Two-Year Treatment Outcomes of Mandibular Fractures in a Suburban Hospital of Taiwan

Chih-Wen Cheng¹, Rong-Wu Yong¹, Che-Yi Lin¹, Min-Te Chang², Chun-Jung Chen¹, Wei-Fan Chiang¹,³

¹Department of Dentistry, Chi-Mei Medical Center, Liouying, Tainan, Taiwan
²Department of Dentistry, Chi-Mei Medical Center, Yongkang, Tainan, Taiwan
³School of Dentistry, National Yang-Ming University, Taipei, Taiwan

Abstract

Purpose: The etiology, type, and surgical outcomes of mandibular fractures in Taiwan have rarely been described. A study of the current trends in mandibular fractures at a suburban hospital would help clinicians and public health researchers better understand the differences between urban and suburban mandibular fractures and to design appropriate treatment strategies.

Patients and Methods: This retrospective study analyzed 67 patients with mandibular fractures between 2009 and 2010 at the Department of Oral and Maxillofacial Surgery, Chi-Mei Hospital, Liouying. Under the supervision of a single surgeon (Chiang), 102 fractured subsites were treated.

Results: The male-to-female ratio was 1.4:1. Motorcycle accidents were the most common cause of mandibular fractures (72%). Symphysis was the major subsite of fractures (41%), followed by body fractures (n=16, 15.7%) and angle fractures (n=15, 14.7%). In this study, 68.7% of the patients displayed combined fracture, which was defined as multiple mandibular subsites or midface fracture. In this study, 67 (66%) fractured sites among 55 patients were treated by surgical reduction and bone plate fixation, including 21 sites treated by the 1.6-mm miniplate system, 36 sites treated by the 2.0-mm bone plate system, 9 sites treated by the 2.3-mm reconstruction plate system and one site by the lag screw technique.

Injury Severity Score, comminuted/splitting fracture, and combined midfacial bone fracture displayed a significant association with a prolonged postoperative stay. Iatrogenic complications, such as postoperative aseptic abscesses and screw loosening, appeared in 3 (4.5%) cases.

Conclusion: Motorcycle accident is a major etiology of mandibular fracture in the suburb and usually results in a more severe Injury Severity Score. The optimal duration of the hospital stay must be evaluated while taking into consideration the associated injuries and the type of fracture. The osteosynthesis of mandibular fractures involving the use of 1.6-mm miniplates, 2.0-mm/2.3-mm nonlocking bone plates yielded ideal outcomes.

Key words: Mandibular fracture, Suburb, Motorcycle, Prolonged postoperative stay, Complications.
Introduction

The management of mandibular fracture is a common practice for Oral and Maxillofacial Surgeons. Mandibular fracture can occur because of various causes, such as traffic accidents, falls, assaults, and sports, and can occur in isolation or in combination with other injuries. The epidemiology of these fractures varies depending on the geographic area, socioeconomic status of the individual involved, and the period of investigation\textsuperscript{1–7}. In Western society, the 1970s involved a documented shift in the mechanism of injury leading to mandibular fractures\textsuperscript{7–12}. Specifically, violence and sporting injuries replaced motor vehicle accidents as the major cause of mandibular fracture. These trends seem to hold true for the urban distinct in particular, whereas rural communities still show a significant number of fractures incurred during automobile accidents\textsuperscript{8–17}. In the 1980s, a study of mandibular fractures in the urban distinct of Taiwan showed that traffic accidents were still the major cause\textsuperscript{18}. Different causes of mandibular fracture may be associated with age and gender, or the site and severity of the injury.

Data available on the etiology and pattern of mandibular injuries in this suburb of Taiwan spurred this hospital-based survey. The results presented here may assist clinicians and health care provider in developing more effective treatments and strategies to prevent these injuries.

