Original article

Comparison occlusion between closed and open reduction of unilateral condylar fractures: a randomized controlled trial

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Objective To compare occlusion, outcome and complications with the closed method versus the open method of treatment for unilateral mandibular condylar fracture.

Methods Twenty patients with unilateral mandibular condylar fractures (neck or subcondyle) of the mandible were evaluated. The patients were randomly divided into two groups, with group 1 receiving closed reduction and group 2 receiving open reduction and internal fixation. Patients were followed up for a period of 3 months.

Results No statistically significant differences between the open and closed treatment methods were found in terms of occlusion, interincisive distance, temporomandibular joint (TMJ) pain, TMJ clicking and period of hospital stay. Statistically significant improvement was seen in group 2 compared with group 1 in terms of chin deviation on mouth opening. Group 1 had shorter operation times and less postoperative pain scores than group 2. None of the Group 2 patients developed permanent facial nerve damage or unsightly scarring.

Conclusions There is no statistically significant difference between the two methods in terms of occlusion. A statistically significant difference was seen in the patients treated with the open method, with improved chin swaying compared with those treated with the closed method. **Chiang Mai Medical Journal 2017;56(4):203-11.**

Keywords: unilateral mandibular condylar fracture, mandibular fracture

Introduction

Fractures of the mandible are the most common fractures of the facial bone, with mandibular condyle fracture representing 18% to 57% of all mandibular fractures, of which 58.8% are unilateral (1). The most common cause of mandibular condyle fracture is road traffic accidents. Other causes include assault, stumbling, sports accidents, falls from height, and industrial accidents. Clinical features of mandibular condylar fractures include malocclusion, open bite, swelling, tenderness over the joint, loss of mandibular function, deviation of the chin, crepitus, and laceration of the skin.

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There are two treatments for mandibular condyle fracture: closed reduction with maxillo-mandibular fixation (MMF) and open reduction with plate and screws (PAS) with MMF (2). There is presently no definitive evidence to indicate which of those treatments is better, nor is there evidence regarding the advantages and disadvantages of each of the treatments including post-operative complications.

Complications which can result from open reduction include intraoperative hemorrhage, postoperative infection, transient facial nerve injury, malocclusion, and hypertrophic scarring. Complications related to closed reduction can include increased malocclusion, shorter posterior facial height, mastication dysfunction, joint pain, and chin deviation (3).

Traditional medical training in many countries has favored a conservative approach to treating condylar injuries, maintaining that the functional results are, on the whole, satisfactory and that the dangers of surgical intervention outweigh the possible advantages.

The decision of what treatment should be used depends on the physician who is responsible for that patient. At present, there is still no definitive indication for a specific mandibular condyle fracture treatment. However, there is a growing trend of using the open reduction treatment.

There have been many studies published on mandibular condyle fracture. Some promote closed reduction treatment, (4) while others promote open reduction treatment (5-11). However, there has been no study comparing those two treatments using randomized controlled trials. The present study used preauricular incision with plate/screws and MMF techniques in open reduction treatment which differs from the study of Ellis *et al.* which used retromandibular incision techniques without MMF after the operation (11). The researchers hope that the findings of the present study will be useful for future unilateral mandibular condyle fracture treatment.

The Trauma Center of Maharaj Nakorn Chiang Mai Hospital treats about 485 patients having facial fractures each year, of which approximately 127 patients (26%) have a mandibular condyle fracture (12). There are two methods of treatment: the open reduction with plate/screws fixation technique and the closed reduction technique. Of the patients treated at Maharaj Nakorn Chiang Mai Hospital during the study period, 0.05% of the open reduction patients returned for an additional operation due to malocclusion after having open reduction as did 1.67% of the closed reduction patients (13).

There is a trend toward performing the open reduction operation; however, that operation is a difficult medical procedure which requires experienced physicians. In addition, it can result in complications which can affect the patient after the operation, e.g., facial nerve damage. Other physicians choose a closed reduction operation with maxillo-mandibular fixation (MMF) to avoid the possibility of those complications (2,4), although the closed reduction technique can result in some complications after the operation as well, e.g., malocclusion, shortening of the ramus hight, chin swaying, and pain while chewing. There is no consensus on which treatment is best (5-11).

