A Prospective Quality Control Study on Methods Used for the Treatment of Non-Complicated Mandibular Angle Fractures by Open Reduction and Internal Fixation in Manitoba

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M(Dent) Report

ABSTRACT

Mandibular fracture is a common diagnosis that the Oral and Maxillofacial Surgeon is presented with, and its management is a critical skill for a competent trauma surgeon. One of the most commonly fractured regions of the mandible is that of the mandibular angle, found where the tooth-bearing corpus of the mandible meets the ascending ramus. While the mandibular angle fracture is a particularly common injury, there remains some openness in the interpretation of the best manner in which to establish fixation in these cases. The Oral and Maxillofacial Surgery Department at the University of Manitoba treats mandibular angle fractures by open reduction internal fixation using one of two typical plating orientations. The first method positions a miniplate angled along the superolateral aspect of the external oblique ridge spanning the fracture site, while the second method positions a miniplate strictly on the lateral aspect of the mandible across the fracture site.

The purpose of this study was to compare the post-operative outcomes of these two plating methods. The study consisted of eighteen patients with mandibular angle fractures eligible for treatment by open reduction internal fixation that were randomly assigned to two treatment groups: Group A (N=8) with the miniplate oriented at the superolateral aspect of the mandible, and Group B (N=10) with the miniplate oriented on the lateral aspect of the mandible. Patients in each group were followed prospectively at 1-week, 4-week and 6-month post-operative time intervals for outcomes that included post-operative malocclusion, maximal interincisal opening, paresthesia, pain, swelling, development of infection, and surgical site dehiscence. There was no statistically significant difference found between the two plating orientation methods in each of the aforementioned outcomes.

KEYWORDS

Mandible Fracture, Angle Fracture, Champy Technique, Upper Lateral Border Plate

ABBREVIATIONS

ORIF, Open Reduction Internal Fixation; VAS, Visual Analog Scale; MIO, maximal interincisal opening; IMF, Intermaxillary Fixation

INTRODUCTION

Trauma to the facial skeleton is associated with significant health morbidity, leading to a wide variety of deficits in function and cosmesis. Post-traumatic psychologic impairments can occur after having sustained facial injuries in association with traumatic mechanism of injury and sequelae from treatments rendered.[1]

Fractures of the mandible are routinely reported as one of the most frequent injuries to the maxillofacial skeleton.[2–5] In addition to serious impacts on the victims of mandibular fractures directly, the treatment of these injuries as well as any potential complications as a result of injury represents a significant burden to healthcare costs; one U.S. study reported the cost of treatment ranging from $7,538 to $15,979 depending on the treatment modality employed.[6]

Causes for mandibular fractures can range from motor vehicle accidents, interpersonal violence, falls, sporting accidents or workplace injuries.[2,3,7] Epidemiologic characteristics of facial trauma and mandibular fractures can vary significantly based on study population.[4] Owing to poorly enforced traffic laws and less compliance with safety features such as seat belts, the incidence of facial injury as a result of motor vehicle accidents has been reported at higher rates in developing countries.[4] By contrast, in Western countries, interpersonal violence is often found to be the leading cause of facial injuries amongst those presenting to healthcare facilities for management.[4] It has been suggested that there may be a role for the involvement of alcohol in regional differences in the etiology of facial and mandibular trauma, as in some Islamic countries where alcohol is less commonly used by residents, so too is the cause of interpersonal violence in the presentation of facial trauma victims.[4,8] In some cases, age can be linked with the mechanism of injury, as falls are the most common etiology of facial fractures in young children and in the elderly.[4] However, the incidence of facial trauma and mandibular fractures tends to be most common in individuals in their 2nd and 3rd decade of life, accounting for 35.2-56.6% of all reports of facial injuries; this appears to hold true for both males and females.[3,4]

Maxillofacial trauma has a predilection for the male gender, with studies based in Western countries reporting a male-to-female ratio in the range between 3:1 and 4:1.[4] Gender differences in occupations and in the practice of driving in Middle-Eastern countries are thought to account for an incidence of maxillofacial trauma that is even further skewed towards male involvement, with ratios being reported from 4.5:1 to 12:1.[4,9]

Mandibular trauma can often result in significant clinical consequences for the victim. Patients often present for evaluation after mandibular trauma with tenderness, ecchymosis, and swelling to the area of a fracture.[10–12] An extremely important component to the clinical examination of a mandibular fracture is the patient's subjective description of malocclusion, as a fracture of nearly any area of the mandible can contribute to occlusal discrepancy.[10–12] Patients with condylar neck fractures may suffer from ramus shortening and therefore an ipsilateral prematurity in occlusal contact.[11] In the case of bilateral condylar neck fractures, an anterior open bite deformity may result.[11] In the tooth-bearing region of the mandible, fractures can present clinically with newfound diastemas, step deformity in the occlusal plane, and mobility of the adjacent mandibular segments on palpation.[11] One feature of clinical exam that is particularly important to note is altered sensation in the distribution of the third branch of the trigeminal nerve; in the case of mandibular angle fractures, tension or crush injury to the inferior alveolar nerve as it runs through the medullary space across the fracture site can lead to notable paresthesia of the lower lip and chin.[10,11] Other relevant intraoral findings would include sublingual ecchymosis, gingival lacerations or bleeding.[10] These clinical findings represent significant ramifications to the patient, as often extreme discomfort is felt while essential functions such as mastication and deglutition are attempted post-injury. Without treatment of the malocclusion, prolonged malnutrition can result, particularly complicating in those who are already susceptible to the adverse effects of such an outcome.

The mandible is a U-shaped bone that articulates with the base of the skull to allow for movement in both a rotational and anterior-posterior translational fashion; this articulation occurs bilaterally between the condyle of the mandible and the glenoid fossa of the temporal bone, in the temporomandibular joint.[12] The upper and lower compartments of the temporomandibular joint are separated by a mobile cartilaginous disc that forms attachments to the anterior aspect of the neck of the condyle and lateral pterygoid muscle anteriorly, and to the temporal bone and posterior aspect of the neck of the condyle posteriorly.[12] The vertical portion of the mandible is referred to as the ramus; at its most superior extent are the condyle and coronoid process, separated by the sigmoid notch.[12] In the tooth-bearing area of the mandible, or corpus, the teeth are housed by the alveolar bone, as well as a buccal and lingual cortex.[12] Bone in the area of the corpus is significantly thicker than posteriorly in the ramus of the mandible, and concentrates in areas of maximal stress on masticatory loading.[13]

Blood is supplied to the mandible from internal and external sources. Overlying periosteum and its muscular attachments provide an external source of nourishment to the mandible.[12] The inferior alveolar neurovascular bundle, which enters the medullary space of the mandible at its medial aspect through the mandibular foramen in the ramus and travels anteriorly to the mental foramen in the region of the bicuspids provides an internal blood supply, as well as the course of the inferior alveolar nerve, which gives sensation to the mandibular teeth and the region of the lower lip and chin.[12,13] In addition to sensory fibers, the inferior alveolar nerve carries a motor nerve, the nerve to mylohyoid, which it gives off prior to entering the posterior mandible.[13]

The mandible is subject to numerous muscle attachments that allow it to accomplish a range of movements; most principally, these are the masticatory and suprahyoid muscular groups.[12] All four of the masticatory muscles (the masseter, temporalis, medial and lateral pterygoid muscles) that attach to the mandible are innervated by the third branch of the trigeminal nerve.[12] The masseter inserts on the lower lateral border of the ramus, and forms a sling on the inferior border with the medial pterygoid muscle which inserts on the medial mandibular angle.[12] These two muscles, along with the temporalis which inserts at the coronoid process and anterior ascending ramus, act to elevate the mandible thereby closing the jaws.[12] The lateral pterygoid muscle, which originates from the lateral aspect of the lateral pterygoid plate of the sphenoid bone and inserts onto the anterior neck of the mandibular condyle and the articular disk, serves to aid in protrusion and opening of the mandible.[12]

The suprahyoid group of muscles is comprised of the digastric, stylohyoid, mylohyoid, and geniohyoid muscles. The muscles in this group serve to elevate the hyoid bone in the coordination of swallowing, or in the case of the digastric muscles, to depress the mandible and open the jaws.[12,14] The digastric muscle consists of two bellies: the anterior belly which is innervated by the nerve to mylohyoid, and the posterior belly which is innervated by the facial nerve.[12] The anterior belly originates on the lingual aspect of the parasymphysis, and travels inferiorly and posteriorly to reach the hyoid bone, where it is joined by the posterior belly via an intermediate tendon.[12] The stylohyoid muscle is important in the initiation of deglutition, as it inserts onto the hyoid and elevates it posteriorly and superiorly towards its origin at the styloid process.[12] The mylohyoid is a broad flat muscle forming a sling in the floor of the mouth, as it originates along the lingual surface of the mandible, from the third molar region to the symphysis and extends inferiorly to attach to the hyoid bone.[12] The geniohyoid originates from the genial tubercles on the lingual aspect of the mandibular symphysis and extends inferiorly to insert onto the body of the hyoid.[12]