Materials and Methods

Patients who had treated for their mandibular fractures at the Department of Oral & Maxillofacial Surgery, Chi–Mei Hospital, Liouying, from February 2009 to December 2010 were retrospectively analyzed. Pathological and infected fractures were excluded. There were two major strategies for treating mandibular fractures. The patients who had high–positioned subcondylar fracture and condylar fractures were reduced with three– and one–week rigid intermaxillary fixation (IMF), respectively (Figure 1). Rubber traction (elastic IMF) was applied to these patients for one to two more weeks thereafter. Another group of patients with symphysis, body and low–positioned subcondylar fractures were treated by open reduction and internal fixation by bone plates. After the surgery, patients postoperatively underwent elastic IMF for one to two more weeks (Figure 2 & 3). If the patients displayed combined midfacial fractures, bottom–up fixation followed the sequence of lower dental arch reconstruction, mandibular fixation, rigid IMF, and midfacial fixation. The surgical reduction and fixation of mandibular fractures was performed as soon as possible if the patient presented stable vital signs and clear consciousness. The surgical intervention was performed in the following sequence: the fractured segments were reduced by the Erich arch bar, any loose teeth were removed, and bone plate and screw fixation were performed. Fixation was achieved through the use of a 2.0–mm non–locking bone plate combined with a bicortical screws system which was applied on the lower border of the symphysis and body fracture and/or by a 1.6–mm miniplate in combination with monocortical screws, applied on the modified Champy line (Figure 3). In patients who did not have open wounds at their fractured site, the surgical approaches was as intra–orally as possible. The occlusion was confirmed before wound closure. Parenteral antibiotics and a 0.1% chlorhexidine gluconate oral rinse were
Fig. 1. A case of bilateral condylar neck fracture underwent rigid intermaxillary fixation (A–C). After 1st week and 3rd month follow up, the condyle head osteogenesis and realign well (D).
Taiwan J Oral Maxillofac Surg

Follow-up examinations were recorded at intervals of 1, 2, 4, 6, and 12 weeks after surgery, with additional examinations if necessary. Patients with less than 6 weeks of follow-up were excluded from the study. A 6-week soft diet was advised for all patients. The Erich arch bars were left in place postoperatively to facilitate guiding elastics if necessary and then removed at the 4-week visit under local anesthesia at the outpatient clinic. The follow-up variables include interdental contact checked by articulation paper, maximal mouth opening checked by inter-incisor distance, and mandible series or panoramic radiographs at intervals of 1, 4 and 12 weeks after surgery. Dental evaluation was performed in patients with significant carious or periodontal destruction. Those teeth meeting the following criteria were

prescribed to all patients at the time of surgery, and their use was continued for 3 to 5 days after the surgery. After discharge, use of an enteral antibiotic for 3 to 5 more days was prescribed.

Age, etiology of injury, Injury Severity Score, site of fracture, type of fracture, associated midfacial fracture, and treatment were regarded as independent variables. A comminuted fracture was defined as three or more fractured lines. A splitting fracture was defined as more than 1 cm between two fracture lines. The affected site was determined by the lowest border of the fracture line. The dependent variables were set as the duration of postoperative hospital stay and major postoperative complications, including infection, malocclusion, nonunion, dehiscence, osteomyelitis, and plate exposure.

Fig. 2. A case of low-positioned, spitting-type subcondylar fracture (A) underwent two lag screws fixation (B).
Fig. 3. A case of combined angle fracture (A) and symphysis fracture (B). He underwent surgical fixation by 2.3 mm bone plate system for symphysis fracture (C) and by 1.3 mm miniplate system for angle fracture (D). Postoperative 4th week panoramic film revealed bone gap was narrowing (E).
extracted: (1) teeth with fractured roots (2) teeth that were unsalvageable as a result of caries or infection in the region of the fracture; and (3) teeth within the fracture line that were loose or unstable. Stable teeth within the fracture line were preserved for added reduction stability. The outcome was evaluated at 12th week. The treatment morbidities are defined if there is uneven teeth contact, any clinical symptoms related to surgery, or bone malalignment on X-ray finding. A statistical analysis using the chi-square test and Fisher’s exact test was performed to determine the risk factors for prolonged hospital stay. The difference was regarded as significance if any the $P$ value was less than 0.05.

### Results

This study included 67 patients (39 males, 28 females) with 102 subsites of mandible fracture, included 42 symphysis, 16 body, 15 angle, 12 subcondylar, 14 condylar, and 3 alveolar fractures (Figure 4). The mean age of the patients was $31 \pm 16$ years (range, 10 to 90 years). The most common etiology was motorcycle accident (MCA) (72%, $n=48$), followed by violence (9%, $n=6$) and sliding (6%, $n=4$). Most of the patients were admitted by the ER (55%, $n=37$) followed by trauma team referral (28%, $n=19$) and clinic referral (17%, $n=11$). The median length of hospital stay was 7 days (range, 2 to 45 days).