This present study aims to determine whether there is a difference between open and closed reduction treatment in terms of occlusion and other post-operative complications. The results of this study were evaluated by experienced surgeons and occlusion dentists.

Methods

A controlled, parallel-group, randomized trial was conducted to compare closed reduction with open reduction internal fixation (ORIF) in unilateral condylar fracture management. The present study is a pilot study. The study population included patients who had had a mandibular condyle fracture either with or without symphysis, parasymphysis, body, or angle mandibular fracture who were treated at Maharaj Nakorn Chiang Mai Hospital between 2013 and 2015. A total of 20 patients with unilateral mandibular condylar fractures were evaluated. The present study was approved by Research Ethics Committee, Faculty of Medicine, Chiang Mai University.

Post-operative occlusion between two groups was a primary outcome. The secondary outcomes were the post-operative pain (measured with visual analog

scales) and post-operative complications (facial nerve injury, mastication dysfunction, chin swaying, TMJ, TMJ clicking sound) (14-19).

Patients who qualified for this study based on the inclusion/exclusion criteria were given a registration form explaining the research and the treatment procedures as well as information on the advantages, disadvantages, and potential complications of each treatment. If the patients had any questions, they were free to ask the physicians about any details.

The inclusion and exclusion criteria for this study were as follows (20-22)

Inclusion criteria

1. Trauma patients with unilateral mandibular condyle fracture (neck or subcondyle) with or without isolated fracture of the symphysis, parasymphysis, body or angle of mandible.
2. Age between 18-60 years

Exclusion criteria

1. Comminuted condylar fracture
2. Condylar fracture with displacement into the cranial fossa
3. Displacement condylar fracture with functional block
4. Lateral extra capsular displacement
5. Open ramus fracture
6. Condylar head fracture
7. Any type of Lefort fracture
8. Panfacial fractures
9. Severe head injury
10. C-spines fracture
11. Unstable vital signs

Before having the operation, the selected patients were evaluated by film X-ray in both Towne view and panoramic view (23) plus blood sampling for CBC, electrolyte, BUN/Cr, and Anti-HIV. Patients over 35 years old were given additional tests including film chest x-ray and electrocardiography (EKG). All selected patients were required to sign a treatment and research permit on the Informed Consent form. Treatment for each patient, either closed or open reduction, was chosen randomly. Thus the patients were divided into two groups, open and closed, but they were blinded to the treatment they were to receive. All patients were operated on within 7 days of their injury.

The open reduction procedures used pre-auricular incision with plate and screws (MMF) and were conducted by a well-trained plastic surgeon (24-29). Teeth were held in place by elastic bands for 3 weeks. After that the elastic bands were removed and an arch bar was put in place for an additional two weeks. A well-trained plastic surgeon followed the gold standard of closed reduction treatment in order to handle the to insure proper occlusion. After the operation, the teeth were held in place by maxillomandibular fixation (MMF) for 3 weeks after which the elastic bands were removed and replaced by an arch bar for two more weeks. Patients in both groups who had other mandibular fractures, e.g., symphysis, parasymphysis, body, or angle, were treated by open reduction with plate and screw fixation. In these patients, after anatomical reduction and internal fixation with two 2.0 mm locking plates and screws to achieve rigid fixation assuming in cases where there were no other site fractures. Both the open and the closed group of patients were given the same post-operative care.

After the operation, operating time was recorded and 24-hour post operation pain was measured using visual analog scales. Both groups of patients were examined to evaluate clinical occlusion and complications in three phases: at 3 weeks, 5 weeks, and 3 months. The examinations included photographs of the patient's mouth in maximum occlusion. A digital camera (Nikon, Japan) with 6x zoom and 12x magnification was used. (Figure 1)

Clinical occlusion was evaluated by two plastic surgeons who were not involved in the initial operation and by one dentist specializing in occlusion. Based on the information obtained, occlusions were rated as good or poor. The patient's data was recorded in a case report form.