The collective influence of the masticatory and suprahyoid muscle groups on the bony mandible is important in the behaviour of mandibular fractures at the time of injury as well as during treatment and post-operatively.[12] The extent to which muscular pull has an influence on the mandible during normal function can be appreciated by findings that indicate the tendency of this very rigid bone to narrow significantly at the mandibular angle on forced protrusion and on wide opening of the jaw.[14] A review by Choi et. al. reported a narrowing of up to 1.4mm at the second molar region on wide opening, and up to 1.5mm upon forced protrusion.[14] In the case of a fractured mandible, the masseter and medial pterygoid will tend to displace proximal fracture segments superomedially, while the suprahyoid group will have the opposite observed effect on distal segments, instead pulling them inferiorly.[10,12] In the case of fractures of the condylar neck of the mandible, the lateral pterygoid's unopposed contraction allows medial and anterior displacement of the proximal segment.[12]

Fractures of the mandible can be classified in a number of different manners, the most common and arguably most important because of distinct differences in management philosophies is that of location. One particularly common site of mandibular fracture accounting for 25-35% of all fractures of this bone is that of the condylar head and neck.[11] Fractures in the anterior mandible in the region between the cuspids are commonly referred to as parasymphyseal fractures, while those in the more posterior tooth-bearing segment of the mandible are referred to as body fractures.[11] Finally, often cited as the most common type of mandibular fracture is that of the mandibular angle, occurring in the region where the body of the mandible meets the ramus.[11] This region of the mandible is thought to be a common site of fracture due to the thin nature of the bony cross-section in this area; furthermore, it is felt that the presence of third molars make this region more prone to fracture.[11]Though there is no universal definition that is accepted for what encompasses a mandibular angle fracture, it is generally agreed that it involves a fracture that begins at the superior border of the mandible where the tooth-bearing segment meets the ascending ramus.[15] This fracture line can then extend inferiorly and posteriorly, exiting the mandible either anteriorly, or more rarely, posteriorly to the region of the anatomic gonial angle of the mandible.[15]

Another method of classification of mandibular fracture is that of favourability. Fracture favourability directly reflects the action of the muscular attachments of the mandible in response to a fracture of a particular orientation.[10]A fracture is considered favourable when the orientation of the fracture line allow the pull of the associated musculature to pull the fractured segments towards one another, thereby reducing them.[10] A fracture that is considered unfavourable accomplishes the opposite action, whereby fracture line orientation allows for the masseter and medial pterygoid to splay the fractured segments further apart.[10] Fractures that are vertically unfavourable will have their segments distracted in a mediolateral direction, while fractures that are horizontally unfavorable will be distracted in a superior-inferior direction.[10]

The concept of mandibular fracture favourability is particularly critical in the region of the mandibular angle, due to common fracture geometry and the muscle attachments in the area. The work of Champy and Michelet famously examined the mandible as a Class 3 lever, with a load placed at the anterior teeth, a fulcrum at the condyle, and an effort in between these points (near the posterior teeth).[10,16–18] In this model, the posterior mandibular body was found to exhibit zones of tension and compression in a characteristic fashion. In a mandibular angle fracture, a tensile zone is created along the superior body of the mandible whereby the segments tend to splay apart anteroposteriorly, while a compressive zone develops along the inferior aspect of the mandible.[10,15] This is attributed to the superior pull of the proximal segment by the pterygomasseteric sling in combination with the inferior pull of the distal segment by the suprahyoid musculature at the anterior mandible.[15] This phenomenon made even more apparent in the case of mandibular angle fractures where the fracture line is posterior to the dentition, as there are no teeth present in the proximal segment to "buttress" it against the opposing maxillary dentition and prevent its superior displacement; the proximal segment is left to freely rotate about the condyle under the influence of the pterygomasseteric sling.[15]

Historically, nearly all types of mandibular fractures were treated in a closed fashion, with various methods of maxillomandibular fixation, most often with wires to maintain the occlusion.[15] However, in the case of mandibular angle fractures where the fracture line traverses the height of the mandible posterior to the tooth-bearing segment of the mandible, maxillomandibular fixation is useless against the force of the pterygomasseteric sling to stabilize the proximal segment of the fracture, despite a protective reduction in biting force that occurs after the time of injury.[15] For this reason, open reduction and fixation with the use of wires or externally placed pins was often employed in combination with maxillomandibular fixation for mandibular angle fractures, even before the era of rigid internal fixation.[15]

Since the introduction of rigid internal fixation, several different fixation schemes have been proposed and documented in the literature for the treatment of non-comminuted mandibular angle fractures, with a varying degree of controversy. Champy's examination of mandibular biomechanics led to the recommendation of the placement of a small miniplate over the external oblique ridge of the mandible, spanning the fracture line near the superior border to counteract tension and allow natural compressive forces in function at the inferior border to act in the benefit of the fractured segments, leading to a functional union of the fracture.[10,16,18] The argument with this scheme relied on the notion that fixation of mandibular angle fractures needed not to withstand the normal forces applied in function of this area, but rather only the lessened forces that occur naturally after a patient sustains a fracture.[15] Owing to the strategic use of zones of tension and compression in the region of the mandibular angle, Champy demonstrated that absolute rigid fixation was not necessarily of paramount importance in the management of these fractures, while offering some theoretical merits: fractures could be approached entirely intraorally, and the roots of teeth were safer from inadvertent damage as the fixation screws were monocortical.[19]

A similar fixation technique for mandibular angle fractures enlists in the use of a single miniplate affixed to the lateral aspect of the mandible near the superior border; this technique relies on the same principle proposed by Champy with respect to a zone of tension at the superior aspect of a mandibular angle fracture, but avoids spanning the plate over the external oblique ridge.[20] Such a fixation scheme has been found to adequately control tensile forces at the superior aspect of the mandible while potentially leading to less frequent dehiscence of the surgical incision when compared to the traditional Champy positioning of the miniplate; however, the angle at which screws must be placed to appropriately utilize this method typically require the intraoperative use of a cutaneous incision to establish transbuccal access with a trochar.[20]

Meanwhile, other authorities on the subject of fracture management of the mandible have stressed the use of strictly rigid fixation to ensure absolute lack of bony movement across the fracture line during the healing process.[19] By definition, the practice of load-bearing rigid internal fixation of the mandible in the region of the angle would require the use of two miniplates, a ladder-style miniplate, or a single larger fixation plate with at least three screws placed bicortically on either side of the fracture line.[15,20] These methods provide robust fixation hardware capable of bearing the entirety of the functional forces generated by the normal mandible, while a single miniplate would necessitate that the load be shared partly by bony buttressing across the fracture line.[20] While the use of one of these load-bearing rigid fixation schemes inherently provides more stability across the fracture line than does a single miniplate as proposed by Champy, this does not necessarily translate to better clinical outcomes. A number of studies have somewhat paradoxically reported for example, that instead of improving clinical outcomes, the use of two miniplates placed at the superior and inferior border of the mandibular angle region led to a greater incidence of post-operative complications than the use of a single miniplate.[20,21] Some authors have postulated that the limited periosteal dissection required for adaptation of a single superior border miniplate accounts for the more limited occurrence of complications seen relative to the placement of two miniplates or a larger “strut” style plate.[15]

Any surgical intervention comes with potential complications, and the treatment of mandibular angle fractures is no exception to this rule. Iatrogenic injury to the inferior alveolar nerve is the most likely intraoperative complication due to the anatomic position of this structure relative to the surgical site.[15] Fixation methods that rely on monocortical screws are less likely to lead to such a result, as they by definition are drilled to a depth that is shallow enough to avoid injury to the inferior alveolar neurovascular bundle.[15] Minor postoperative surgical site infections without the presence of purulent discharge can typically be resolved with a course of oral antibiotics.[15] Surgical site dehiscence poses a risk of screw-loosening and hardware failure, and often needs to be managed conservatively with oral rinses and antibiotics until a stable bony union occurs across the fracture site.[15] Once healing has occurred, loosened or failed hardware should be removed, either under local anesthetic in a clinic setting if the positioning of the hardware allows, or potentially in the operating room setting under general anesthetic.[15] Post-operative malocclusion is another potential complication; typically in cases where patients have been treated with a single monocortical miniplate, the occlusion can be adequately settled into position in the early post-operative period using guide elastics.[20]

In Manitoba, the Oral and Maxillofacial Surgery Department has commonly practiced one of two techniques for the fixation of non-comminuted mandibular angle fractures: that of a Champy orientation with a single 4-hole miniplate positioned along the superolateral aspect of the mandible, or a 4-hole miniplate positioned directly on the lateral aspect of the mandible near its superior edge (Figure 1, Figure 2). These techniques, among others, are commonly used as an accepted standard of treatment in many other centres. This study was therefore structured as a quality control study to examine the post-operative outcomes in the treatment of mandibular angle fractures using each of these two methods, to determine any tendency toward complications or adverse outcomes in either method. Markers tracked included patient-oriented outcomes including the development of post-operative infection, surgical site dehiscence, malocclusion, swelling of the surgical area, and range of mandibular opening.

EXPERIMENTAL PROCEDURES

Patient Selection.

