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Open Reduction and Internal Fixation of Mandibular Fractures in a Nonhospital Surgical Facility: Retrospective Chart Review

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ABSTRACT

Background: Many patients with mandibular fracture need treatment with open reduction and internal fixation (ORIF). These patients are typically treated in hospital, as either inpatients or day surgery patients. However, it is possible to perform these surgeries in a nonhospital surgical facility (NHSF). In this study, we review the outcomes of ORIF surgery for mandibular fracture performed in an NHSF.

Methods: A retrospective chart analysis was conducted for all patients with mandibular fracture who were referred, between 2019 and 2024, to an NHSF in Edmonton, Alberta, Canada, for ORIF. Data were collected for patient- and injury-related variables, including cause of trauma; fracture location; time from injury and diagnosis to ORIF; time in the operating room and post-anesthesia care unit (PACU); complication rates for nausea, vomiting, pain or bleeding in the PACU; rates of same-day discharge, hardware failure, non-union and infection; and length of postoperative follow-up. A cost analysis was also conducted.

Results: A total of 69 patients with mandibular fracture who underwent ORIF as day surgery in an NHSF met the inclusion criteria. The mean times from injury to ORIF and from fracture diagnosis to ORIF were 6.0 and 2.5 days, respectively. The mean times spent in the operating and recovery rooms were 61.6 and 62.2 minutes, respectively. All of the patients were discharged home, and no patients experienced surgical or anesthesia complications requiring transfer to a hospital. The cost analysis showed that performance of ORIF was more cost-effective in an NHSF than in hospital.

Conclusion: These preliminary data are the first in Canada suggesting that for selected cases of mandibular fracture, ORIF in an NHSF is efficient, safe and cost-effective, provided stringent patient selection criteria and postoperative protocols for discharge are followed.

Introduction

The maxillofacial region is prone to injuries and fractures due to its protruding and unprotected anatomic structure.[1] The mandible is the only movable maxillofacial bone and is the second most frequently fractured facial bone.[2] Mandibular fractures are classified by location (symphysis, body, angle, ramus, condyle), fracture type (simple, compound, comminuted, green-stick, pathologic) and displacement.[3] Symptoms of mandibular fracture include pain, trismus, difficulty chewing, paresthesia of the lower lip and chin, malocclusion, abnormal mandibular movements, swelling, redness, hematoma and bruising.[3]

Mandibular fractures can lead to temporomandibular joint syndrome, poor mastication, disocclusion and chronic pain.[2] The goal in treating mandibular fracture is to restore the form and function of the mandible, ensure proper occlusion and alignment, and minimize complications.[2] Treatment options include medical therapy, closed reduction, external fixation, and open reduction with internal fixation (ORIF).[3,4] Nonoperative therapy is the treatment of choice for minimally displaced fractures, which often occur in children and elderly edentulous patients.[3] Closed reduction with maxillomandibular fixation (MMF) is indicated for nondisplaced or grossly comminuted fractures in an atrophic mandible and for fractures of the coronoid process or condyle.[5] External fixation of the jaw is primarily reserved for pathologic or infected fractures, or for edentulous patients with unstable fractures.[3]

ORIF involves directly exposing and reducing the fracture segments, then stabilizing them with titanium miniplates and screws.[3] This method is preferred when it is impractical to leave the patient in MMF

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for a prolonged period, when there are multiple fractures or when MMF does not sufficiently reduce the malocclusion or displacement of a fracture.[4,6] The benefits of ORIF include more precise alignment of the fracture, immediate stability, early mobilization of the jaw, less functional pain and more rapid return to work or school relative to other modalities.[6]

Traditionally, patients undergo ORIF of a mandibular fracture in a hospital, either as an inpatient or as a day surgery patient. However, hospital operating room time is currently scarce because of the aging population, fiscal restraints and hospital staff shortages.[7,8] We have had success performing ORIF in a nonhospital surgical facility (NHSF) located 5.6 km from the nearest hospital. The purpose of this study was to show that ORIF of simple mandibular fractures can be performed in an NHSF rather than a hospital. The objectives were to assess and evaluate the efficiency, safety and cost-effectiveness of ORIF performed in an NHSF.

Methods

Ethics approval for this study was obtained from the University of Alberta Health Research Ethics Board Health Panel (REB ethics approval Pro00142588).

