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Endoscopic-Assisted Intraoral Approach for Osteosynthesis of Mandibular Subcondylar Fractures

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Introduction: The aim of this study is to follow-up and evaluate the treatment result of mandibular subcondylar (MSC) fractures by osteosynthesis via endoscopy-assisted intraoral approach.

Materials and Methods: This is a prospective study, in which 47 patients with 51 sites of MSC fractures treated osteosynthesis via endoscopic-assisted intraoral approach at the Department of Maxillofacial Surgery, National Hospital of Odonto-Stomatology HoChiMinh City—Vietnam were followed-up and evaluated clinically and radiographically up to 6 months postoperative.

Results: Before surgery, all of the patients were malocclusion, 15% of patients were isolated MSC fractures, the rate of concomitant midface fractures were 30%, 92.2% of fracture sites with moderate displacement, 7.8% of fracture sites with severe displacement, 5.9% of fracture sites with dislocation. After surgery, all of the patients had preinjured centric occlusion; no patient had facial paralysis; 6% of patients had surgical site infection within 1 week; pain frequency were 56.9% at 1 month, 35.3% at 2 months, 7.8% at 3 months, and 2.0% at 6 months with Visual Analog Scale (VAS) means of pain were 1.74 ± 1.85 at 1 month, 0.55 ± 1.12 at 2 months, 0.08 ± 0.27 at 3 months and 0.02 ± 0.14 at 6 months; 90% of fracture sites had precise anatomy at 1 week and 96% at 6 months; 96% fracture sites had no displacement the of correlation between condyle and articular fossa at 1 week and 98% at 6 months; 1 fracture site had screw loosening at 2 months; 88% fracture sites had stage-4 radiographic bone healing at 6 months.

Conclusion: Endoscopic-assisted intraoral approach for osteosynthesis of MSC fractures have provided the esthetic and functional success and good bone healing.

Key Words: Centric occlusion, dislocation, endoscopic-assisted intraoral approach, facial paralysis, mandibular subcondylar fractures, osteosynthesis, surgical site infection

Mandibular condylar fractures are complicated kinds of maxillofacial fractures, with a high percentage 30% to 55% among mandibular fractures.^{1,2} Mandibular condylar fractures can be classified into condylar head fractures, high, and low subcondylar fractures.³ Mandibular subcondylar (MSC) fractures may clearly affect to the function of the masticatory system, and may lead to such complications as temporomandibular disorders, ankylosis, and malocclusion.^{4–8}

Nowadays, surgical treatment of MSC fractures are gradually indicated and performed widely. Extraoral approaches

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consist of preauricular, retromandibular, and submandibular approaches may be due to some complications such as saliva fistula, visible skin scar, permanent or temporary paralysis of branches of facial nerve.^{5,9–12} Mandibular subcondylar osteosynthesis via endoscopic-assisted intraoral approach has maximally limited such complications, with the assistance of endoscopic instruments, so that this is an advancement in the surgical treatment of MSC fractures.^{13–22}

The aim of this study is to follow-up and evaluate clinically and radiographically the treatment results of MSC fractures by osteosynthesis via endoscopic-assisted intraoral approach.

MATERIALS AND METHODS

Patients

Forty-seven consecutive patients with 51 sites of MSC fractures at the Department of Maxillofacial Surgery, National Hospital of Odonto-Stomatology HoChiMinh City from September 2011 to October 2013, with the following characteristics.

Inclusion Criteria

- Indicated by surgical treatment.²³
- Capable of general anesthesia.
- Capable of maintaining centric occlusion.
- Sign in consent form with agreement of taking part in operation and research.

Exclusion Criteria

- Fractures not due to trauma.
- Comminuted fractures, defect fractures.

Methods

Study design: time-series design.

Patients were thoroughly explained for taking part in operation and research.

Materials

- Kit of maxillofacial osteosynthesis instruments (Aesculap).
- Titanium miniplates, screws and accompanying instruments (Jeil Medical Corporation).
- Kit of endoscopic-assisted instruments via intraoral approach (Synthes).
- Endoscopic camera and accompanying instruments (Wolf).