Ethics approval was obtained at the outset of the study. Patients over the age of 18 years that presented to the care of the Oral and Maxillofacial Surgery Service at the Health Sciences Centre between September 2019 and January 2021 with non-comminuted mandibular angle fractures that were candidates for treatment by open reduction internal fixation (ORIF) were enrolled in the study. Exclusion criteria included patients under 18 years of age, patients who did not consent to surgical treatment of the mandibular angle fracture, patients unfit for treatment under general anesthesia, patients with bilateral mandibular angle fractures, patients with previous hardware at the site of the fracture, patients with pathologic bone conditions at the site of injury, patients with conditions affecting bone healing, patients with insufficient dentition to adequately reconstruct the occlusion, patients in whom the fracture was not evaluated within two weeks from the time of injury and patients with concomitant LeFort or mid-palatal split fractures of the maxilla. Forty consecutive eligible patients were randomly assigned to one of two treatment groups, and twenty-two patients were lost to follow-up. Group A (N=8) was treated superolateral positioning of a titanium miniplate at the mandibular angle fracture site, while Group B (N=10) was treated by positioning of a miniplate along the lateral aspect of the mandible. Randomization was carried out by blindly choosing a treatment method from an envelope with twenty pieces of paper labelled with Group A, and twenty labelled with Group B. Data collected at the time of enrollment included cause of injury, smoking status, presence of a mandibular third molar at the fracture site, paresthesia of the third division of the trigeminal nerve distribution at the time of injury, and any concomitant mandibular fracture sites present.

Materials.

Implanted materials were from the Synthes MatrixMANDIBLE fixation kit. Fixation of mandibular angle fractures for patients in Group A was done using a pre-bent 1.0mm pure titanium 4-hole Champy-style fixation plate (Synthes GmbH, Switzerland). Fixation of mandibular angle fractures for patients in Group B was carried out using a 1.25mm pure titanium 4-hole crescent style fixation plate (Synthes GmbH, Switzerland).

Surgical Procedures.

All patients were treated under general anesthesia, and were given a single pre-operative dose of IV antibiotics at the time of induction. Patients in Group A were given a single dose of Ampicillin 1 gram IV, or Clindamycin 600 milligrams IV if a history of penicillin allergy was present. Patients in Group B were given a dose of Ancef 1 gram IV. After injection of local anesthetic solution into the operative area, a standard intraoral transmucosal incision at the posterior aspect of the mandible in the operative area was made. Subperiosteal dissection was carried out to gain access to the underlying bony mandible, and the fracture site was adequately exposed. If a concomitant mandibular parasymphyseal or mandibular body fracture was present, these were exposed in a similar manner. A series of intermaxillary fixation screws were then placed transmucosally, hand-driven into the interdental alveolar bone throughout the maxilla and mandible. Intermaxillary fixation (IMF) was then established in a best-fit occlusion by running 25-gauge stainless steel wire loops between the maxillary and mandibular IMF screws. Once the occlusion appeared to be a suitable replication of the pre-morbid condition, attention was turned to reduction of the already exposed mandibular fractures. Fractures in the tooth-bearing regions of the mandible (if present) were reduced and fixated first, followed by the mandibular angle fracture. Patients in Group A were treated by adaptation of a pre-bent 1.0mm titanium miniplate (Synthes GmbH, Switzerland) adapted to the superolateral aspect of the external oblique ridge, which was fixated by an entirely intraoral approach, using monocortical screws following pre-drilled holes using a drill guide. Patients in Group B were treated by adaptation of a 1.25mm titanium miniplate (Synthes GmbH, Switzerland) to the lateral aspect of the mandible just inferior to the external oblique ridge and superior to the likely position of the inferior alveolar canal. Transbuccal access was established using a small (<1cm) skin incision to allow the application of screw fixation at an angle that was perpendicular to the lateral aspect of the mandible. Holes were pre-drilled using a transbuccal drill guide, and screws were placed bicortically where it was felt they would not damage tooth roots or the mandibular canal. Once applicable fractures were fixated, the patient was released from intermaxillary fixation by cutting the 25-gauge wire loops, and the occlusion was tested to ensure it was stable and repeatable in a manner that was felt to replicate the premorbid condition. Closure was then obtained at the surgical incision sites using a 3-0 chromic gut suture in a continuous locking fashion for mucosa; if applicable, muscular layers were resuspended using 3-0 vicryl sutures in an interrupted fashion. Intermaxillary fixation screws were then removed. Post-operatively, patients were provided a prescription for a one week course of Amoxicillin (or Clindamycin in the case of Penicillin allergy), and instructed to resume eating but to maintain a soft diet for a period of four weeks.

Post-operative Assessment of Mandibular Angle Fractures.

Patients were seen and evaluated post-operatively at time points of 1 week, 4 weeks, and 6 months. At each post-operative follow-up visit, data collected included degree of paresthesia of the third division of the trigeminal nerve distribution on the operative side, maximal interincisal opening, Visual Analog Scale (VAS) pain scores, presence of surgical site dehiscence, presence of surgical site infection, post-operative swelling on the surgical and non-surgical side, and presence of post-operative malocclusion.

The degree of post-operative paresthesia on the operative side was measured objectively using the classic Zuniga Neurosensory Deficit Test.[22] This method allocates and categorizes the degree of altered sensation that they experience in a manner that correlates to the Sunderland Scale of Nerve Injury.[22] Testing is carried out by assessing a patient's ability to appropriately respond to up to three different tests as needed; tests only proceed until an appropriate response is achieved. Level A testing includes directional sensation with a cotton wisp or two-point discrimination with a Boley Gauge. Level B testing measures detection of contact with light touch of a cotton swab, either without indentation on the skin or with indentation on the skin if required. Level C testing measures the detection of temperature or a noxious stimulus, and is carried out with a sharp instrument. An appropriate response to Level A testing corresponds to a Sunderland First Degree Injury, while a failure of Level A testing with normal Level B testing corresponds to a Sunderland Second Degree Injury. An abnormal result of Level B testing with normal Level C testing corresponds to a Sunderland Third Degree Injury. Abnormal Level C testing corresponds to a Sunderland Fourth Degree Injury, while a complete absence of any sensation corresponds to a Sunderland Fifth Degree Injury. For the purposes of numeric statistical analysis, the traditional Zuniga Levels of A, B, and C were assigned representative values of 1, 2 and 3 respectively.

Maximal interincisal opening (MIO) was evaluated at each follow-up visit with a millimetre rule. A measurement was taken from the incisal edge of the right maxillary central incisor (when present) to the incisal edge of the right mandibular central incisor, and the difference between MIO at post-operative Week 1 and post-operative Week 4 was tracked and is reported as a "percent reduction".

Post-operatively, patients were provided with a typical regimen of prescription analgesia upon discharge from hospital (Tylenol #3, twenty tablets and Naproxen 500mg, twenty tablets), and were questioned on their analgesia control using a 10-point Visual Analog Scale (VAS) at the time of each return visit. On the VAS, a score of 0 indicated absence of pain, while a score of 10 indicated the worst level of pain that the individual had ever experienced.

Post-operative swelling was expected to be mainly in the buccal regions and masseteric region as a result of instrumentation of the lateral aspect of the mandible in accordance to access required for fixation of mandibular angle fractures. In order to quantify the degree of post-operative swelling on the operative side relative to the non-operative side, a measurement from the lobule to menton landmarks was taken on each side using a flexible millimeter ruler thereby spanning the region of greatest proposed post-operative edema in the masseteric region.

Presence of post-operative malocclusion was reported on a binary scale, simply as presence or absence thereof. As the masticatory system is exquisitely sensitive to changes in the position of occlusal contacts, the patients were each interviewed as to whether or not they felt that the position of their maximal intercuspation had altered post-operatively. Then, the presence of malocclusion was determined by observation of any prematurity in occlusal contact on jaw closure into maximal intercuspation, as well as the presence of any open bites in the anterior or posterior regions that were not consistent with the pre-morbid occlusion.

Presence of surgical site dehiscence was determined by clinical observation of the surgical incision site at each post-operative visit. A surgical site dehiscence was said to have occurred if the surgical incision had gaped open and the underlying mandibular bone or newly fixated hardware was clinically visible by inspection. Presence of surgical site infection was charted separately from the occurrence of surgical site dehiscence, as the presence of a dehiscence does not necessarily lead to the development of an infection in all cases. A site was said to be infected if the following clinical signs were present: pain on palpation beyond that which would be expected, the ability to express purulent discharge from the site, as well as localized swelling and redness.

Statistical Analysis.

Data was collected and tabulated for each of the patients in Group A (N=8) and Group B (N=10). Statistical analyses were carried out using IBM® SPSS Statistics® software. Fisher's Exact Test was utilized to determine the presence of any statistically significant difference between the two treatment groups with respect to post-operative paresthesia, post-operative malocclusion, post-operative surgical site dehiscence and surgical site infection. A two-tailed t-test was used to determine the presence of any statistically significant difference between the two treatment groups with respect to measurement of maximal interincisal opening at one week post-operatively, percent reduction in maximal interincisal opening from one week post-operatively to four weeks post-operatively, degree of post-operative swelling, severity of post-operative paresthesia, and VAS pain scores.

RESULTS

A total of 18 patients with non-comminuted mandibular angle fractures and adequate follow-up data were included in the study, with eight in Group A treated by superolateral positioning of miniplate fixation and ten in Group B treated by positioning of a miniplate on the lateral aspect of the mandible for fixation. Table 1 outlines the descriptive statics of enrolled patients in each group.

The mean follow-up time was 5.3 weeks in Group A, and 5.1 weeks in Group B. In seventeen of the total eighteen patients in the study, the mechanism of injury was reported as interpersonal violence; one patient in Group B was injured as a result of participation in sports, though this sport was boxing. Seven out of eight patients in Group A were smokers, while seven out of ten patients in Group B were smokers; there was no statistically significant difference in the incidence of smokers between Group A and Group B (Fisher's Exact Test, two-tailed p = .588).