This retrospective chart analysis involved all patients with mandibular fracture who were referred for ORIF to a single NHSF over a 5-year period (2019–2024). The NHSF is a free-standing day surgery facility that is certified or regulated for this procedure by the College of Physicians and Surgeons of Alberta, the College of Dental Surgeons of Alberta and Alberta Health Services (AHS). Each province in Canada has its own regulatory framework that may allow this surgery in an NHSF, and the particular framework varies from one province to another.

Each patient was evaluated clinically, and the diagnosis was confirmed radiologically by the attending oral and maxillofacial (OMF) surgeon with either computed tomography or plain film radiography before the ORIF. The clinical inclusion criteria were one or more isolated fractures (noncomplex) in a patient 16–60 years of age who had adult accompaniment at discharge. The clinical exclusion criteria were complex fracture (i.e., 3 or more sites or severe comminution), additional trauma, homelessness, significant substance abuse, acute intoxication and significant medical comorbidities. A significant medical comorbidity was defined as any condition that would prevent the patient from undergoing general anesthesia and ORIF surgery in a day surgery facility. Patients for whom charting was incomplete were also excluded.

The patients underwent general anesthesia with intubation, using a nasal tracheal tube, performed by a medical doctor with a specialty in anesthesiology certified by the Royal College of Physicians and Surgeons of Canada. Surgery was performed by 1 or 2 OMF surgeons with surgical assistance from 1 or 2 registered dental assistants (RDAs). Recovery room care was provided by at least 2 registered nurses.

The following patient- and injury-related variables were collected: patient demographic characteristics; cause of trauma; anatomic location of the fracture; time from injury or fracture to ORIF; time from diagnosis (by the OMF surgeon) to ORIF; time in the operating room; time in the post-anesthesia care unit (PACU) until discharge; complication rates for nausea, vomiting, pain or bleeding in the PACU; rates of same-day discharge, transfer to hospital, hardware failure, non-union, and infection; and length of postoperative follow-up. Identifiable costs (professional fees, hardware, NHSF facility fee and a daily hospital fee) for ORIF were compared between the NHSF and hospital settings. Microsoft Office Excel spreadsheet software (Microsoft Excel for Mac Version 16.89/2024, Microsoft Corporation, Redmond, WA) was used for data collection and analysis.

Results

Charts for 156 consecutive patients with suspected fracture, seen over the period 2019–2024, were reviewed. No patients were excluded because of incomplete data, and no data were missing; however, 16 patients were excluded for clinical reasons (ORIF not required), and 69 received care in a setting other than an NHSF (i.e., underwent inpatient surgery in a hospital). Of the remaining 71 patients who underwent ORIF in the NHSF, 2 were excluded from the data set because they were less than 16 years of age; as such, 69 patients were included in the analysis.

The mean age was 29.8 years (range 16–58 years), and 55 (79.7%) were male (**Table 1**). The mode of American Society of Anesthesiology (ASA) physical status classification[9] was 2 (range 1–3), and all 69 patients had a body mass index below 35. Assault was the most common cause of fracture, accounting for 46 cases (66.7%) (**Table 1**).

Of the 69 patients, 44 (63.8%) had a single fracture and 25 (36.2%) had 2 fracture sites. Mandibular fractures were categorized according to the anatomic location. Parasymphyseal fractures were most common (n = 40, 58.0%), followed by angle fractures (n = 35, 50.7%) (**Table 2**). Dental extractions were performed in 31 (44.9%) patients (**Table 2**). All patients underwent ORIF involving the use of miniplate(s) and screws. The mean time from injury to definitive ORIF was 6.0 days (range 0–43). The mean time from confirmation of the diagnosis by the OMF surgeon to ORIF was 2.5 days (range 0–26) (**Table 3**).

The mean time spent in the operating room was 61.6 minutes (range 35–138 minutes), where operating room time was defined as the interval from first recording of vital signs on the anesthesia monitor to arrival of the patient in the PACU. The mean time in the PACU was 62.2 minutes (range 26–157), with time in the PACU defined as the

interval from arrival in the PACU to discharge from the PACU (into the care of a responsible adult). All of the patients were discharged home. No patients experienced surgical or anesthesia complications requiring transfer to a hospital, and none were admitted to a hospital within 30 days for any reason (**Table 3**).