Collect Patient's Characteristics Before Surgery

- Centric occlusion: preinjured/malocclusion
- Radiography: OPG, Towne's and computed tomography scan (if necessary) with features:

Displacement²³: minimal/moderate/severe

Correlation between condyle and articular fossa²⁴: no displacement/displacement/dislocation.

Others fractured sites in the mandible (symphyseal and parasymphyseal/body/angle/ramus/coronoid process) and midface.

Surgery

- Surgical treatment of concomitant midface fractures and other mandibular fractures.

- Osteosynthesis of MSC fractures via endoscopic-assisted intraoral approach with titanium miniplates and screws (Fig. 1).

Postoperative Evaluation Clinical Criteria

- 1 week after surgery:
 - Centric occlusion: good (preinjured occlusion)/malocclusion.
 - Infection: non/mild (swelling and pus purulent <1 mL, only antibiotic treatment)/moderate (swelling and pus purulent 1–5 mL, management by drainage and antibiotics)/serious swelling and pus purulent >5 mL, management by widen drainage and intravenous antibiotics).
 - Facial nerve paralysis: yes/no.
- One month, 2 months, 3 months and 6 month after surgery:
 - Centric occlusion, facial nerve paralysis.
 - Maximal mouth opening: normal (≥ 40 mm), minor trismus (30–40 mm), trismus (<30 mm).
 - Maximal protrusion (mm), lateral excursion (mm).
 - Pain at fracture site: VAS score (0–10).

Radiographic criteria (by an independent surgeon) on Orthopantomogram (OPG) and Towne's radiographs at 1 week, 1 month, 2 months, 6 months postoperative:

- Anatomy at fracture sites: precise/minor displacement/severe displacement.
- Correlation between condyle and articular fossa: no displacement/displacement/dislocation.
- Plate/screw fracture: yes/no.
- Screw loosening: yes/no.
- Bone healing on OPG and Towne's at 6 months postoperative with 4 stages²⁵:

Stage 1: one radiolucent line and no calcification image at fracture sites.

Stage 2: osteolytic image and increased radiolucent line at fracture sites.

Stage 3: calcification and osteogenic image at fracture lines.

Stage 4: no radiolucent image, no fracture lines.

This study was approved by Ethics Committee of Biomedical Research of University of Medicine and Pharmacy at Ho Chi Minh City.

RESULTS

Sample Characteristics

The sample includes 47 patients with 51 MSC fracture sites of osteosynthesis in which some characteristics were distributed in Supplemental Table 1 (Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>) and Supplemental Table 2 (Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). There were 87.2% male and 12.8% female, and 74.5% patients in the group of 19 to 39 years old (as shown in Supplemental Table 1, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

There were 43 patients had unilateral MSC osteosynthesis and 4 patients had bilateral MSC osteosynthesis (Supplemental Table 2, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>), so there were a total 51 sites of MSC osteosynthesis.

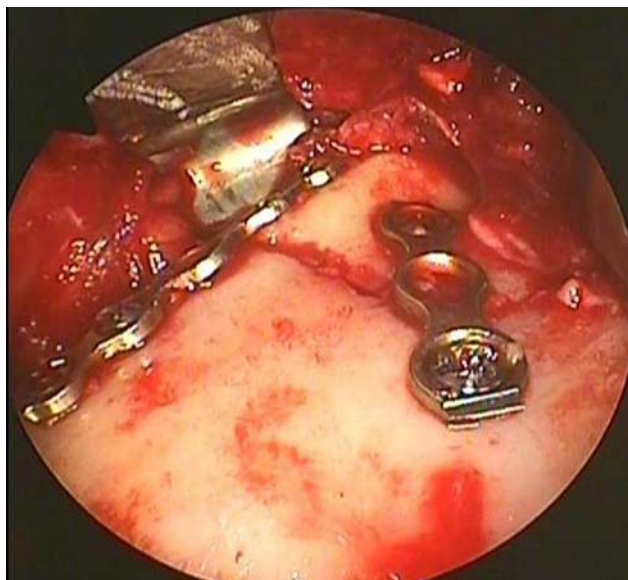


FIGURE 1. Osteosynthesis with miniplates and screws at left mandibular subcondylar fracture via endoscopic-assisted intraoral approach.