Fractures of the left mandibular angle were more common than fractures of the right angle in both groups, with left mandibular angle fractures comprising 75% of the sample in Group A (6/8) and 70% of the sample in Group B (7/0). There was no statistically significant difference in the sidedness of the fracture site between the two groups (Fisher's Exact Test, two-tailed p = 1.00). Mandibular angle fractures occurred in combination with other fractures of the mandible in five subjects in Group A, while four patients in Group B sustained mandibular angle fractures concomitantly with other mandibular fractures at the time of injury. Mandibular third molars were present at the site of injury in five of eight patients in Group A, while seven of ten patients in Group B had mandibular third molars present at the site of injury. There was no statistically significant difference in the presence of third molar at the fracture site between Group A and Group B (Fisher's Exact Test, two-tailed p = 1.00).

In Group A, 50% of patients (4/8) reported post-operative paresthesia in the distribution of the inferior alveolar nerve on the operative side where pre-operative anesthesia was not reported. In Group B, 40% of patients (4/10) were found to demonstrate post-operative paresthesia where pre-operative paresthesia was not reported. Fisher's exact test was used to determine if there was a significant association between operative technique and the occurrence of post-operative paresthesia. There was not a statistically significant association between the operative technique and the occurrence of post-operative paresthesia. (two-tailed p = 1.00). In patients where post-operative paresthesia on the operative side was reported and measured by the Zuniga Neurosensory Deficit Test, the severity of neurosensory deficit was compared between Group A and Group B using a two-sample t-test (Figure 3). There was not a statistically significant difference between Group A (Mean = 1.28, SD = 0.76) and Group B (Mean = 1.00, SD = 0.67); t(15) = 0.824, p = .211.

In Group A, three patients were found to have post-operative malocclusion (Figure 4). Of these three patients, one was treated for an isolated mandibular angle fracture while the remaining two were treated for a multiply-fractured mandible (each with a concomitant angle and parasymphyseal fracture). In Group B, there were no patients found to have a post-operative malocclusion. Fisher's exact test was used to determine if there was a significant association between operative technique and the occurrence of post-operative malocclusion. There was not a statistically significant association between the two variables (two-tailed p = .069).

The maximal interincisal opening at initial follow-up one week postoperatively for patients in Group A was compared to that of Group B using a two-sample t-test (Figure 5). There was not a statistically significant difference in maximal interincisal opening at one week postoperatively between Group A (Mean = 25.43mm, SD = 6.50mm) and Group B (Mean = 29.70mm, SD = 7.71mm); t(15) = 1.194, p = .251. In order to evaluate if a reduction in maximal interincisal opening was greater as a result of one surgical method or the other, the maximal interincisal opening at the one-week postoperative time point was compared to that of maximal interincisal opening at the four-week time point in each group; the value of maximal interincisal opening at one week was represented by a percent-reduction in interincisal opening at four weeks. The mean percent reduction in maximal interincisal opening between Group A and Group B was compared using a two-sample t-test (Figure 6). There was not a statistically significant difference in the percent reduction of maximal interincisal opening between Group A (Mean = 37.5%, SD = 14.9%) and Group B (Mean = 25.8%, SD = 16.7%); t(8) = 1.124, p = .294.

The degree of post-operative swelling as recorded by a lobule to menton measurement in millimetres on the operative and non-operative sides at one week post-operatively were compared between Group A and Group B using a two-sample t-test (Figure 7). There was not a statistically significant difference in the degree of swelling on the operative side between Group A (Mean = 2.2%, SD = 3.05%) and Group B (Mean = 2.90%, SD = 2.42%); t(15) = 0.506, p = .620.

The post-operative VAS pain score reported by patients in Group A and Group B at the one-week post-operative time point was compared using a two-sample t-test (Figure 8). There was no statistically significant difference between VAS pain scores in Group A (Mean = 3.17, SD = 2.79) and Group B (Mean = 4.00, SD = 1.94); t(13) = 0.660, p = .504.

There was one patient in Group A that developed a post-operative infection at the operative site, while no patients in Group B developed a post-operative infection. Fisher's exact test was used to determine if there was a significant association between operative technique and the occurrence of post-operative infection. There was not a statistically significant association between the two variables (two-tailed p = .444).

There was one patient in Group B who developed a post-operative dehiscence at the operative site, while no patients in Group A developed post-operative dehiscence. Fisher's exact test was used to determine if there was a significant association between operative technique and the occurrence of post-operative infection. There was not a statistically significant association between the two variables (two-tailed p = 1.000).

DISCUSSION

Mandibular fractures are a frequently reported facial injury with significant negative sequelae for those affected.[2–5] Several factors make the mandibular angle fracture specifically a unique clinical problem. It is consistently one of the most commonly injured areas of the mandibular skeleton. Lack of occlusal support proximal to the fracture site makes the mandibular angle fracture a poor candidate for treatment by closed reduction. The common presence of a third molar in the site of the fracture can complicate reduction and healing of the fracture site. Injury or surgical manipulation in the region of the fracture can lead to adverse neurosensory deficits of the third division of the trigeminal nerve due to the proximity of the inferior alveolar nerve to the site of injury. Furthermore, there exists some degree of ambiguity or controversy in the best manner in which to achieve an appropriate level of fixation at this site to encourage functional healing while limiting the development of complications and surgical morbidity in the process of treatment. This study served as a prospective evaluation of patient-centered outcomes for two methods of mandibular angle fracture fixation, specifically in positioning of fixation hardware. Eight patients were treated with a superolateral position of miniplate fixation via entirely intraoral access, while ten patients were treated with direct lateral border fixation and transbuccal access.

Post-operative complications with superolateral plate and lateral plate position.

Initial data irrespective of fracture fixation method sheds some light on the challenges in dealing with the patient population associated with facial trauma. An astounding 94% (17/18 patients) of the pool reported interpersonal violence as the mechanism of injury. While higher rates of facial trauma secondary to interpersonal violence is often reported in Western countries,[4,8] the rate of interpersonal violence in this patient population is particularly high. With trauma populations also typically comes challenges with patient follow-up; this study proved to be no exception, as twenty-two patients were lost to follow-up or had insufficient data to report on, and mean follow-up times were a mere 5.3 weeks in Group A and 5.1 weeks in Group B. These factors make the ability to draw sound conclusions regarding the statistical significance of any similarity or difference in outcomes between the two treatment groups challenging; indeed, any inferences should be made with extreme caution. In addition, while many of the outcomes followed are likely to present in the early post-operative period (malocclusion, paresthesia, pain, reduction in interincisal opening), there is a distinct possibility that late post-operative infection of the operative site can occur, and the limited follow-up time makes it possible that these outcomes may have been missed as a result.

Treatment groups showed no statistically significant variability in terms of sidedness of fracture site, presence of third molars in the fracture line, or smoking status of the patients. Though the treatment protocol was attempted to be made as standardized as possible, fractures were treated by two extensively experienced primary Staff Surgeons with the aid of up to six different Resident Surgeons with varying degrees of seniority and experience, so some variance in outcomes is to be expected.

While there was no statistically significant difference in the incidence or peak severity of post-operative paresthesia between the two treatment groups, those patients in Group A experienced a slightly higher mean peak severity of paresthesia than those in Group B. The fixation scheme employed in Group B typically involved the use of bicortically placed fixation screws; given the proximity of the hardware to the inferior alveolar nerve, it is possible that a plate positioned too inferiorly on the lateral aspect of the mandible could put this neurovascular bundle at risk during application of hardware. On the other hand, the orientation of the posterior screw holes in the fixation plate used for patients in Group A is such that a vertically upright drill bit that penetrates too deeply into the marrow space of the mandible, or the choice of fixation screws of excessive length could put the neurovascular bundle at risk of damage at a more proximal position; it is possible that this could explain the slightly higher mean peak severity of neurosensory deficit in Group A.

The finding of a post-operative malocclusion was exclusive to patients in Group A, though statistically not significant. While transbuccal access employed in Group B to apply fixation to the lateral aspect of the mandible gives essentially unimpeded straight-line access to the fixation hardware, the orientation of a plate oriented superolaterally in a “Champy” fashion such as was used in Group A can prove somewhat more challenging. Specifically, the position of the posterior-most screw-holes of the fixation plate require an access angle that is made difficult with the patient in intermaxillary fixation. There are three methods that are typically used to circumvent these challenges. The first way is to approximately adapt the plate to the reduced fracture site with the patient’s mandible depressed (and therefore not in occlusion), fixate the proximal two holes, and then place the patient into intermaxillary fixation and fixate the anterior two holes on the miniplate. This method ensures relatively easy access to the posterior screw holes, but does not ensure accurate adaptation of the fixation plate to the underlying bone. The second method is to utilize a drill guide to gain straight-line access to the posterior holes of the superolateral border plate while the patient is in intermaxillary fixation. This decreases the flexibility that the operator has in the orientation of the screw holes, and it is conceivable that the applied best-fit occlusion could be shifted by the drill guide during the preparation of the cortical drill holes during this method, which could lead to development of post-operative malocclusion. The third way to circumvent challenges with screw fixation is to adapt the plate with the patient in intermaxillary fixation, fixate the two holes of the plate in the distal segment of the fracture as well as one hole on the proximal segment adjacent to the fracture line, and then release the patient from intermaxillary fixation to allow improved access to the remaining most proximal hole for fixation. In this method, because only one screw is fixated on the proximal side prior to releasing the patient from intermaxillary fixation, there is some room afforded for mobility of the fracture segments in an unfavorable manner prior to applying the final screw. In addition, the gauge of miniplate typically employed in a superolateral border orientation is lighter than that used in a lateral border orientation (1.0mm compared to 1.25mm); the reduced thickness and strength of fixation hardware in Group A treatment therefore could be seen as a factor that allows increased opportunity for post-operative shift in the fracture segments and development of post-operative malocclusion. In addition, the position of the plate in Group A is at the farthest superior position possible, leading to an axis of rotation around it that could allow a greater deal of shifting at the inferior border of the mandible than would be possible with a plate positioned slightly more inferiorly, as in Group B. It should be noted that with either method, given that a single miniplate is utilized and a functional fixation rather than true rigid fixation is achieved, a post-operative malocclusion could be corrected to a certain degree with a course of post-operative application of elastic intermaxillary fixation.