Figure 1. Photographs of occlusion

Comparison of the results of the two groups was accomplished using various statistical tests, e.g., Fisher's exact test for categorical data, Student's t-test for continuous data, and logistic regression for comparison of outcomes between closed and open reduction. The computer program used was STATA version 10.1

Results

The most common mechanism of injury was motorcycle accidents (80%). Mild head injury was the most common associated injury (20-30%) (Table 1). In this study, follow-up data were recorded for up to 3 months. At 3 months, 2 patients in the closed reduction group had poor occlusion as did 1 patient in the open reduction group. There was no significant difference between the two groups with regarded to occlusion (p =0.534), interincisive distance, TMJ pain, TMJ clicking sound, or period of hospital stay (Tables 2 and 3).

Deviation of the chin on mouth opening was evaluated (Figure 2). At 3 months following treatment, no patient in open reduction group showed any deviation, whereas 40% of the patients in closed reduction group had deviation, a statistically significant difference (p =0.025). The closed group had statistically significantly better than the open group in terms of shorter operating time (p <0.001) and less postoperative pain scores (p =0.001) (Table 2, Table 4). In addition, the open group had longer operating times on average than the closed group (p <0.001).

Of the patients who had open reduction treatment, 30% had transient facial nerve injury, but none of those patients had developed permanent facial nerve damage at the 3-month evaluation, and none had an unsightly scar (Figure 3).

Table 1. Patient demographics and risk factors

Baseline characteristics	Closed reduction (n=10)	Open reduction (n=10)	*p-value*
Age (years), mean (SD)	33.1 (15.28)	32.1 (16.99)	0.891
Gender, n (%)			
Male	8 (80.00)	7 (70.00)	0.606
Female	2 (20.00)	3 (30.00)	
Weight (Kg), mean (SD)	59.8 (6.23)	59.8 (12.22)	1.000
Height (cm), mean (SD)	165.6 (9.68)	162.3 (5.69)	0.365
Side of condylar fracture, n (%)			
Right	5 (50.00)	2 (20.00)	0.160
Left	5 (50.00)	8 (80.00)	
Associated mandibular fracture, n (%)			
None	3 (30.00)	4 (40.00)	
Symphysis	1 (10.00)	1 (10.00)	
Parasymphysis	3 (30.00)	3 (30.00)	0.649
Body	2 (20.00)	0 (0.00)	
Angle	1 (10.00)	2 (20.00)	
Mechanism of injury, n (%)			
Motorcycle accident (MCA)	8 (80.00)	8 (80.00)	
Fall	-	-	
Assault	2 (20.00)	1 (10.00)	0.513
Other	0 (0.00)	1 (10.00)	
Associated injury, n (%)			
None	6 (60.00)	7 (70.00)	
Mild head injury	3 (30.00)	2 (20.00)	0.871
Moderate head injury	1 (10.00)	1 (10.00)	
C-spine injury	-	-	

Table 2. Outcome measurement

Outcome measurement	Closed reduction (n=10)	Open reduction (n=10)	*p-value*
Incidence of Occlusion at 3 months, n (%)			
Good occlusion	8 (80.00)	9 (90.00)	0.534
Poor occlusion	2 (20.00)	1(10.00)	
Operating time, mean (SD)	109.5 (32.18)	205.5 (35.62)	<0.001*
Postoperative pain score, mean (SD) (Visual analog scales)	4.5 (1.08)	6.1 (0.87)	0.001*
Facial nerve injury at 3 months, n (%)			
Negative	10 (100)	10 (100)	NA
Positive	0	0	
Interincisive distance at 3 months (cm), mean (SD.)	3.85 (0.57)	4.1 (0.65)	0.380
Mastication dysfunction, n (%)			
Chin swaying at 3 months	4 (40.00)	0 (0.00)	0.025*
TMJ Pain at 3 months	1 (10.00)	1 (10.00)	1.000
TMJ Clicking sound at 3 months	0 (0.00)	1 (10.00)	0.305
Period of hospital stay (days), mean (SD.)	6.1 (1.5)	5.7 (2.7)	0.652

Table 3. Comparison of post-operative occlusion: closed and open reduction

Parameters	Closed reduction (n=10)	Open reduction (n=10)	OR	95% CI	*p-value*
Post-operative occlusion 3 months (Poor occlusion)	2 (20%)	1 (10%)	2.5	0.17-29.46	0.538