In all, 91.5% of patients suffered motorbike accidents caused MSC fractures. All of patients had malocclusion. A total of 59.6% of patients had concomitant symphyseal fractures and 29.7% had concomitant midface fractures. In all, 14.9% had isolated MSC fractures (as shown in Supplemental Table 2, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

Characteristics of Displacement/Dislocation of MSC Fracture Sites

There were 92.2% fracture sites with moderate displacement, 7.8% with severe displacement and no site with minimal displacement. There were 5.9% fracture sites with dislocation, 15.7% fracture sites had displacement of condyle in articular fossa and 78.4% had no displacement of condyle in articular fossa (as shown in Supplemental Table 3, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

Clinical Evaluation at First Week Postoperative

All of patients (100%) had recovered to preinjured occlusion. There were 3 MSC fracture sites that suffered infection, with 1 mild site, 1 moderate site, and 1 severe site. No case suffered facial paralysis (as shown in Supplemental Table 4, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

Pain at Osteosynthesis Sites as Jaw Movements Postoperative

There were 29 MSC osteosynthesis sites that had pain at 1 month postoperative and it decreased to 18 sites at 2 months postoperative, 4 sites at 3 months postoperative, and 1 site at 6 months postoperative. The VAS means of pain were 1.74 ± 1.85 at 1 month, 0.55 ± 1.12 at 2 months, 0.08 ± 0.27 at 3 months and 0.02 ± 0.14 at 6 months postoperative (as shown in Supplemental Table 5, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

Radiographic Evaluation After Surgery

After surgery, there were 90.2% precise reduction results at MSC osteosynthesis sites at 1 week and 1 month. At 6 months

postoperative, there were 96.1% MSC osteosynthesis sites that had precise reduction (as shown in Supplemental Table 6, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). There were 96.1% MSC osteosynthesis sites that had no displacement of condyle in articular fossa at 1 week and 1 month postoperative and 98% at 6 months postoperative (as shown in Supplemental Table 7, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). There was 1 case of screw loosening at 2 months postoperative (as shown in Supplemental Table 8, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). At 6 month postoperative, 88.2% MSC osteosynthesis sites had radiographic bone healing at stage 4 and 11.8% at stage 3 (as shown in Supplemental Table 9, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

DISCUSSION

Preoperative Sample Characteristics

This study consisted of 47 patients with 51 MSC osteosynthesis sites. Most of patients were male (87.2%), this had been very common in many maxillofacial trauma studies in Vietnam. A percentage of 74.5% patients with age group 19 to 39 years old indicated that most of patients in labor age with a high frequency of traffic joining (as shown in Supplemental Table 1, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). Almost patients have causes of trauma due to motorbike accidents (91.5%), besides there were causes due to work-related accidents and assaults.

Malocclusion is the most common clinical sign in displaced MSC patients. In this study, all of patients were malocclusion after trauma, so they had needs of treatment (as shown in Supplemental Table 2, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). Malocclusion due to MSC fractures are ipsilateral overbite and contralateral openbite in isolated unilateral MSC fractures; bilateral posterior overbite and anterior openbite in isolated bilateral MSC fractures. Concomitant mandibular fractures could also cause malocclusion after trauma, added malocclusion caused by MSC fractures. With injured mechanisms of MSC fractures were kinetic energy of the chin (fall) or onto the chin (assault, sport, work) or combinations (traffic accidents), so the symphyseal fractures were the most common of concomitant mandibular fractures (59.6%). There were 7 patients (14.9%) with isolated MSC fractures in this study. Concomitant midface fractures were categorized into types caused of displaced maxilla (lead to malocclusion—19.1%) and the others (no lead to malocclusion—10.6%, such as zygomatic complex fractures).