It would be expected that maximal interincisal opening would be reduced in the early post-operative phases after the treatment of mandibular angle fractures, as the musculature with attachment to the inferolateral aspect of the mandible (most importantly the masseter) is stripped away to allow surgical access and adequate alignment of the fracture segments in the process of treatment. While both Group A and Group B showed a decreased degree of maximal interincisal opening at post-operative week 1 relative to post-operative week 4 and there was no statistically significant difference between the two groups, the percent reduction was greater in Group A than in Group B. This is a perhaps unexpected result, as instrumentation of the masseter musculature is often more significant in the required establishment of transbuccal access with Group B fixation hardware orientation. However, it may be that in the placement of fixation hardware in a superolateral orientation as in Group A treatment protocol, there is further stripping of the medial pterygoid musculature on the medial aspect of the mandible that is required to gain appropriate access and adaptation of the plate hardware; the involvement and iatrogenic surgical trauma to this additional musculature may explain the slightly greater percent reduction in maximal interincisal opening in the early post-operative period for patients treated in Group A.

It should also be noted that the measurement of maximal interincisal opening, while serving as a stable measurement for repeated recordings of the degree of mouth-opening, is subject to some anatomic variance between different individuals, as a result of the presence of variability in the degree of overbite present as well as the slope of the articular eminence of the temporomandibular joint. In addition, dysfunction of the temporomandibular joint is a condition that could lead to impairment in mouth opening irrespective of surgical instrumentation in the process of fracture fixation, and this was not controlled for in the present study.

Post-operative swelling was evaluated with a lobule to menton measurement on the operative side at the one-week post-operative mark, and a comparison was made to the non-operative side as a baseline. There is a number of issues that may have introduced error in this process. First, post-surgical edema typically is thought to peak at the 48-72 hour mark post-operatively; therefore, by recording surgical swelling at the 7-day post-operative date, it is highly likely that the greatest degree of surgical swelling was missed. Secondly, data collection among patients in each group was carried out by several different Resident Clinicians during follow-up visits; it is possible that despite calibration of the recorders, variability in the positioning of these anatomic landmarks may have existed. Furthermore, this study did not exclude patients with concomitant fractures of the mandible in addition to the mandibular angle fracture in question; surgical edema of operative sites on the contralateral side may have in fact skewed the baseline measurement of the lobule to menton distance on the non-angle side of the face. Finally, glucocorticoids are commonly administered to patients undergoing surgical procedures in an effort to limit post-operative edema at the operative site; however, the type of steroid and the amount administered was not controlled for in this study, likely leading to variability in the degree of effect in reducing post-operative edema between different patients. For these reasons, in addition to the lack of statistical significance in the difference between treatment groups in post-operative swelling recorded, little can be concluded as to the effect of one treatment over the other in this regard.

Statistically significant differences in peak post-operative VAS scores reported by Group A and Group B was not found, though the mean VAS scores of patients in Group B was slightly higher than that of Group A. This could be due to an additional incision created on the skin in patients treated in Group B to allow for establishment of transbuccal access to the fracture site, though the extremely small nature of the skin incision makes this less likely. It is possible that the additional stretching of tissues in the process of transbuccal access to allow for adequate alignment of the fixation hardware is more likely a cause of higher post-operative VAS pain scores in this group.

One dehiscence of the surgical site was found in Group B, while one post-operative infection was identified in Group A, with no statistically significant difference noted between groups with respect to either outcome. It should be considered that the average follow up time of this study was quite short in both groups, and that as a result these outcomes may be under reported. While there may be no difference found in the incidence of post-operative infection or post-operative dehiscence at the surgical site, one should consider that the eventual treatment for these outcomes is often to remove the implanted hardware at the operative site once a suitable degree of fracture healing is achieved. In the case of lateral border hardware, its removal typically requires the same method as its installation: transbuccal access, which is likely ill-tolerated by patients in a local anesthetic or even conscious sedation setting; indeed, hardware removal may require the arrangement of general anesthesia in such cases. On the contrary, removal of hardware placed in a superolateral orientation at the mandibular angle fracture site can be fairly simply removed via the application of local anesthesia in an outpatient clinic setting, as its placement occurs entirely via an intraoral approach. This factor should be given consideration, as the need for a general anesthetic has implications in terms of both cost and health risks for the patient.

Future Directions.

While this study provides a glimpse into the patient-centred outcomes and how they may differ between two treatment groups in terms of the orientation of fixation schemes in the treatment of mandibular angle fractures, its validity is severely hampered by small sample sizes and limited follow-up data. Further studies of similar nature would require greater patient samples and long term follow-up to allow more useful conclusions to be drawn. Furthermore, this study only examined the surgical outcomes with respect to two fixation methods, each of which employs a four-hole miniplate affixed to the mandible in the region of the mandibular angle, to achieve a functionally stable fixation. Consideration may be given to the investigation of additional fixation methods such as with a ladder-style fixation plate, or with a superior and inferior miniplate at the mandibular angle site, both of which are methods that would achieve true rigid fixation.

While it was not investigated as part of this study, operating room time is an ever-precious commodity, and consideration could be given to tracking the time elapsed in placement of fixation hardware with both a superolateral and lateral border fixation scheme in the treatment of mandibular angle fractures.

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APPENDICES

FIGURE LEGENDS

Figure 1. Clinical photograph of fixation schemes for ORIF of non-comminuted mandibular angle fractures. ***A,*** Superolateral border positioning of miniplate, adapted to span the fracture site of the mandibular angle across the external oblique ridge in the posterior mandible transitioning from the superior to lateral aspect of the mandible in accordance with Champy's technique. ***B,*** Lateral border positioning of a 4-hole miniplate, adapted to the lateral aspect of the mandible at a level inferior to the external oblique ridge and superior to the position of the canal of the inferior alveolar neurovascular bundle.

Figure 2. Post-operative panoramic radiographs of two fixation schemes for ORIF of non-comminuted mandibular angle fractures. Panoramic radiographs were routinely taken at the one week post-operative follow-up appointment, and were evaluated for suitability of fracture reduction and adaptation of hardware. ***A,*** Post-operative panoramic radiograph shows superolateral orientation and adaptation of a four-hole miniplate to the left mandibular angle fracture site. Fixation hardware is also seen at a concomitant right mandibular parasymphyseal fracture site. ***B,*** Post-operative panoramic radiograph shows adaptation of a four-hole miniplate to the lateral aspect of the mandible at the left mandibular angle fracture site. Fixation hardware is also seen at a concomitant right mandibular parasymphyseal fracture site.

Figure 3. Peak severity of post-operative paresthesia. Patients were seen in follow-up and evaluated for post-operative paresthesia on the operative side using the Zuniga Neurosensory Deficit Test, and assigned a value of Level A, Level B, and Level C. For the purposes of statistical analysis, the traditional labeling of the degree of paresthesia (A, B, or C) was then replaced by numerical values (1, 2 or 3 respectively). The severity of neurosensory deficit was then compared between Group A and Group B using a two-sample t-test. There was not a statistically significant difference between Group A (Mean = 1.28, SD = 0.76) and Group B (Mean = 1.00, SD = 0.67); t(15) = 0.824, p = .211.

Figure 4. Presence of post-operative malocclusion. At post-operative follow-up visits, the presence of malocclusion was determined by observation of any prematurity in occlusal contact on jaw closure into maximal intercuspation, as well as the presence of any open bites in the anterior or posterior regions that were not consistent with the pre-morbid occlusion. In Group A, three patients (37.5%) were found to have a post-operative malocclusion, while in Group B, there was no reported post-operative malocclusion. Fisher's exact test was used to determine if there was a significant association between operative technique and the occurrence of post-operative malocclusion. There was not a statistically significant association between the two variables (two-tailed p = .069).

Figure 5. Mean maximal interincisal opening at 1-week post-operatively. Maximal interincisal opening was determined at the 1-week post-operative time point using a millimetre ruler to measure the distance between the incisal edges of the right upper and lower central incisors at maximum unassisted mouth opening. The mean maximal interincisal opening at initial follow-up one week postoperatively for patients in Group A was compared to that of patients in Group B using a two-sample t-test (Figure 5). There was not a statistically significant difference in maximal interincisal opening at one week postoperatively between Group A (Mean = 25.43mm, SD = 6.50mm) and Group B (Mean = 29.70mm, SD = 7.71mm); t(15) = 1.194, p = .251.