Some patients were given ondansetron, as a prophylactic measure, at the discretion of the registered nurse (**Table 4**). For purposes of our analysis, nausea was deemed to be present if a patient reported nausea and received any antiemetic (ondansetron, metoclopramide or dimenhydrinate) in the PACU. Postoperative vomiting in the PACU was defined as at least one episode of involuntary expulsion of stomach contents through the mouth or nose. Pain was deemed to be present if any additional analgesia was administered in the PACU (**Table 4**).

All patients received prescriptions for antibiotics and analgesics, and follow-up appointments were scheduled at the time of discharge. Of the 69 patients, 59 (85.5%) attended at least one in-person appointment, and 1 (1.5%) attended a single video conference appointment. The remaining 9 (13.0%) did not attend scheduled postoperative appointments with the OMF surgeon and instead had telephone follow-up and chart documentation with an RDA (**Table 5**).

Of the 60 patients who were seen in person or by video, 6 had postoperative surgical complications, including hardware failure, non-union and surgical site infection; the 9 patients who had telephone follow-up with an RDA did not report any complications. At the time of manuscript submission, all patients were at least 7 months beyond their procedure.

In our region, the government covers the cost of professional fees for the OMF surgeon, anesthesiologist and hardware costs, irrespective of whether the ORIF is performed in a hospital or NHSF. In an NHSF, the government provides a bundled NHSF fee to cover costs from admission through surgery (including consumables). Data are reported on the cost payable to the NHSF and a hospital for an ORIF procedure (**Table 6**).

Discussion

In this study, we sought to determine whether ORIF for mandibular fractures could be safely performed in an NHSF. The results of our retrospective analysis suggest that this approach may be an efficient, safe and cost-effective alternative to the inpatient (or day surgery) hospital-based approach. We believe the use of an NHSF is advantageous in this context, because it can reduce demand for hospital operating room time. Mandibular ORIF in an NHSF thus allows for more efficient use of hospital operating rooms, leading to potentially shorter wait times for other patients and more efficient surgical care. The nonhospital setting can be particularly cost-effective for patients with uncomplicated fractures requiring ORIF who are otherwise healthy and who can be discharged to a responsible caregiver after a brief stay in the recovery room.

A literature search did not reveal any publications reporting surgical treatment of isolated mandibular fractures with ORIF in an NHSF in Canada or the United States. Ali and colleagues[11] confirmed the safety of treating isolated facial fractures in a hospital outpatient setting but did not specify whether their study group included patients who underwent ORIF for mandibular fracture. Several studies have supported the feasibility and potential cost savings of performing ORIF for mandibular fracture in a hospital outpatient setting.[12–14] In Australia, the financial burden associated with inpatient surgery for mandibular fracture makes a strong argument for a selected group to be treated as outpatients, given that 93% of the study group would have been suitable for discharge the same day as their surgery.[12] In the United Kingdom, similar results were observed regarding the number of patients suitable for early discharge from hospital,[13] which suggests that there could be significant health care cost savings if these patients were treated on an outpatient basis. These studies provide evidence establishing the safety of hospital outpatient ORIF for selected patient groups. However, outpatient day surgery in a hospital necessitates a greater amount of personnel, bureaucracy and infrastructure than procedures in an NHSF. Performing ORIF for mandibular fractures in an NHSF has the potential to reduce health care costs by avoiding hospital admission for these patients and increasing hospital access for patients needing surgery more urgently.

Increasing access to health care should be a priority, and a model allowing ORIF for mandibular fractures outside the traditional hospital setting can facilitate such increased access. When ORIF is performed in hospital, patients may occupy a hospital bed for several days while awaiting their surgery, a problem that is further compounded when patients with higher acuity from other specialties are prioritized for emergent procedures.[15] Hospital admission may expose patients to nosocomial infections and venous thromboembolism secondary to decreased mobilization.[16,17] In their analysis of a nationwide US inpatient database, Pena and colleagues[6] determined that, on average, inpatient treatment of mandibular fracture required 2.65 days in hospital at a cost of US$35 084 per patient. David and colleagues[18] reported that after initial evaluation in the emergency department, subsequent management in a hospital operating room, in the form of outpatient day surgery, may be the most cost-effective model of treatment.

