this evidence-based information in their decision-making process.

Participation will result in your regularly scheduled appointment requiring an additional 10 minutes. You will also need up to 10 minutes a day to complete a take-home diary during the first 7 days after the procedure. The diary contains a few questions (how many pain pills are taken, alcohol use, smoking activity for a 24 hour period) and a visual analog scale that allows a patient to mark the level of oral pain (a visual analog scale is a 10 cm line in which one end represent “no pain” while the opposite end represents “worst pain ever” – an individual marks an X along the line to record their experience). We will use the information collected in the diary in our analyses. We will also record certain information from your confidential patient information and medical history form. Specifically, we will be recording your age, gender, list of pain medications taken to manage oral and non-oral pain; and mineral, vitamin and/or herbal supplements taken, smoking status and history.
When you return for your follow-up visit that is scheduled 2 weeks after today’s appointment, you will return your diary in which you recorded your use of pain medication and pain experienced.

Your participation will help us to establish normative data regarding what to expect after dental implant placement or a soft tissue graft, allowing future patients to use this evidence-based information in their decision-making process.

If you have any pertinent questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905-688-5550 ext. 3035, reb@brocku.ca)

If you have any questions, please feel free to contact me.

Thank you,

Wendy E. Ward

**Principal Investigator:**
Dr. Wendy E. Ward, Associate Professor & Canada Research Chair in Bone and Muscle Development
Faculty of Applied Health Sciences
Brock University
905-688-5550 (x3024)

**Co-Investigator:**
Dr. Peter C. Fritz, Periodontist & Implant Surgeon
Reconstructive Periodontics and Implant Surgery Clinic
165 Highway 20 West, Suite 1
Fonthill, ON
This study has been reviewed and received ethics clearance through the Brock University Ethics Board (file #XX-XXX)
7.3 Consent Form

Faculty of Applied Health Sciences
Department of Kinesiology &
Department of Community Health Sciences

Informed Consent

Date: January 2014
Project Title: Use of Pain Medication Following Periodontal Procedures

Principal Investigator:
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Faculty of Applied Health Sciences
Brock University
peter.fritz@utoronto.ca

INVITATION
You are invited to participate in a study that examines the amount and duration of pain medication required after placement of a dental implant or a soft tissue graft. We want to establish normative data regarding what to expect after such a procedure, allowing future patients to use this evidence-based information in their decision making process.

WHAT’S INVOLVED
We will record certain information from your confidential patient information and medical history form. Specifically, we will be recording your age, gender, list of pain medications taken to manage oral and non-oral pain; and mineral, vitamin and/or herbal supplements taken, smoking status and history. Prior to your procedure, you will be asked to use a visual analog scale related to pain to assess your perception prior to the procedure (a visual analog scale is a 10 cm line in which one end represents "no pain" while the opposite end represents "worst pain ever" — an individual marks an X along the line to record their experience). You will be asked to complete a diary for the first 7 days after your procedure — the diary will involve completing a visual analog scale related to pain experienced due to the procedure.

POTENTIAL BENEFITS AND RISKS
Your participation will help us to provide normative data from which to guide patients using an evidence-based approach regarding what to expect after dental implant placement or a soft tissue graft. There are no direct benefits to participants. There are no anticipated physical risks related to participation in this study.

CONFIDENTIALITY
Any information that arises from participants will be treated with confidentiality. Your name will not be included or, in any other way, associated with the data collected in the study. Data collected during this study will be stored in a locked filing cabinet in Dr. Ward’s office at Brock University or Dr. Fritz’s office and will be destroyed 10 years after your participation in the study. Access to this data will be restricted to the principal investigator, co-investigator, and their research team.

VOLUNTARY PARTICIPATION
Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. You may withdraw from the study at any time. Withdrawal from the study will not affect your clinical care. Non-participation will not adversely affect your clinical care.

**PUBLICATION OF RESULTS**
Results of this study may be published in professional journals and presented at conferences. You will receive a summary of results by mail when the study is completed.