Figure 6. Post-operative percent reduction of maximal interincisal opening at initial follow-up appointment. The values of maximal interincisal opening at 1-week post-operatively were converted to represent percentages of the recovered maximal interincisal mouth opening recorded at the 4-week post-operative time point. The mean percent reduction in maximal interincisal opening between Group A and Group B was compared using a two-sample t-test (Figure 6). There was not a statistically significant difference in the percent reduction of maximal interincisal opening between Group A (Mean = 37.5%, SD = 14.9%) and Group B (Mean = 25.8%, SD = 16.7%); t(8) = 1.124, p = .294.

Figure 7. Operative side swelling at 1-week post-operative. In order to quantify the degree of post-operative swelling on the operative side relative to the non-operative side, a measurement from the lobule to menton landmarks was taken on each side using a flexible millimeter ruler thereby spanning the region of greatest proposed post-operative edema in the masseteric region. The degree of post-operative swelling as recorded by a lobule to menton measurement in millimetres on the operative and non-operative sides at one week post-operatively were compared between Group A and Group B using a two-sample t-test (Figure 7). There was not a statistically significant difference in the degree of swelling on the operative side between Group A (Mean = 2.2%, SD = 3.05%) and Group B (Mean = 2.90%, SD = 2.42%); t(15) = 0.506, p = .620.

Figure 8. Mean VAS pain score at 1-week post-operative. At each follow-up visit, patients were questioned on their level of analgesia control using a 10-point Visual Analog Scale (VAS) at the time of each return visit. On the VAS, a score of 0 indicated absence of pain, while a score of 10 indicated the worst level of pain that the individual had ever experienced. The post-operative VAS pain score reported by patients in Group A and Group B at the one-week post-operative time point was compared using a two-sample t-test (Figure 8). There was no statistically significant difference between VAS pain scores in Group A (Mean = 3.17, SD = 2.79) and Group B (Mean = 4.00, SD = 1.94); t(13) = 0.660, p = .504.

Table 1. Distribution of study sample variables by fixation type. Data recorded for both treatment groups included the mechanism of injury, fracture site, smoking status of the patient, and the presence of a mandibular third molar at the fracture site. There was no statistically significant difference in the incidence of smokers (Fisher's Exact Test, two-tailed p = .588), the sidedness of mandibular angle fractures (Fisher's Exact Test, two-tailed p = 1.00), or the presence of third molars at the fracture site (Fisher's Exact Test, two-tailed p = 1.00) between Group A and Group B.

FIGURE 1.

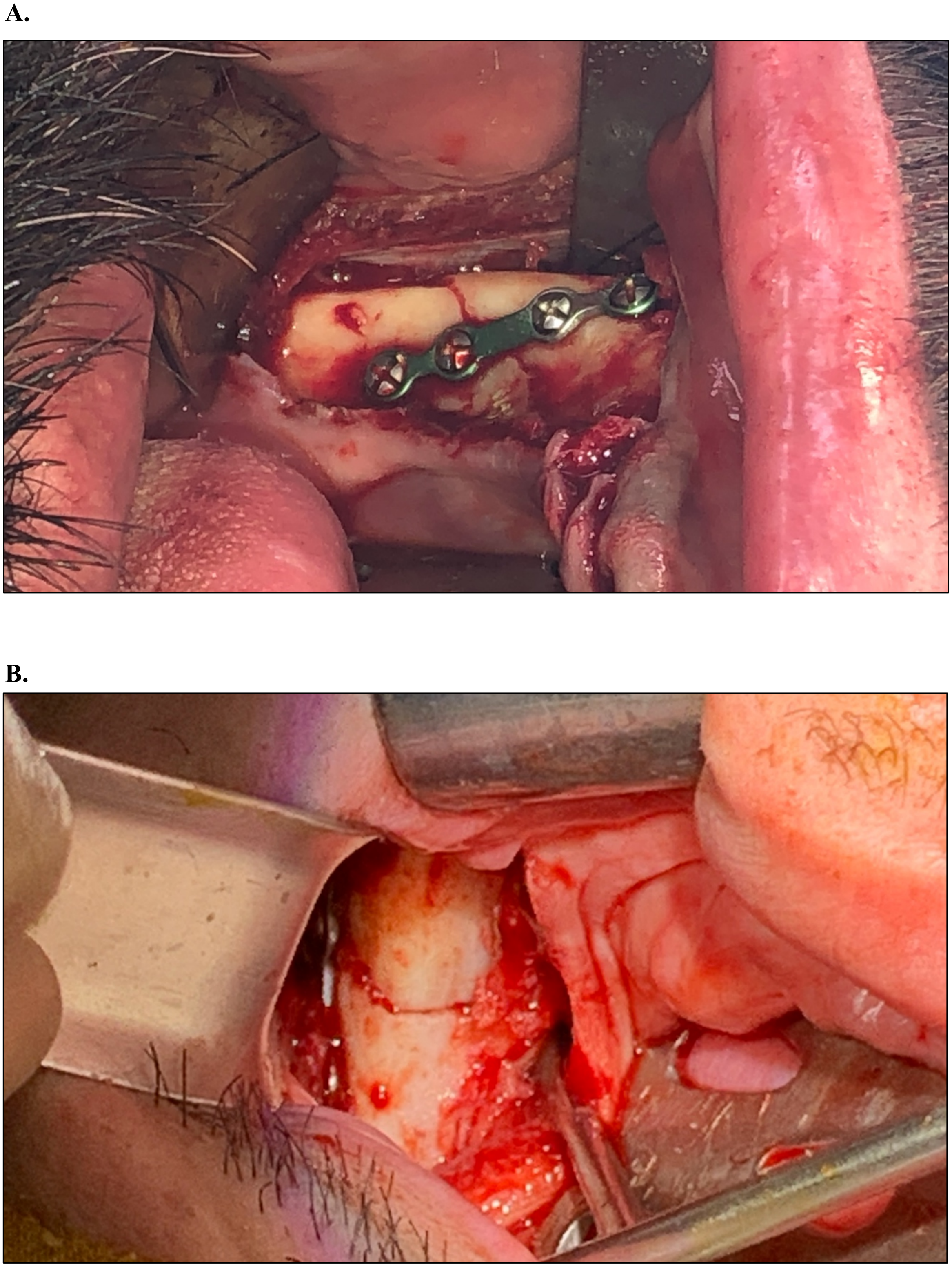
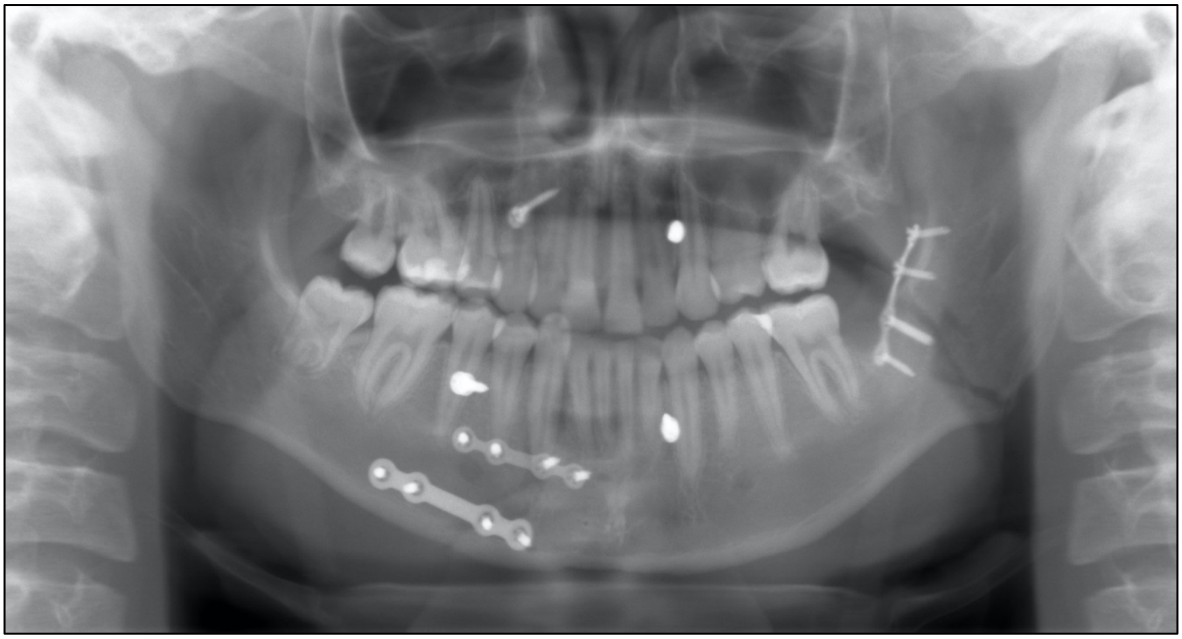


FIGURE 2.

A.



B.

FIGURE 3.