In our cost analysis, completing these outpatient surgeries in an NHSF was more cost-effective than doing the same procedures in hospital. The NHSF setting allows for decreased surgical waiting time compared with a traditional hospital, where access to the operating room is prioritized for patients with higher acuity. The NHSF offers advantages in terms of efficiency and lower cost for surgical care by eliminating inpatient hospital stays and would thus yield health care cost savings. Moreover, mean time in the operating room and the

PACU was about 1 hour each, all patients were discharged directly home, and there were no hospital admissions, all of which support the efficiency of ORIF in the NHSF for this type of fracture. Lee and colleagues[14] reported longer operating room times, specifically mean 164.8 (standard deviation 70.0) minutes, for patients undergoing ORIF for mandibular fracture as outpatients at the Massachusetts General Hospital. The shorter operating room times observed in our study may be attributable to less bureaucracy, more streamlined infrastructure and more experienced maxillofacial surgeons and anesthesiologists at our NHSF, in contrast to the Massachusetts General Hospital, which is a teaching hospital.

In all provinces in Canada, surgery for mandibular fracture is paid for by the government if that surgery occurs in a hospital. In Alberta, such surgery is paid for by the government regardless of whether the ORIF takes place in a hospital or in an NHSF (with a government contract for payment). More specifically, government remuneration for professional fees payable to the OMF surgeon and the anesthesiologist are the same, regardless of the location of the surgical facility (hospital or NHSF). There is no difference in the cost of the surgical hardware, because the government pays for the hardware, regardless of surgical location. The only remaining financial variable is the cost of a hospital stay versus the bundled facility fee paid by the government to the NHSF, which is $898.70 per surgery. This bundled facility fee is a fraction of the cost of a single-day (inpatient) stay in hospital and covers the admission process, preoperative care, operating room time, recovery room staffing and consumables. For 2022–23, the Canadian Institute for Health Information reported that the average Canadian hospital inpatient cost per day was $7826.[10] Patients in our initial sample who were ineligible for treatment in the NHSF were admitted to the Royal Alexandra Hospital in Edmonton, Alberta, where the average inpatient cost per day was $9602 in 2022–23.[10]

According to AHS data, 44 patients with mandibular fracture were admitted to the OMF surgical service for ORIF at the Royal Alexandra Hospital between 2021 and 2023, with a mean total length of inpatient stay of 3.18 days. Data obtained from AHS Data and Analytics (Tableau Server Version: 2024.2.5 (20242.24.1112.0335) 64-bit Windows© 2024 Tableau Software, LLC and its licensors. All rights reserved.) Completing these surgeries in an NHSF would yield significant cost savings for our health region by eliminating inpatient hospital stays. The mean inpatient stay of 3.18 days did not include time in the emergency department (ED) waiting to be assessed, treatment time in the ED or time waiting for an inpatient bed in the ED. Many patients wait in the ED after admission for an inpatient bed, which hinders the delivery of timely and effective care. In Canada, ED visits from April 2023 to March 2024 were 15.5 million, up by 400 000 from the previous year, and patients who were admitted to hospital had significantly longer ED stays (up to 48 hours for 9 of every 10 patients) than those who were discharged (7.7 hours).[19]

In our review of 69 patients, 6 (8.7%) had postoperative surgical complications, including hardware failure, non-union and surgical site infection. In a retrospective study of 82 patients with isolated mandibular fractures treated with ORIF as outpatients at the Massachusetts General Hospital, Lee and colleagues[14] reported postoperative complications in 14 patients (17.1%), which included malunion or non-union, hardware removal, wound dehiscence and other infections.

Of the 69 patients in our study, 9 (13.0%) did not attend their in-person or video follow-up appointment, and instead had follow-up with an RDA by telephone. These 9 patients were nonetheless included in the study group, as the follow-up for all patients included questions eliciting complications. All 69 patients had written documentation of at least 1 follow-up and were advised to contact the surgeon if complications developed. Other research has shown that long-term follow-up is uncommon in patient groups with high rates of trauma and assault.[14]

It is our practice to provide analgesia in the PACU to ensure that patients can swallow a pill or elixir and are starting to establish a therapeutic level of oral analgesics before discharge. This accounts for the relatively high proportion (nearly 80%) who received an analgesic before discharge.

This study had some limitations. The design was retrospective, and the study took place in a single NHSF. To address some aspects of these limitations, we have planned a larger, prospective study of patients with mandibular fracture that will directly compare data from an NHSF and a hospital.