Poor occlusion: reference group

Table 4. Comparison of pain scores between closed and open reduction

Parameters	Closed reduction (n=10)	Open reduction (n=10)	OR	95% CI	*p-value*
Pain score > 6	2 (20%)	7 (70%)	0.11	0.01-0.83	0.033*

Pain score > 6: reference group

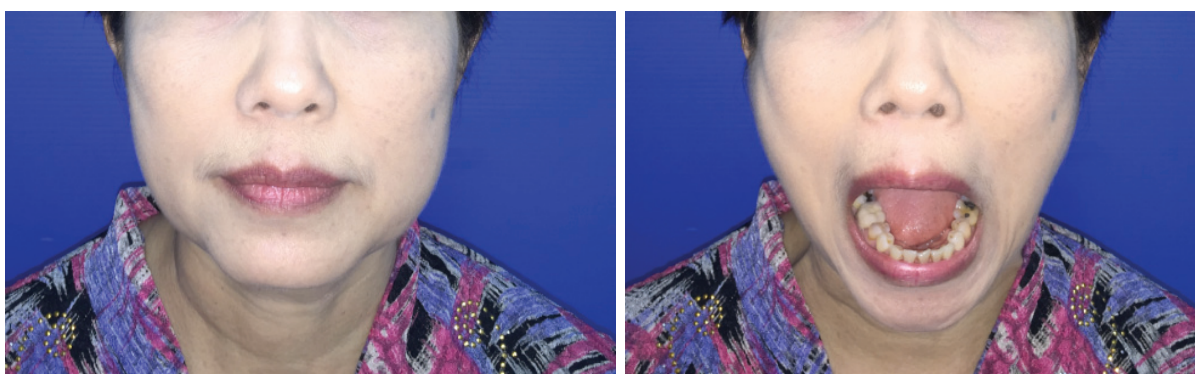

Figure 2. Chin swaying to the left at 3rd month post-operation in patients with left unilateral condylar fracture treated with closed reduction

Figure 3. Preauricular incision scar at 3rd month post-operation

Discussion

The choice of surgical versus nonsurgical treatment for fractures of the condylar process remains a controversial issue. Baker *et al.* (1998) (2) studied treatment strategies for condylar fractures which are displaced and associated with an altered occlusion. That study included a survey of 120 oral and maxillofacial surgeons who responded to questions about mandibular condyle fracture treatment. The survey found that 78% of surgeons chose closed reduction with MMF, 9% chose open fixation of the condyle alone, 10% chose open reduction with MMF, and 3% chose no active treatment, i.e., most of the surgeons chose closed reduction treatment. However, a study by Haug *et al.* (4) of outcomes of open versus closed treatment of mandibular sub-condylar fractures found no statistically significant difference between open reduction treatment and closed reduction treatment. That study also found no significant difference in post-operative occlusion between the open and closed treatment methods. Moreover, Haug, in contrast to Baker, reported that 57% of surgeons chose open reduction treatment (4).

A study by Ellis *et al.* found dislocation of the condylar process in patients following closed reduction treatment (5) The Ellis study of post-operation complications reported that patients who had closed reduction treatment had a shorter posterior facial height, more tilting of the occlusion plane, more malocclusion, and less excursion toward the fractured side (6) while 17.2% of patients who had open reduction treatment had hypertrophic scarring and transient nerve injury (7). However, the present study found no significant differences in post-operative occlusion between the open and closed treatment methods, and none of patients in the study had permanent facial nerve injury or unsightly preauricular scars at 3 months following treatment.

Worsaae, Thorn *et al.* reported that 39% of patients who had closed reduction treatment had malocclusion, mandibular asymmetry, mastication dysfunction, and pain, while only 4% of patients who had open reduction had those complications (8,9). The present study found no significant differences in terms of TMJ pain or TMJ clicking sound. Takenoshita *et al*. found that 8% of patients who had open reduction treatment had transient frontal branch palsy, and the rate of chin deviation was two times higher in patients who had closed reduction treatment (10,11). This study also found no patients in the open group had permanent facial nerve injury, and that the open technique reduced chin swaying.