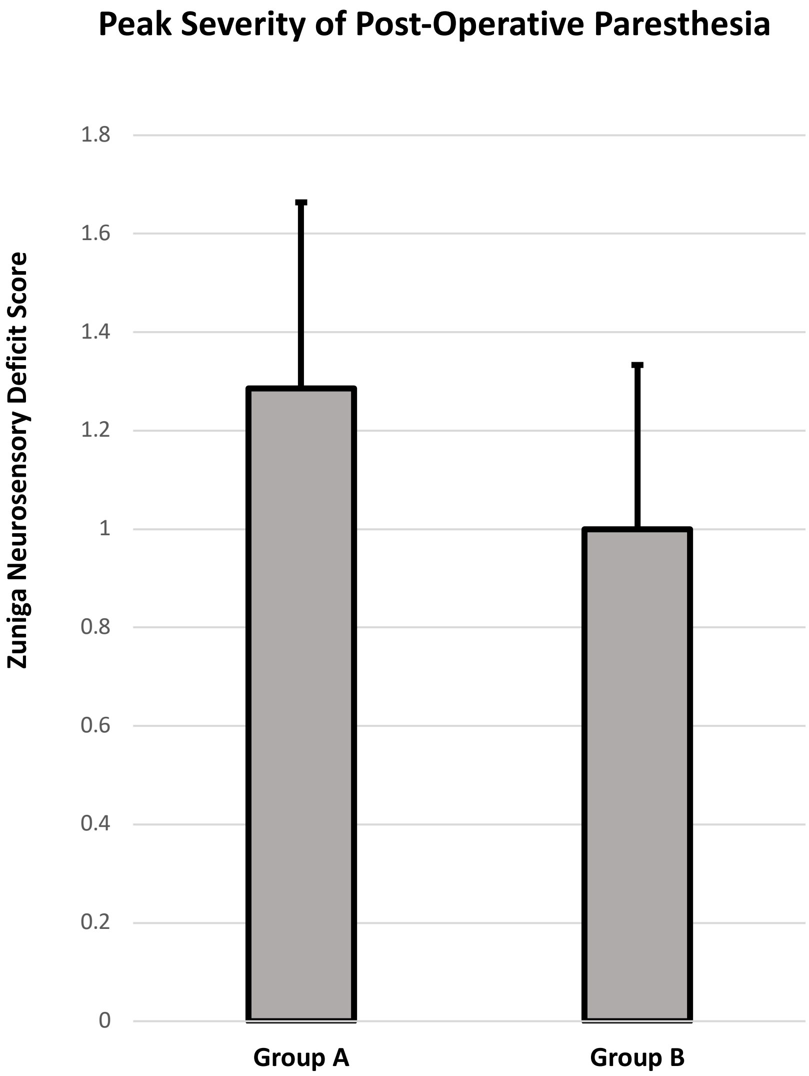

Peak Severity of Post-Operative Paresthesia
Zuniga Neurosensory Deficit Score
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Group A
Group B

FIGURE 4.

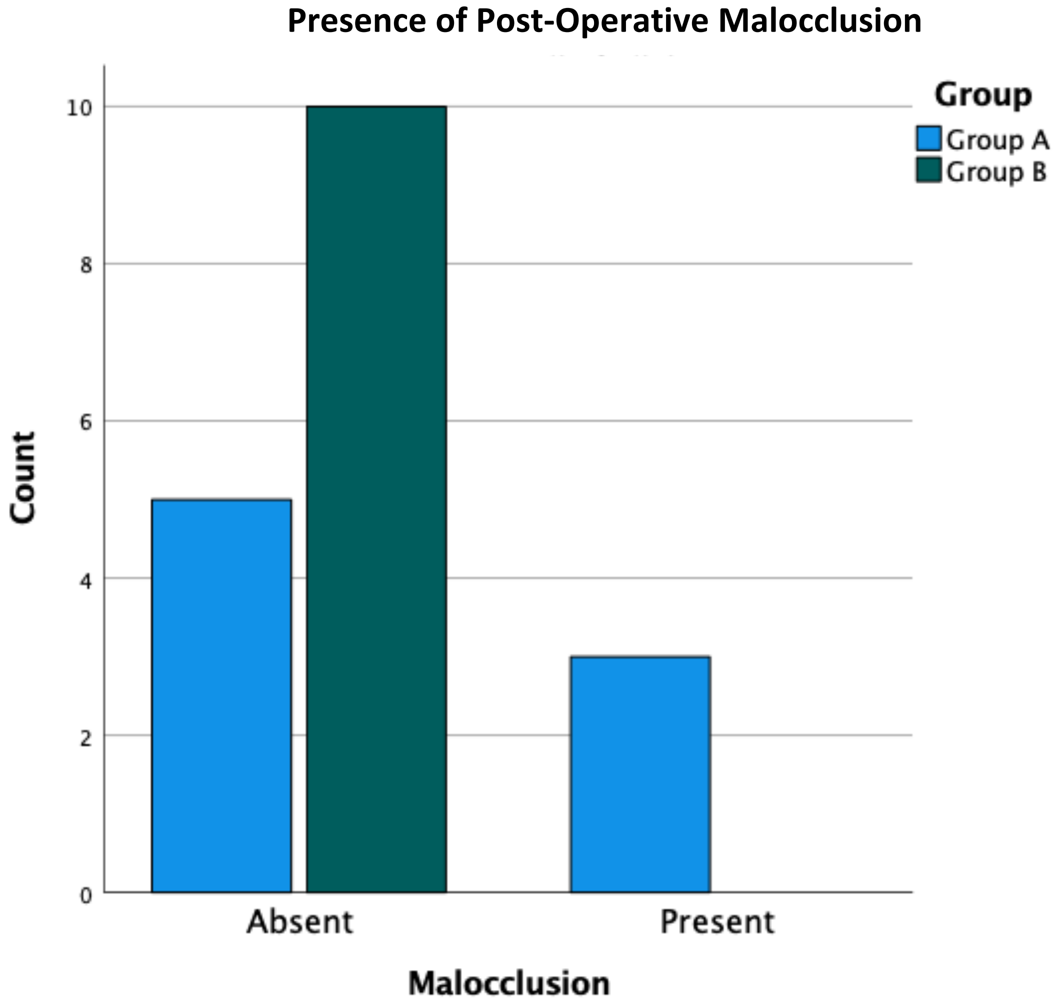

Presence of Post-Operative Malocclusion
Group
Group A
Group B
Count
0
2
4
6
8
10
Absent
Present
Malocclusion

FIGURE 5.

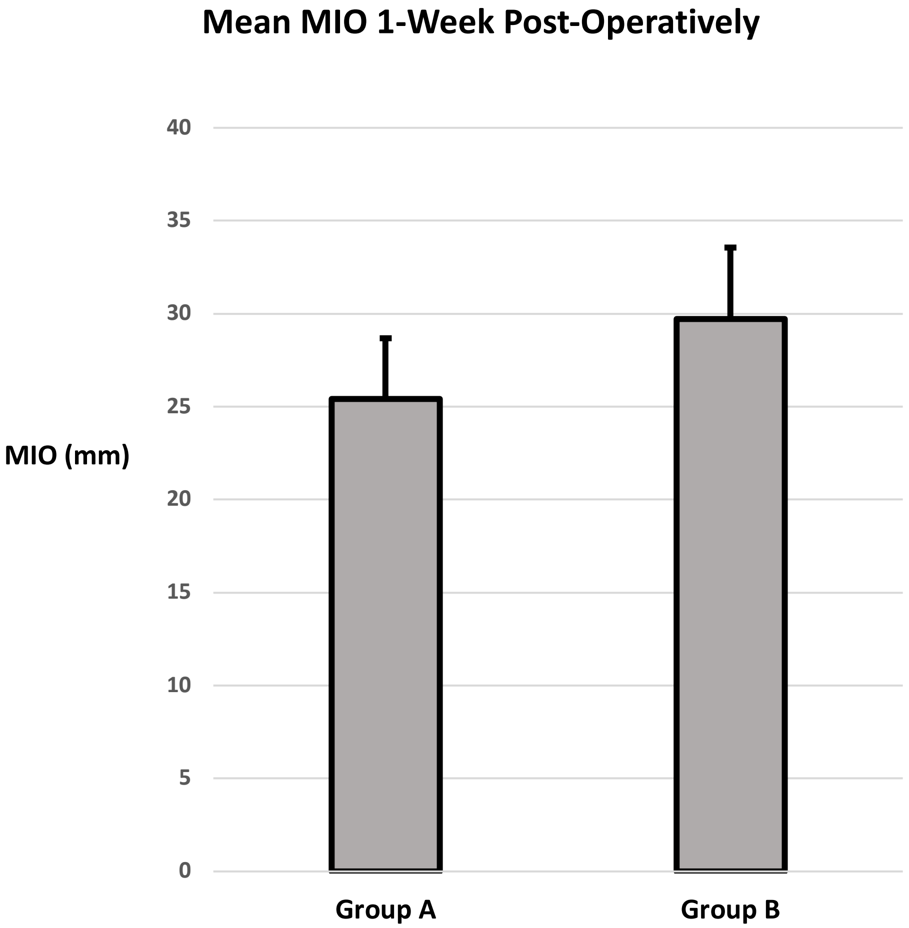

Mean MIO 1-Week Post-Operatively
MIO (mm)
40
35
30
25
20
15
10
5
0
Group A
Group B

FIGURE 6.