Radiographic characteristics consisted of displacement of MSC fracture sites and correlation between condyle and articular fossa showed that most of fracture sites were moderate displacement (92.2%) and high percentile of no displacement of condyle in articular fossa (78.4%) (as shown in Supplemental Table 3, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>).

Clinical Evaluation Postoperative

Occlusion is one of essential standards for evaluating intraoperative and postoperative surgical treatment of MSC fractures. In operative process, occlusion must be always checked and must be in good centric occlusion, becoming preinjured occlusion before performing osteosynthesis. With 100% patients in preinjured occlusion at first week postoperative (as shown in Supplemental Table 4, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>), it is successful in evaluating early clinical results, contributing in the restoration of masticatory

function for patients. The study of Kang et al²⁶ indicated that there are 3 overbite cases and 2 openbite cases after performing MSC osteosynthesis via endoscopic-assisted intraoral approach in 26 patients. Moreover, the study of Kellman and Cienfuegos¹⁶ in 43 patients also indicates that 2 cases of slight malocclusion and 1 case of severe malocclusion must be reoperated. However, the study of Schön et al²¹ in 58 patients indicates 100% patients in good centric occlusion. This study shows the comprehensive success of the biggest sample of patients of MSC fractures treated by osteosynthesis via endoscopic-assisted intraoral approach.

In the first week postoperative, there are 3 sites of infection (1 severe, 1 moderate, 1 mild) were treated comprehensively and recovered satisfactorily indicating that infection is able to occur, although with a low rate (as shown in Supplemental Table 4, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). The severe infectious case was recorded with mildly smelly bluish pus and there is *Pseudomonas aeruginosa* as performing an antibiogram. This case was treated with intravenous antibiotics and recovered after 1 week. Therefore, it is needed to emphasize the compliance antiseptic principles in surgery and consider the ability of nosocomial infection after surgery.

With no cases of facial nerve paralysis recorded at first week postoperative (as shown in Supplemental Table 4, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>), this study showed that endoscopic-assisted intraoral approach is safe for the facial nerve due to this approach being deeper than the plane of the ipsilateral facial nerve.²⁷ However, there is a risk of facial nerve damage with extraoral approaches such as submandibular approach, retromandibular approach, preauricular approach due to these approaches traverse through the plane of the facial nerve.²⁷ Therefore, endoscopic-assisted intraoral approach is not only an esthetic approach due to not to create visible extraoral scars but also an approach not caused to facial paralysis compared to extraoral approaches.²⁸ So it is necessary to choose an endoscopic-assisted intraoral approach for osteosynthesis of MSC fractures if there are enough conditions and facilities.

Pain at osteosynthesis sites as jaw movements was recorded to evaluate the postoperative recovery as well as a part of the healthy condition of the temporomandibular joint. At 1 month postoperative, there are 56.9% cases of pain at osteosynthesis sites. The pain frequency and intensity decrease at 2, 3, and 6 months postoperative with significant difference ($P < 0.05$) at 2 and 3 months postoperative compared with previous time (as shown in Supplemental Table 5, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). With VAS mean ~ 0.08 at 3 months and 0.02 at 6 months postoperative, it is concluded that from 3 months postoperative, the pain intensity at osteosynthesis sites recovered almost entirely. Compared with the study of Schneider et al (2007) shows that the VAS mean ~ 1.3 in EA group at 6 months postoperative.²⁹

