*Original Article*

# Factor of Long Term Outcome in Closed Reduction of Condylar Fracture of the Mandible: A Prospective Study

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***Background:*** Condylar fractures of the mandible are one of the most common facial fractures, however, methods of treatment remain controversial. Closed reduction is the alternative method but long-term outcome has never been established.

***Materials and Methods:*** A prospective study of condylar fractures of the mandible in Phramongkutklao Hospital between January 2010 and December 2014 was conducted. Clinical and radiologic examinations were recorded. All patients were followed up at 3, 6, and 12 months for complete protocol.

***Results:*** Thirty-two patients that presented pure condylar fractures were included in the present study. Thirty-five fracture sites of the condyle were analyzed from 29 and three patients in unilateral and bilateral fracture, respectively. Average time for maxillomandibular fixation [MMF] was 20.4 days (14 to 28 days). Condylar neck and slightly displaced were the most common types of fracture. The occlusion was returned to pre-injury 86.21% in unilateral and 66.67% in bilateral fractures. Six and one patients in unilateral and bilateral fractures had pain when chewing, respectively. The clicking sound of TMJ was found among eight patients presenting unilateral and one patient presenting bilateral fracture. Deviation of mandible during open mouth was found in 21 patients of unilateral and one patient of bilateral fracture. Mean deviation of the mandible was 2.35 mm (1 to 4 mm). Means of interincisal distance was 35mm (30 to 42 mm). No statistical significance was found between malocclusion, pain on chewing on each site and type of fracture for both unilateral and bilateral condylar fractures. Statistical significance was found between clicking sound and fractures site in unilateral condylar fractures.

***Conclusion:*** Closed reduction of condylar fracture in unilateral fracture has favorable long-term outcome. The predictive factor of malocclusion is dislocated subcondylar bilateral fractures of condyle. The predictive factor of clicking sound is unilateral fracture head of condyle.

***Keywords:*** Condylar fracture of the mandible, Closed reduction, Outcome

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Condylar fractures of the mandible are one of the most common facial fractures and represent 34% to 45% of maxillofacial fractures[1]. Treatments of condylar fracture are either closed reduction with maxillomandibular fixation [MMF] or open reduction with internal fixation. Although they are common fractures of facial bones, no gold standard exists to treat condylar fractures and management remains controversial. Method of treatment depends on the location and the skills of the surgeon.

The advantage of open reduction with internal fixation is that patients do not have to suffer with MMF but the disadvantages are prolonged operative time, difficult procedures, risk of facial nerve injury, and facial scar from surgery. In contrast, the advantages of closed reduction with MMF are short operative time, common procedures, and no risk of facial nerve injury or facial scarring. The main disadvantage is that patients suffer from MMF.

Many methods have been developed to improve the results of open reduction either the incision approach such as intraoral[2,3], pre-auricular[3], retromandibular[4], and submandibular[2] or the stability of fixation such as K-wire[5], lag screw[6,7], and plate[7-9]. Some reports had shown the superior results of open reduction over closed reduction such as Hidding et al demonstrated the deviation of the mandible 64% in closed reduction, while 10% in open reduction[10]. Worsaae et al showed that the complications including facial asymmetry, malocclusion, reduced maximum inter-incisal opening [MIIO], pain, and headache was 39% for closed reduction, compared with 4% for open reduction[11].

However, many studies reported that no statistical significant difference exist in occlusion, range of

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motion, contour, and maximum bite forces[12-14]. Facial nerve paresis occurred in 17% to 18%[15,16]. Hence, no comparative study has shown the best result of treatments and outcome remains inconclusive. Closed reduction is the main treatment method in Phramongkutklao Hospital but the factor of long-term outcome has never been conducted.

The objective was to establish the factor of long-term outcome of closed reduction of condylar fractures of the mandible including occlusion, pain at rest and when chewing, interincisal distance, clicking sound of tympanomandibular joint [TMJ], facial asymmetry, and radiologic change.

## Materials and Methods

The present study was Approved by the Ethics Committee of Phramongkutklao Hospital and College of Medicine. A prospective study of the patients with maxillofacial fractures in Phramongkutklao Hospital between January 2010 and December 2014 was conducted. Inclusion criteria included patients with condylar fractures of the mandible and treated with closed reduction. Patients with severe head injury combined with other maxillofacial fractures, edentulous, and previous TMJ dysfunctions were excluded. The database included age, sex, cause of injury, presenting symptoms, pre-operative imaging findings, site of fracture, occlusion (pre-and post-operation), postoperative complication, duration of MMF, pain at rest and when chewing, interincisal distance, clicking sound of TMJ, facial asymmetry, and radiologic change.