**CONTACT INFORMATION AND ETHICS CLEARANCE**
If you have any questions about this study or require further information, please contact the Principal Investigator (Dr. Wendy Ward) or the Co-Investigator (Dr. Peter Fritz) using the contact information provided above. This study has been reviewed and received ethics clearance through the Brock University Ethics Board (file #12-XXX). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at 905-688-5550 ext. 3035, reb@brocku.ca.

Thank you for your assistance in this project. Please keep a copy of this form for your records.

**CONSENT FORM**
I agree to participate in this study described above. I have made this decision based on the information I have read in the Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: __________________________ (please print)
Signature: _______________________
Date: __________________________
Expected Pain Rating

Study Name:

USE OF PAIN MEDICATION FOLLOWING PERIODONTAL PROCEDURES

Prior to Procedure:

On the line below, mark the level of pain you expect to experience due to your periodontal procedure with an “X”.

No Pain                                     Worst Pain Imaginable
7.5 Patient Diary

PATIENT DIARY

Study Name:

USE OF PAIN MEDICATION
FOLLOWING PERIODONTAL
PROCEDURES

Please complete a diary entry at the end of each day for the first 7 days following your procedure. Day 1 is the day of your procedure.

If you have any questions about completing this form, please contact:

Dr. Fritz’s office 905 892 0800 or

Professor Ward 905 688 5550 X3024 wward@brocku.ca

Please return this form at your post-operative follow-up appointment.
DAY 1 (Day of procedure)

On the line below, mark the level of pain you have experienced today related to your periodontal procedure with an "X".

No Pain                                           Worst Pain Imaginable

Number of pain pills:  
Servings of alcohol:  
Number of cigarettes: 
Number of cigars: 

Please list any non-prescription pills or supplements you took today (include name and dose):

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

DAY 2

No Pain                                           Worst Pain Imaginable

Number of pain pills:  
Servings of alcohol:  
Number of cigarettes: 
Number of cigars: 

Please list any non-prescription pills or supplements you took today (include name and dose):

☐ same as previous day or list below:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Study ID Number: 14 -

DAY 3

No Pain                       Worst Pain Imaginable

Number of pain pills: _________
Servings of alcohol: _________
Number of cigarettes: _________
Number of cigars: _________

Please list any non-prescription pills or supplements you took today (include name and dose):

☐ same as previous day or list below:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

DAY 4

No Pain                       Worst Pain Imaginable

Number of pain pills: _________
Servings of alcohol: _________
Number of cigarettes: _________
Number of cigars: _________

Please list any non-prescription pills or supplements you took today (include name and dose):

☐ same as previous day or list below:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
Day 5

No Pain

Worst Pain Imaginable

Number of pain pills: __________
Servings of alcohol: __________
Number of cigarettes: __________
Number of cigars: __________

Please list any non-prescription pills or supplements you took today (include name and dose):

☐ same as previous day or list below:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Day 6

No Pain

Worst Pain Imaginable

Number of pain pills: __________
Servings of alcohol: __________
Number of cigarettes: __________
Number of cigars: __________

Please list any non-prescription pills or supplements you took today (include name and dose):

☐ same as previous day or list below:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Study ID Number: 14 -

DAY 7

No Pain Worst Pain Imaginable

Number of pain pills: _________
Servings of alcohol: _________
Number of cigarettes: _________
Number of cigars: _________

Please list any non-prescription pills or supplements you took today (include name and dose):

☐ same as previous day or list below:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
7.6 Patient Information and Medical Questionnaire

Confidential Patient Information and Medical History

(Please print)

Patient Name: __________________________ Date of Birth (dd/mm/yyyy): __________________
Home Address: __________________________
City: __________________________ Postal Code: __________________
Home Telephone: __________________________ Cell Telephone: __________________
Best Phone Number to Contact You: __________________________
E-Mail Address: __________________________ Marital Status: __________________________
Employer: __________________________ Occupation: __________________________
Business Address: __________________________
Business Telephone: __________________________

Name of your general dentist: __________________________ Referred by: __________________________

Do you have dental insurance? □ Yes □ No

In case of an emergency, contact:
Name: __________________________ Relationship: __________________________ Phone Number: __________________________

Family Physician’s Name: __________________________ Phone Number: __________________________
Pharmacy: __________________________ Phone Number: __________________________

My last physical examination was: __________________________ Are you in good health? □ Yes □ No
Has there been any change in your health in the last year? □ Yes □ No
If so, please elaborate. __________________________

Has it ever been recommended that you routinely have antibiotic coverage before surgery or dental treatment? □ Yes □ No

PLEASE LIST ALL MEDICATIONS YOU ARE CURRENTLY TAKING.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

ARE YOU CURRENTLY TAKING ANY MINERAL, VITAMIN AND/OR HERBAL SUPPLEMENTS? IF SO, PLEASE SEE BLUE SHEET.