Radiographic Evaluation Postoperative

OPG and Towne's radiographs were used to evaluate postoperative results in both sagittal and frontal planes. Reduction results showed that precise bone reunion appeared with the percentages of 90% within 1 week after surgery (as shown in Supplemental Table 6, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). Moreover, most patients had no displacement in correlation between condyle and articular fossa, with 96% within 1 week after surgery (as shown in Supplemental Table 7, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). There is one fractured site which had severe displacement after osteosynthesis on radiographs at 1 week postoperative. This site was unchanged after 1 month, but due to the osteolysis and osteogenesis, at 6 month postoperative it became

minor displacement and functionally and anatomically acceptable. Otherwise, the study of Schneider et al²⁹ showed that 52% in 20 patients were reduced precisely on radiographs after surgery. The study of Lauer et al³⁰ also showed 15/19 osteosynthesis sites which were reduced precisely on radiographs immediately after surgery and this percentage was 14/19 at 6 months postoperative. Therefore, there is a small rate of osteosynthesis sites which did not have good bone reunion after surgery and this would be an essential attention as performing these operations via endoscopic-assisted intraoral approaches.

For stability, there were at least 2 screws on each side of the fractured site as osteosynthesis. To perform osteosynthesis via intraoral approach, using miniplates and screws is the most convenient. The first drill hole should be on the condylar fragment at the mesial hole. If we are going to perform osteosynthesis with 2 plates, the posterior one should be performed firstly. Due to the difficulty of the deep surgical field, it is necessary to insert plates and screws harmoniously between surgeons and assistants with endoscopic-assisted instruments. In this study, we used the straight plate with 5 holes for osteosynthesis in which 2 holes for screws each side and the middle hole is at the fracture line. We also used 2 straight plates for osteosynthesis each fracture line, due to the biomechanics of mandibular condyle. The anterior border of the mandibular condyle sustains a tension force so we should put a plate toward this border. To avoid the twist force, we used the second plate toward the posterior border. We recorded screw loosening happened in 1 osteosynthesis site at 2 months postoperative and no case of plate fracture (as shown in Supplemental Table 8, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). The screws were loosen which were inserted into the condylar fragments, not ramus; but it had not moved out of the bone at 6 months postoperative. Therefore, we should pay attention to drilling into the condylar fragment due to the dominant cancellous bone of the condyle. Schneider et al reported that in 21 cases of endoscopic-assisted intraoral approach, there were one case of plate fracture and 8 cases of screw loosening.²⁹

Bone healing at 6 months postoperative showed that 88% of stage 4 on radiographs (as shown in Supplemental Table 9, Supplemental Digital Content 1, <http://links.lww.com/SCS/E204>). With miniplates used in this study, bone healing took place for 4 stages of secondary fracture healing. There was only 1 case that bone healing took place at stage 2 on radiograph at 6 months postoperative so we followed it and this case had bone healing at stage 4 on radiograph at 1 year postoperative.

CONCLUSION

This study showed that surgical treatment of MSC fractures by osteosynthesis via endoscopic-assisted intraoral approach have provided esthetic and functional success and good bone healing.

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Sinus Augmentation Using Caldwell-Luc Technique in the Existence of Ectopic Tooth in the Maxillary Sinus: A Multidisciplinary Approach

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Abstract: Ectopic maxillary third molar teeth can often be located in the maxillary sinus, and the region necessarily requires a multidisciplinary approach due to its proximity to the oral cavity. Ectopic third molar tooth in the maxillary sinus was detected by oral and radiological examination in a 26-year-old male patient. The tooth was removed, and sinus augmentation was performed through the Caldwell-Luc procedure, and a dental implant was placed afterward. The treatment was ended by making a prosthetic metal-supported ceramic crown. Both removals of the ectopic tooth from the maxillary sinus, sinus augmentation, and implant operation can be achieved in a single operation of a single-window opened in the bone. As a result, because of the adjacency of the regions in operations related to the maxillary sinus, both the dental practitioner and the otolaryngologist should evaluate the operation, and multidisciplinary work should be done when necessary.

Key Words: Ectopic teeth, maxillary sinus, sinus augmentation

There are many publications about ectopic maxillary molar teeth cases.^{1,2} Ectopic maxillary third molar teeth can often be located in the maxillary sinus, and the region necessarily requires a multidisciplinary approach due to its proximity to the

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