<table>
<thead>
<tr>
<th></th>
<th>Symphysis</th>
<th>Body</th>
<th>Angle</th>
<th>Subcondyle</th>
<th>Condyle</th>
<th>Alveolus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple sites</td>
<td>27</td>
<td>6</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Single site</td>
<td>16</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. 4. Sixty-seven patients with 102 subsites of mandible fracture. The symphysis fracture combined with posterior subsite fracture is the most common type of fracture.
In these 102 subsites of fracture, most fractures were categorized as greenstick or simple (54%) followed by comminuted (24%) and splitting (22%). Thirty-one (65%) of forty-eight patients traumatized by MCA displayed symphysis fractures, including 16 simple type, 11 comminuted type, and 4 splitting type. In 55 (82%) patients, 67 fractured sites underwent open reduction and internal fixation for mandible fracture, including 21 sites treated by the 1.6-mm miniplate system, 36 sites treated by the 2.0-mm bone plate system, 9 sites treated by the 2.3-mm reconstruction plate system and one site by the lag screw technique. The median length of the hospital stay after surgery was 5 days (range, 2 to 35 days). Fifteen (27%) patients required a prolonged postoperative stay (> 5 days). Injury Severity Score, comminuted/splitting fracture, and combined midfacial bone fracture displayed significant associations with a prolonged postoperative stay (Table 1 & Figure 5).

All 15 angle fracture patients had an impacted or erupted third molar associated with the fracture; 13 (87%) patients underwent impacted third molar extraction during surgery. Minor occlusal discrepancies responded to elastic IMF, applied for 1 to 3 weeks. Occlusion was judged as normal in all patients at the time of

Table 1. The Clinical Parameters associated with Prolonged Postoperative Stay (> 5 days) in 59 Patients with Mandibular Fracture

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Regular Stay</th>
<th>Prolonged Stay</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–30 years</td>
<td>21 (64%)</td>
<td>14 (62%)</td>
<td>0.446</td>
</tr>
<tr>
<td>&gt; 30 years</td>
<td>12 (36%)</td>
<td>12 (38%)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20 (61%)</td>
<td>16 (62%)</td>
<td>0.920</td>
</tr>
<tr>
<td>Female</td>
<td>13 (39%)</td>
<td>10 (38%)</td>
<td></td>
</tr>
<tr>
<td>Cause of injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorcycle</td>
<td>24 (73%)</td>
<td>20 (77%)</td>
<td>0.708</td>
</tr>
<tr>
<td>Other</td>
<td>9 (27%)</td>
<td>6 (23%)</td>
<td></td>
</tr>
<tr>
<td>Injury Severity Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–15</td>
<td>24 (73%)</td>
<td>10 (39%)</td>
<td>0.008</td>
</tr>
<tr>
<td>&gt; 15</td>
<td>9 (27%)</td>
<td>16 (61%)</td>
<td></td>
</tr>
<tr>
<td>Type of Mandible Fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>20 (61%)</td>
<td>4 (15%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Comminuted/Splitting</td>
<td>13 (39%)</td>
<td>22 (85%)</td>
<td></td>
</tr>
<tr>
<td>No. of fractured sites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>24 (73%)</td>
<td>14 (54%)</td>
<td>0.133</td>
</tr>
<tr>
<td>&gt; One</td>
<td>9 (27%)</td>
<td>12 (46%)</td>
<td></td>
</tr>
<tr>
<td>Combined midface fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>32 (97%)</td>
<td>19 (73%)</td>
<td>0.017*</td>
</tr>
<tr>
<td>Yes</td>
<td>1 ( 3%)</td>
<td>7 (27%)</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square test was performed unless otherwise specified.
* Fisher’s exact test.
Taiwan J Oral Maxillofac Surg

Erich arch bars removal.

The median follow-up was 3 months (range, 2 to 22 months). Seven patients displayed morbidities, and three of the complications were judged to be iatrogenic. These three patients displayed screws loosening and orocutaneous fistula over the previous comminuted body fracture site approximately one to two weeks after surgery. Their symptoms and signs disappeared after re-entry to remove the sequestrum and to re-fix the bone segments using a stronger bone plate. The symptoms and signs subsided after the re-entry to remove hardware with or without re-fixation with a stronger plate and maintenance of rigid IMF for 4 more weeks.

**Discussions**

The treatment of mandibular fractures has changed significantly in the past century. The use of a Barton bandage or a Gunning splint has evolved to the use of IMF alone, IMF plus open reduction with intrabony stainless-steel wire fixation, and IMF with open reduction using bone plates and screws. Multiple plate application techniques have been proposed in the past 30 years for the treatment of mandibular fractures. The lower-border plating techniques proposed by AO/ASIF and Luhr have demonstrated reproducible results\(^\text{19-21}\). Their approach is based on the concept that the largest plate can provide the greatest interfragmental stability. In contrast, Michelet and Champy advocated the use of the small plates. This approach evolved from a surgical approach based on skin incision to one based on intraoral access because of the use of a relatively small size plate\(^\text{22}\).