ALLERGIES - Are you allergic or have you reacted adversely to any of the following?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penicillin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetracycline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other antibiotics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other allergies [please list]:

Do you smoke? □ Yes □ No
If so, how many cigarettes/day? _______ How many years have you smoked? _______

Are you a former smoker? □ Yes □ No
If so, how many cigarettes/day? _______ How many years did you smoke? _______

How long ago did you quit? _______
Pain associated with periodontal surgery

Do you have or have you had any of the following conditions?

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Blood Pressure/Heart Trouble</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angina Pectoris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitral Valve Prolapse (MVP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Murmurs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artificial Heart Valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Surgery or Heart Attack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive Bruising</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroid Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemophilia or Blood Transfusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent Cough</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emphysema/Bronchitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuberculosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hayfever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinus Troubles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes or Excessive Thirst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteoporosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Apnea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artificial Joint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney Trouble</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stomach Ulcer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glaucoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis A/B/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow Jaundice</td>
<td></td>
<td></td>
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<tr>
<td>Leukemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV (AIDS)</td>
<td></td>
<td></td>
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<tr>
<td>Venereal Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Sores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug Addiction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol Dependency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Painting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eating Disorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychiatric Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epilepsy/Seizures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatic or Scarlet Fever</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Have you ever been hospitalized? If so, what was the illness or operation? ____________

Are there any medical conditions that run in your family? (i.e. High blood pressure, diabetes, cancer)

Have you ever had abnormal bruising or bleeding associated with previous extractions, surgery or injuries?

Have you had any serious trouble with any previous dental treatment?

Do you have any disease, condition or problem not listed above you think we should know about?

Women only: Are you pregnant? If so, what month are you due? ____________ Are you nursing?

Are you willing to spend 15 minutes a day to keep your teeth a lifetime?  □ Yes  □ No

On a scale of 1 to 5, how nervous are you about dental treatment? (Please circle)

(Not nervous at all) 1........2........3........4........5 (very nervous)

I understand the above information is necessary to provide me with dental care in a safe manner. I have answered all questions truthfully and to the best of my knowledge. I consent to your obtaining, from other practitioners who are currently treating me or have treated me, such further information as may be necessary for providing me with proper dental treatment and care.

Signature: ______________________________ Date: ____________________ D.D.S.: __________

Please be advised that our office policy is not to accept assignment of benefits as payment for accounts.

Dr. Fritz is committed to providing his patients with evidence-based care. In doing so, there may be research questions that he would like to answer using data collected during your visit to improve future patient care. Please know that in using such information your personal identity would not be revealed.

□ Please check this box if you DO NOT want your information included in a future research study.

Your decision will in no way impact the care you receive.
### Supplement Questionnaire

(Please print)

Patient Name: ____________________________
Date: ____________________________

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Dose</th>
<th>Brand</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ B vitamin complex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ β-carotene</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Calcium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Chondroitin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Copper</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Dong Quai</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Echinacea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Fish oil (DHA or EPA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Omega 3, 6, 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Cod Liver oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Flaxseed (ground)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Flaxseed (unground)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Flaxseed oil</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>□ Folic Acid (Folate)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Garlic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Ginko</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Glucosamine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Goldenseal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Green tea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Iron</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Kava</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Lycopene</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Magnesium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ Multivitamin/multimineral</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Continued on reverse)
<table>
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<tr>
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<th>Dose</th>
<th>Brand</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. John’s wort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valerian root</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B12 (oral or injection)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td></td>
<td></td>
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<tr>
<td>Vitalux (for eye health)</td>
<td></td>
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<tr>
<td>Zinc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other(s):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dr. Fritz is committed to providing his patients with evidence-based care. In doing so, there may be research questions that he would like to answer using data collected during your visit to improve future patient care. Please know that in using such information your personal identity would not be revealed.