Table 1: Patient demographic characteristics and cause of injury (2019–2024)

Characteristic	No. patients (%)* *n* = 69
Age, years, mean ± SD (range)	29.8 ± 10.1 (16–58)
Sex	
Male	55 (79.7)
Female	14 (20.3)
ASA physical status class, mode ± SD (range)	2 ± 0.5 (1–3)
Body mass index < 35	69 (100)
Cause of fracture	
Assault	46 (66.7)
Fall	10 (14.5)
Sporting injury	9 (13.0)
Other	3 (4.3)
Motor vehicle crash	1 (1.4)

Note: ASA = American Society of Anesthesiology, SD = standard deviation.

* Unless otherwise stated.

Table 2: Mandibular fracture type

Characteristic of fracture	No. patients (%)* *n* = 69
Parasymphyseal	40 (58.0)
Angle	35 (50.7)
Subcondylar	10 (14.5)
Body	6 (8.7)
Ramus	2 (2.9)
Symphyseal	1 (1.4)
Combination (2 fractures)	25 (36.2)
Dental extractions at time of ORIF	31 (44.9)

Note: ASA = American Society of Anesthesiology, SD = standard deviation.

* Unless otherwise stated.

Table 3: Surgical and postoperative timelines

Interval	Time, mean ± SD (range)
Time from injury or fracture to ORIF, days	6.0 ± 6.7 (0–43)
Time from diagnosis (by OMF surgeon) to ORIF, days	2.5 ± 3.7 (0–26)
Time in operating room, minutes	61.6 ± 22.1 (35–138)
Time in PACU, minutes	62.2 ± 24.0 (26–157)

Note: OMF = oral and maxillofacial; ORIF = open reduction and internal fixation; PACU = post-anesthesia care unit; SD = standard deviation.

Table 4: Recovery room complications and postprocedure disposition

Complication or postprocedure disposition	No. patients (%)* *n* = 69
Ondansetron given prophylactically	15 (21.7)
Antiemetic given for nausea	3 (4.3)
Vomiting (expulsion of stomach content)	0 (0)
Pain (any analgesia given)	55 (79.7)
Bleeding (other than expected)	0 (0)
Discharged home	69 (100)
Transferred to hospital	0 (0)

* Data are number (%).

Table 5: Postoperative follow-up

Type of follow-up	No. patients (%)a *n* = 69	Timing after ORIF surgery, days, mean (range)
In person, with OMF surgeon	59 (85.5)	99.2 (2–1042)
Video conference, with OMF surgeon	1 (1.5)	30.0
By telephone, with RDA	9 (13.0)	33.0 (15–111)

Note: OMF = oral and maxillofacial; ORIF = open reduction and internal fixation; RDA = registered dental assistant.

Table 6: Cost analysis

Cost analysis	Care setting; cost (CAD$)	
	NHSF	Hospital
OMF surgeon fee (pre-, intra- and post-operative care)	Same[a]	Same[a]
Anesthesiologist fee (pre-, intra- and post-operative care)	Same[a]	Same[a]
Hardware cost (miniplates and screws)	Same[a]	Same[a]
Bundled facility fee paid to NHSF[b]	$898.70	NA
Average inpatient cost/day in Canada[c]	NA	$7826.00
Average inpatient cost/day in Alberta[c]	NA	$9341.00
Average inpatient cost/day in authors' region[c]	NA	$9602.00

Note: NA = not applicable; NHSF = nonhospital surgical facility; OMF = oral and maxillofacial; ORIF = open reduction and internal fixation.

[a] The single government payer funds the exact cost regardless of surgical location.

[b] The government provides a bundled NHSF fee to cover costs from admission though surgery (including consumables) to same-day discharge.

[c] Data from the Canadian Institute for Health Information (CIHI) for fiscal year 2022–23.[10] Patients who were ineligible for surgery at this NHSF were admitted to a local hospital in the authors' region for the ORIF procedure.

Conclusion

To the authors' knowledge, this is the first study in Canada to show that for selected cases of isolated mandibular fracture, ORIF procedures in an NHSF are efficient, safe and cost-effective. The strengths of this approach lie in the novelty of performing ORIF in the nonhospital setting, the low complication rates, the cost-effectiveness of the procedure, and the nature of the data reported. These factors make the study a strong contribution to the body of literature on ORIF for mandibular fracture in an NHSF, highlighting the impetus to perform such surgery in the nonhospital setting and suggesting that this model could be adopted in other jurisdictions. However, this approach is predicated on careful patient selection and consideration of patients' overall health, fracture complexity and the ability of the particular NHSF to provide comprehensive perioperative care and to manage complications effectively

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