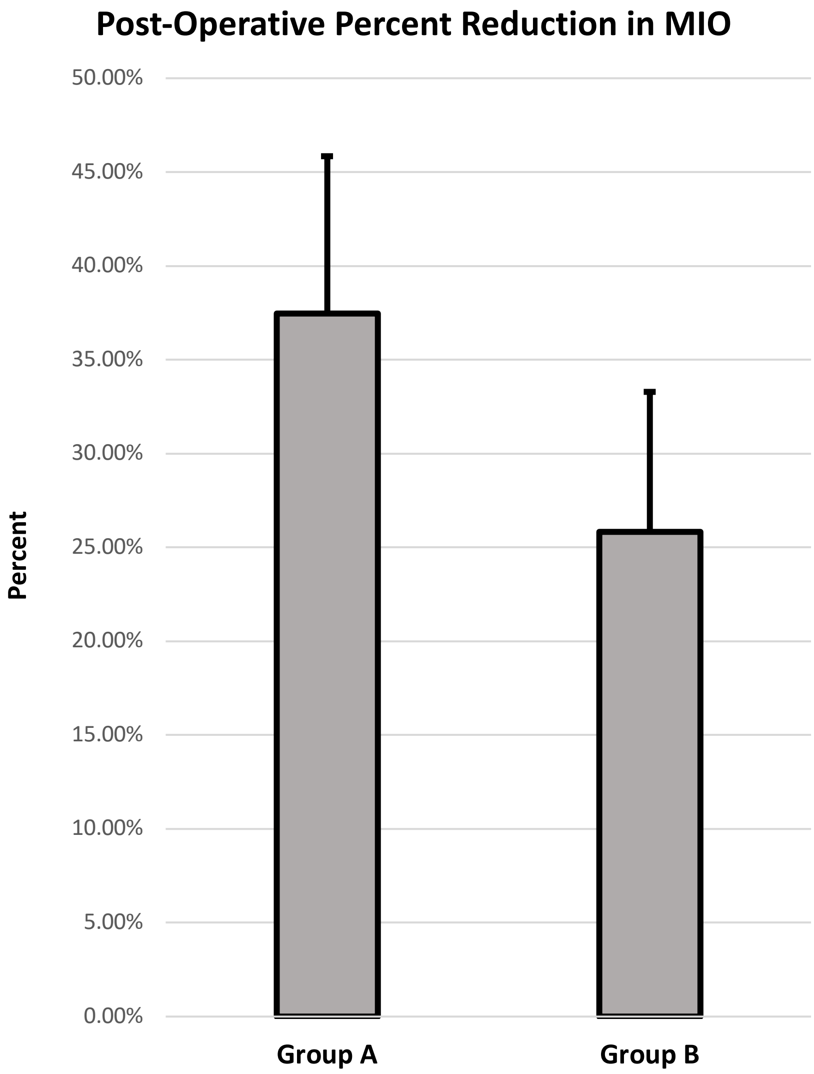

Post-Operative Percent Reduction in MIO
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Percent
Group A
Group B

FIGURE 7.

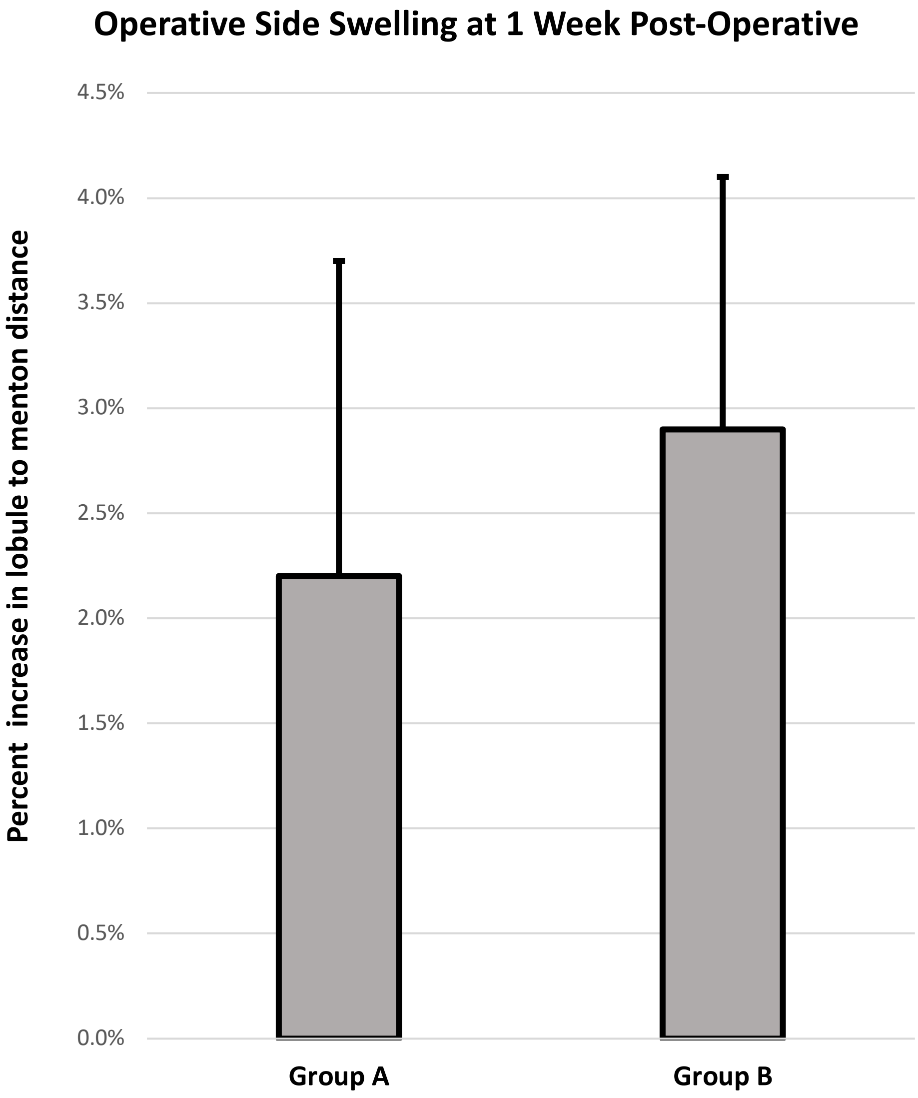

Operative Side Swelling at 1 Week Post-Operative
Percent increase in lobule to menton distance
4.5%
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
Group A
Group B

FIGURE 8.

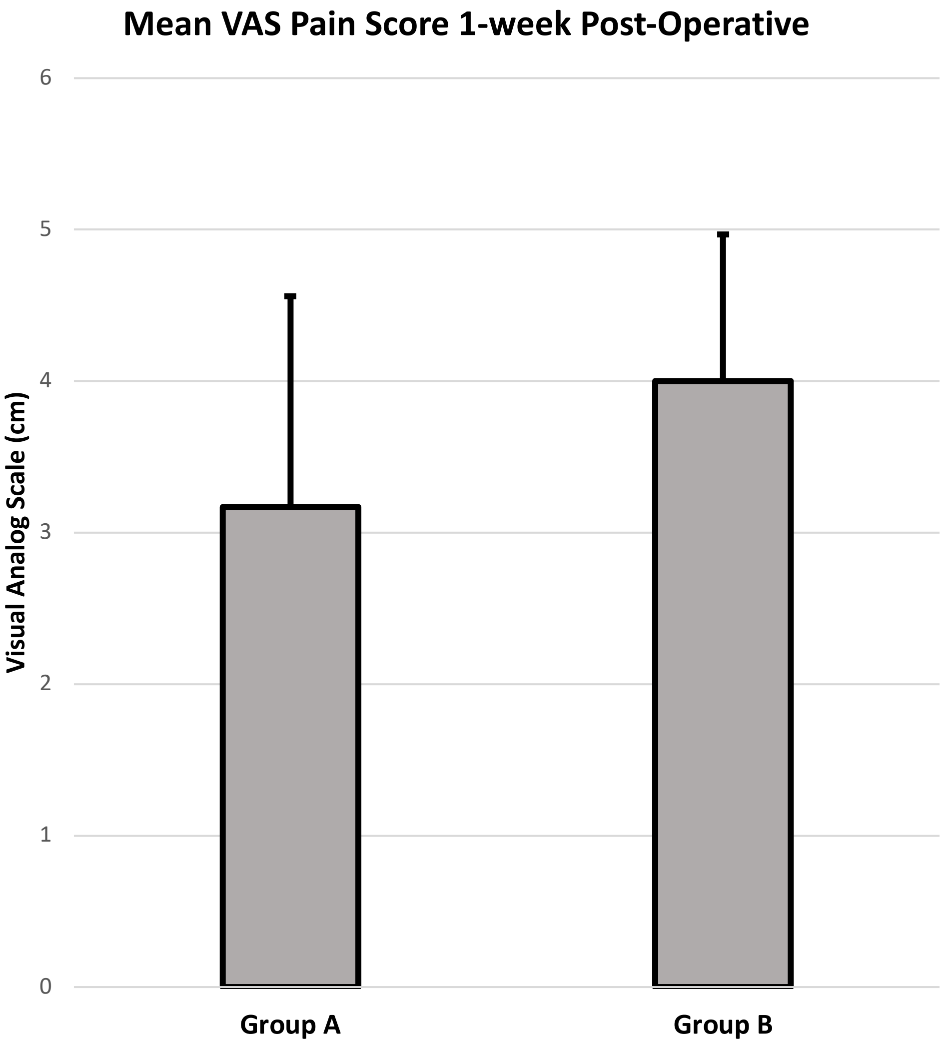

Mean VAS Pain Score 1-week Post-Operative
Visual Analog Scale (cm)
0
1
2
3
4
5
6
Group A
Group B

TABLE 1.

Variable	Group A (N = 8 patients)	Group B (N = 10 patients)
Mechanism of Injury		
Interpersonal Violence	8	9
Sports	0	1
Fracture Site		
Isolated Left Angle	2	4
Isolated Right Angle	1	2
Left Angle + Other	4	3
Right Angle + Other	1	1
Smoking Status		
Smoker	7	7
Non-smoker	1	3
Presence of Third Molar		
Present	5	7
Absent	3	3