☐ Please check this box if you **DO NOT** want your information included in a future research study. Your decision will in no way impact the care you receive.
7.8 Scatterplot Matrix
7.9 Scatterplot to Test Homoscedasticity of Pain Regression

Scatterplot

Dependent Variable: SMEAN(Pain1)

Regression Standardized Residual

Regression Standardized Predicted Value
7.10 Histogram Showing Distribution of Residuals of Pain Regression

Histogram

Dependent Variable: SMEAN(Pain1)

Mean = 5.81E-16
Std. Dev. = 0.975
N = 184

Regression Standardized Residual
7.11 Pain Regression Results

**Model Summary**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.474(^a)</td>
<td>.224</td>
<td>.184</td>
<td>2.17599</td>
<td>.224</td>
<td>5.597</td>
<td>9</td>
<td>174</td>
<td>.000</td>
<td>1.994</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Sex, Supplement_user, Smokingstatus, Painpills1, Painbefore, Sedation, Implant, Nervousness, Age

b. Dependent Variable: SMEAN(Pain1)

**Unstandardized Coefficients**

- **Model**
  - **B**
  - **Std. Error**
  - **Beta**
  - **t**
  - **Sig.**
  - **95.0% Confidence Interval for B**
    - **Lower Bound**
    - **Upper Bound**
  - **Tolerance**
  - **VIF**

<table>
<thead>
<tr>
<th>Model</th>
<th>B</th>
<th>Std. Error</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>2.498</td>
<td>.839</td>
<td></td>
<td>2.978</td>
<td>.003</td>
<td>.843</td>
<td>4.154</td>
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<tr>
<td>Implant</td>
<td>-.388</td>
<td>.370</td>
<td>-.080</td>
<td>-1.049</td>
<td>.296</td>
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<td>.343</td>
<td>.758</td>
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<td>Supplement</td>
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<td>-8.860</td>
<td>.613</td>
<td>.804</td>
<td>1.244</td>
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<tr>
<td>user</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Pain pills</td>
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<td>.140</td>
<td>.287</td>
<td>4.094</td>
<td>.000</td>
<td>.297</td>
<td>.849</td>
<td>.909</td>
<td>1.100</td>
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<tr>
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<td>.423</td>
<td>-1.77</td>
<td>-2.354</td>
<td>.020</td>
<td>-1.830</td>
<td>-.161</td>
<td>.790</td>
<td>1.265</td>
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<tr>
<td>Pain before</td>
<td>.228</td>
<td>.074</td>
<td>.222</td>
<td>3.059</td>
<td>.003</td>
<td>.081</td>
<td>.375</td>
<td>.848</td>
<td>1.179</td>
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<tr>
<td>Nervousness</td>
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<td>.143</td>
<td>.061</td>
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<td>.433</td>
<td>-.170</td>
<td>.394</td>
<td>.745</td>
<td>1.342</td>
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<tr>
<td>Smoking status</td>
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<td>.861</td>
<td>.391</td>
<td>-.316</td>
<td>.805</td>
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<td>-2.131</td>
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<td>-.055</td>
<td>-.002</td>
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<tr>
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<td>.360</td>
<td>-.037</td>
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<td>.610</td>
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</table>
7.12 Scatterplot to Test Homoscedasticity of Pain Pill Regression

Scatterplot
Dependent Variable: Painpills1

Regression Standardized Residual

Regression Standardized Predicted Value
7.13 Histogram Showing Distribution of Residuals of Pain Pill Regression
7.14 Pain Pill Regression Results

Model Summary

<table>
<thead>
<tr>
<th>Model</th>
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<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Durbin-Watson</th>
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</thead>
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<td>.170</td>
<td>.128</td>
<td>1.126</td>
<td>.170</td>
<td>3.973</td>
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</tbody>
</table>