The etiology of the trauma determined

---

Fig. 5. Compared with the group of regular post-operative stay, the group of prolonged (> 5 days) post-operative stay present more complicated mandibular fracture, midface fracture and complications.
the site of the fracture. Because of the high prevalence of violence in Western society, the closed-type angle fracture is the most common type of mandibular fracture\(^8\)\(^–\)\(^17\). The mandibular angle is subject to the forces related to masticator and suprahoid musculature resulting in unstable rotation of the proximal and distal fracture segments\(^{23}\). An impacted third molar tooth may complicate the angle fracture, even resulting in the abatement of bone contact and compromising ideal interfragmental reduction\(^{24},\)\(^{25}\). Unlike people living in urban areas, who have access to a well-established Mass Rapid Transit\(^8\)\(^–\)\(^18\), people living in suburban Taiwan typically commute by motorcycle. In a crash, the anterior facial bones will be severely traumatized not only because of the poor quality of the road but also because of the lack of law-abidance among motorcyclists. Several studies have indicated that the mandibular body is the most common subsite affected by an MCA\(^26\)\(^–\)\(^29\). Our study revealed that among individuals living in this suburban distinct, the symphysis was the subsite most commonly affected by motorcycle injury. We used occlusal film to evaluate the anterior mandible if the patient presented a condylar trauma; this approach allows visualization of fracture line in the symphyseal region that cannot be seen using plain film or panoramic film (Figure 3).

Despite the compressive, tensile, and torsional forces around the symphysis region, the advancement of bone plate and screw fixation and the easy intra-orally approach have facilitated treatment. Angle fracture can usually be reduced by rigid IMF for 4 to 6 weeks because of vital structures around the surgical field. Poor oral hygiene, a malaligned dental arch, and missing teeth are not uncommon among Taiwanese; therefore, IMF is difficult and may precipitate other complications related to oral hygiene maintenance, risk of infection traveling along the gingival sulcus to the fractured site, and short-term limited mouth opening. Indirect interfragmental reduction assisted by IMF may not yield proper reduction and may increase the width of the lower face\(^30\). Although the rigid fixation has been shown to decrease or eliminate IMF time, the complication rates were still not low compared with other subsites because of the difficulty of plate manipulation at the lower border. Champy and Kahn proposed intraoral placement of monocortical screws and miniplates along the ideal lines of osteosynthesis, which would theoretically neutralize undesirable tensile forces and retain favorable compressive forces during function\(^{22},\)\(^{31}\). Unlike the concept of rigid fixation, this nonrigid technique of fixation could be defined as functionally stable fixation\(^{32},\)\(^{33}\).

Some advantages of miniplate osteosynthesis by an intraoral approach over other means of rigid fixation include eliminating the risk of a large hypertrophic cutaneous scar, eliminating the risk of damaging the marginal branch of the facial nerve, and the capacity for simultaneous observation of fracture line reduction and occlusal relationships. In addition, miniplates are less palpable externally and less thermally sensitive to the patient. Although there are various techniques available for upper-border plating, single miniplate insertion would give consideration to economize the treatment cost and eliminate “foreign body sensation” in patients\(^34\). Although providing functionally stable fixation, noncompression of the fracture using miniplates decreases necrosis of the fracture segments and causes less stress shielding. Because there is less resistance to torsional movements, miniplates are not recommended for comminuted and infected
fractures, where a rigid fixation plate system that prevents micromotion of body fragments under function is desired.

The 4.5% complication rate of our study population was not unfavorable compared with previous studies (Table 2). Noncompliance was manifested in the patients with poor oral hygiene, poor oral intake, smoking, and early self-removal of the IMF. Seemingly, it was only the latter that resulted in infection in the present group. The other three patients displayed infection at the site of the comminuted fracture after the surgery. These complications were treated with another course of antibiotics, prolonged rigid IMF, use of a stronger plate, and enhanced oral hygiene. The stability of the 2.0-mm bone plate system used to treat mandibular fractures might make it possible to shorten the 4-week period of rigid IMF to 2-week elastic IMF while maintaining acceptable complication rates. However, in the study done by Ellis and Graham, in which 80 fractures in 59 patients were treated with 102 plates using a locking plate and screw system without any period of IMF, there were 12 complications (15%); 6 infections, 2 malocclusions, and 4 instances of hardware removal.35 We believe combined 2-week elastic IMF is needed with transoral mandibular fracture fixation because this would allow reattachment of the soft tissue drape, stabilize the occlusion, and thus decrease the incidence of complication. We believe this period of elastic IMF helped to decrease the rate of complications associated with the use of a nonlocking system. We highly recommend this intraoral technique.