The preauricular incisional approach for condylar fractures has been described in the literature. Because of the close anatomic relationship between the facial nerve and the temporal blood vessels, this incisional approach pose a risk of damage to these important structures (30-34). Also, extraoral approaches are generally associated with visible scarring. However, this study found none of the patients had permanent facial nerve injury or unsightly preauricular scars.

Conclusions

This study indicates that no significant clinical difference exists between the closed and open treatment methods in terms of occlusion. Chin swaying is reduced with the open method than with the closed method. Closed reduction has shorter operation times and postoperative pain scores are lower than open reduction. Neither of the open reduction patients results in permanent facial nerve damage or unsightly scars.

There are no definitive indications for closed or open reduction. The choice of treatment should therefore be left to the patient after receiving a thorough explanation of the pros and cons of each of the treatment modalities and the possible complications.

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Conflicts of Interest

None

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การเปรียบเทียบผลการรักษาในด้านการสบฟันระหว่างการรักษาด้วยวิธีจัดกระดูกแบบปิดและการเปิดผ่าตัดกระดูกขากรรไกรหักบริเวณ condyle ข้างเดียว

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[1]หน่วยศัลยศาสตร์ตกแต่ง ภาควิชาศัลยศาสตร์ คณะแพทยศาสตร์, [2]ภาควิชาชีววิทยาช่องปากและการวินิจฉัยโรคช่องปาก คณะทันตแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่

วัตถุประสงค์ เพื่อเปรียบเทียบการสบฟัน ผลการผ่าตัด และภาวะแทรกซ้อน ระหว่างวิธีการรักษาแบบมัดฟันอย่างเดียวกับการเปิดผ่าตัดตรงตำแหน่งที่หักในผู้ป่วยกระดูกขากรรไกรหักบริเวณ condyle ข้างเดียว

ผู้ป่วยและวิธีการ ทำการศึกษาในผู้ป่วยกระดูกขากรรไกรหักบริเวณ condyle ข้างเดียว (neck หรือ sub-condyle) จำนวน 20 ราย ผู้ป่วยถูกแบ่งแบบสุ่มเป็น 2 กลุ่ม โดยกลุ่มที่ 1 ได้รับการจัดกระดูกให้เข้าที่โดยไม่ผ่าตัดและมัดฟันอย่างเดียว กลุ่มที่ 2 ได้รับการผ่าตัดจัดกระดูกบริเวณที่หักร่วมกับการยึดกระดูกและมัดฟัน ทั้ง 2 กลุ่มได้รับการติดตามผลเป็นเวลา 3 เดือน

ผลการศึกษา ไม่มีความแตกต่างอย่างมีนัยสำคัญระหว่างวิธีการรักษาแบบเปิดและแบบปิดในแง่ของการสบฟัน ระยะระหว่างฟันหน้าขณะอ้าปากเต็มที่ อาการปวดของข้อต่อกระดูกกราม เสียงผิดปกติในข้อต่อกระดูกกราม และระยะเวลานอนโรงพยาบาล แต่กลุ่มที่ 2 ให้ผลที่ดีกว่าอย่างมีนัยสำคัญทางสถิติในแง่ของความเอียงของคางขณะอ้าปาก ส่วนกลุ่มที่ 1 มีระยะเวลาการทำหัตถการสั้นกว่าและคะแนนความเจ็บปวดหลังผ่าตัดน้อยกว่ากลุ่มที่ 2 นอกจากนี้ในกลุ่มที่ 2 ไม่พบการบาดเจ็บอย่างถาวรของเส้นประสาทเลี้ยงใบหน้า หรือรอยแผลเป็นจากการผ่าตัดที่เห็นได้ชัด

สรุป ไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติระหว่างวิธีการรักษาทั้ง 2 แบบในแง่ของการสบฟัน ส่วนการเปิดผ่าตัดให้ผลการรักษาที่ดีกว่าอย่างมีนัยสำคัญทางสถิติ ในแง่ของการความเอียงของคางขณะอ้าปาก เมื่อเปรียบเทียบกับวิธีการรักษาแบบปิด **เชียงใหม่เวชสาร 2560;56(4):203-11.**

คำสำคัญ: กระดูกขากรรไกรหักบริเวณ condyle ข้างเดียว กระดูกขากรรไกรหัก