<sup>a</sup> Predictors: (Constant), SMEAN(Pain1), Smokingstatus, Sedation, Sex, Supplement_user, Painbefore, Implant, Nervousness, Age

b. Dependent Variable: Painpills1

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>2.091</td>
<td>.416</td>
<td>5.030</td>
<td>.000</td>
<td>1.271</td>
<td>2.912</td>
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<tr>
<td>Implant</td>
<td>-.080</td>
<td>.192</td>
<td>-.033</td>
<td>-.415</td>
<td>.678</td>
<td>-.459</td>
<td>.299</td>
</tr>
<tr>
<td>Supplement user</td>
<td>-.096</td>
<td>.193</td>
<td>-.038</td>
<td>-.496</td>
<td>.620</td>
<td>-.477</td>
<td>.285</td>
</tr>
<tr>
<td>Sedation</td>
<td>.206</td>
<td>.222</td>
<td>.073</td>
<td>.927</td>
<td>.355</td>
<td>-.232</td>
<td>.643</td>
</tr>
<tr>
<td>Pain before</td>
<td>-.013</td>
<td>.040</td>
<td>-.026</td>
<td>-.336</td>
<td>.737</td>
<td>-.091</td>
<td>.065</td>
</tr>
<tr>
<td>Nervousness</td>
<td>-.075</td>
<td>.074</td>
<td>-.081</td>
<td>-1.013</td>
<td>.313</td>
<td>-.220</td>
<td>.071</td>
</tr>
<tr>
<td>Smoking status</td>
<td>-.036</td>
<td>.147</td>
<td>-.018</td>
<td>-.243</td>
<td>.809</td>
<td>-.326</td>
<td>.255</td>
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<td>Age</td>
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<td>.007</td>
<td>-.112</td>
<td>-1.300</td>
<td>.195</td>
<td>-.023</td>
<td>.005</td>
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<tr>
<td>Sex</td>
<td>.323</td>
<td>.185</td>
<td>.131</td>
<td>1.748</td>
<td>.082</td>
<td>-.042</td>
<td>.688</td>
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<tr>
<td>Pain 1</td>
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<td>.037</td>
<td>.307</td>
<td>4.094</td>
<td>.000</td>
<td>.079</td>
<td>.227</td>
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</tbody>
</table>
7.15 Scatterplot to Test Homoscedasticity of Anticipated Pain Regression
Pain associated with periodontal surgery

7.16 Histogram Showing Distribution of Residuals of Anticipated Pain Regression

![Histogram](image)
### Model Summary\(^b\)

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
<th>Durbin-Watson</th>
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<tbody>
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<td>1</td>
<td>.394(^a)</td>
<td>.155</td>
<td>.125</td>
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\(^a\) Predictors: (Constant), Implant, Nervousness, Supplement_user, Smokingstatus, Sex, Sedation, Age

\(^b\) Dependent Variable: Painbefore

### Unstandardized Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>B</th>
<th>Std. Error</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
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<tbody>
<tr>
<td>(Constant)</td>
<td>3.003</td>
<td>.681</td>
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<td>4.410</td>
<td>.000</td>
<td>1.660 - 4.346</td>
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<tr>
<td>Sex</td>
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<td>.340</td>
<td>.094</td>
<td>1.342</td>
<td>.181</td>
<td>-1.215 - 1.128</td>
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<tr>
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<td>.012</td>
<td>.032</td>
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<td>.684</td>
<td>-0.019 - 0.029</td>
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<tr>
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<td>.274</td>
<td>.042</td>
<td>.607</td>
<td>.544</td>
<td>-0.374 - 0.706</td>
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<tr>
<td>Nervousness</td>
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<td>.131</td>
<td>.234</td>
<td>3.226</td>
<td>.001</td>
<td>.164 - 0.680</td>
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<tr>
<td>Sedation</td>
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<td>.408</td>
<td>.135</td>
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<td>.066</td>
<td>-.050 - 1.560</td>
</tr>
<tr>
<td>Supplement user</td>
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<td>.344</td>
<td>-.060</td>
<td>-.849</td>
<td>.397</td>
<td>-.971 - .387</td>
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<tr>
<td>Implant</td>
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<td>.349</td>
<td>-.127</td>
<td>1.724</td>
<td>.086</td>
<td>-.291 - .087</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tolerance</th>
<th>VIF</th>
</tr>
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<tbody>
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<td>.847</td>
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<td>1.274</td>
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