| Table 2. Profile of the Patients presenting Major Surgical Complications |
|---|---|---|---|---|
| Age | No. of cases | Subsites and Type of fracture | Primary treatment | Complication rate |
| Singh et al | 16–52 | 76 | Symphysis 21%, Body 38.4%, Angle 34.2%, Condyle 7.9% | 2.0-mm locking plate, 2.0-mm nonlocking plate | Symphysis 18.8%, Body 3.6%, Angle 11.5% |
| Mathog et al | 27–45 | 906 | Symphysis 17.6%, Body 17.6%, Angle 27.7%, Ramus 10.3%, Condyle 19.6% | ORIF with bone plate, IMF only, External fixation, ORIF with wire | 2.8% |
| Furr et al | 14–68 | 271 | NM | ORIF, IMF only, IMF & ORIF | 6.6% |
| Ellis et al | 12–60 | 196 | Symphysis 24.9%, Body 50.3%, Angle 15.7%, Ramus 9.1%, Comminuted type | 2.7-mm reconstruction locking plate, 2.3-mm bone plate, 2.0-mm miniplate | 13% |

ORIF, open reduction with internal fixation. NM, no mention. IMF, intermaxillary fixation.
Conclusions

Because complicated mandible fractures are common type of facial trauma in this suburban distinct, we should not ignore the major contributory factor of motorcycle accidents and should force government to make improvement strategies. The duration of postoperative stay must be evaluated in consideration of associated injuries and the type of fracture. In our study, use of the rigid 2.0–mm and 2.3–mm nonlocking bone plate system for anterior mandibular fractures and of the 1.6–mm miniplate system along a modified Champy’s line for angle fracture plus two-week elastic IMF represent reliable treatments for mandibular fractures.

References


鄉村區醫院之下顎骨折表現—兩年期
病例回溯分析

鄭智文1 楊榮武2 林哲毅2 張敏德2 陳俊榮2 蔣維凡2,3

1柳營奇美醫院 牙醫部
2永康奇美醫院 牙醫部
3國立陽明大學 牙醫系

摘 要

目的：台灣地區下顎骨折的成因、型態、手術治療與相關預後，甚少在文獻被提出，甚至以鄉村地區為背景進行的研究更是付之闕如。本文針對一
所鄉村區醫院之病例進行分析，除了有利臨床醫師瞭解鄉村區之下顎骨骨折
病例表現特色與相關治療成果，也提供公共衛生學家進行相關政策制定之參
考。病患與方法：本研究針對2009年至2010年間在柳營奇美醫院口腔顱面外
科治療之67名病患共102處下顎骨骨折點進行回溯性分析，所有病患之治療皆
遵從固定之準則，並在單一醫師指導下進行。結果：男女比為1.4比1，下顎
骨骨折之主要成因為摩托車事故(72%)，發生部位以正中聯合區最多(41%)，
其次依序為體區(15.7%)、角區(14.7%)。68.7%病患為多處下顎骨骨折或是合
併中顱面骨骨折之複合式骨折。共有55位病患的67處骨折位接受開放式復位
及內固定之手術，其中包括：21處以1.6 mm迷你骨板固定、36處以2.0 mm系統
骨板固定、9處以2.3 mm系統骨板固定、1處以lag screw進行固定。手術後超
時住院(超過5日)之相關因子有：外傷嚴重指數、複雜形態之骨折、合併中顱
面骨骨折等等因素，醫源相關性之併發症共有3例(4.5%)。結論：摩托車交通
意外為鄉村區下顎骨折之主要因素並且造成較高分數之外傷嚴重指數。術
後超時住院與否必須端賴身體其他外傷情形與下顎骨折之型態來決定。本院
以1.6 mm迷你骨釘骨板和2.0 mm骨釘骨板針對不同部位之下顎骨骨折進行手術
治療，相關成果尚稱理想，值得參考運用。

關鍵詞：下顎骨骨折，鄉村，摩托車，術後超時住院，併發症。