Condylar fractures of the mandible were classified as the head of the condyle, condylar neck (thin, constricted region below the head of the condyle), and subcondylar (from the sigmoid notch to the posterior mandible just below the neck of the condyle). Condylar segments were divided in non-displaced, slightly displaced, moderately displaced (medially or laterally), and dislocated.

Clinical and radiologic studies were recorded. Radiologic examination included panoramic views, skull postero-anterior, lateral views, mandibular Towne view, and computed tomographic facial bone. Panoramic view was performed in all patients at initial diagnosis and one year after treatment. All patients were performed closed reduction with MMF under general anesthesia by a single surgeon. Standard follow-up appointments were at 1, 2, 4, and 6 weeks after closed reduction. A liquid food diet was advised for all patients in the first two weeks after removing MMF, and a gradual increase of consistency of food was allowed. All patients were recommended to stimulate the range of motion of TMJ and followed up at 3, 6, and 12 months for complete protocol in this study.

### *Statistical analysis*

Data analysis was performed in percentage of outcome for both unilateral and bilateral condylar fractures. Correlation between site and type including subgroup classification of unilateral and bilateral condylar fractures and long-term outcome were analyzed. The univariate analysis of the independent variables was accomplished using Chi's square test. A *p*-value smaller than 0.05 was considered statistically significant.

## Results

Three hundred seventy-four maxillofacial fractures were recorded. One hundred thirty-six patients involved mandibular fractures (36.36%). Forty-five patients (33.01%) with mandibular fractures involved condylar fractures, and of these, 32 patients presented pure condylar fractures and were included in the present study. Twenty-nine and three patients presented unilateral and bilateral fractures of the condyle, respectively. Mean age of patients was 32.1 years (range 19 to 57 years). Thirty patients were male (93.75%). Causes of injury included traffic accident (43.75%), fall (37.5%) and body assault (18.75%). Thirty-five fracture sites of the condyle from 29 unilateral and three bilateral fractures were analyzed. Average time for MMF was 20.4 days (14 to 28 days). All patients were followed up at 12 months.

The condylar neck was the most common site of fracture (16 patients) and slightly displaced was the most common type of fracture (13 patients) (Table 1). Fractured neck, subcondylar, and the head of the condyle were found in 13, 10, and six patients with unilateral fractures, and at three, two, and one sites for bilateral fractures, respectively. Slightly, moderately medially displaced, and dislocated fractures were found among 11, nine, and seven patients with unilateral fractures, respectively (Figure 1-4). Regarding bilateral fractures, slightly, moderately medially displaced, and dislocated fractures were found in one case in each group (Table 2). No statistical significance was found between unilateral and bilateral fractures concerning fracture site and type.

The occlusion restored to pre-injury among 25 patients (86.21%) with unilateral and two patients

**Table 1.** Characteristics of condylar fracture in 32 patients

| | n (%) |
|---|---|
| Sex (male:female) | 30:2 (93.75:6.25) |
| Cause of fracture | |
| Traffic accident | 14 (43.75) |
| Fall | 12 (37.50) |
| Body assault | 6 (18.75) |
| Fracture involve | |
| Unilateral | 29 (90.62) |
| Bilateral | 3 (9.38) |
| Fracture site | |
| Head of condyle | 7 (20.00) |
| Neck of condyle | 16 (45.71) |
| Subcondylar | 12 (34.29) |
| Fracture type | |
| Non-displaced | 2 (5.71) |
| Slightly displaced | 13 (37.14) |
| Moderately displaced (medially) | 11 (31.43) |
| Moderately displaced (laterally) | 0 (0.00) |
| Dislocated | 9 (25.71) |

**Table 2.** Demonstration of classified the fracture site and type

| | Unilateral (n = 29) | Bilateral (n = 6) | *p*-value* |
|---|---|---|---|
| Fracture site, n (%) | | | 0.96 |
| Head of condyle | 6 (20.69) | 1 (16.67) | |
| Neck of condyle | 13 (44.83) | 3 (50.00) | |
| Subcondylar | 10 (34.48) | 2 (33.33) | |
| Fracture type, n (%) | | | 0.89 |
| Non-displaced | 2 (6.90) | 0 (0.00) | |
| Slightly displaced | 11 (37.93) | 2 (33.33) | |
| Moderately displaced (medially) | 9 (31.03) | 2 (33.33) | |
| Moderately displaced (laterally) | 0 (0.00) | 0 (0.00) | |
| Dislocated | 7 (24.14) | 2 (33.33) | |

* Chi-square test

**Figure 1.** Demonstrated fracture head of left condyle (arrow) from CT facial bone (coronal view).

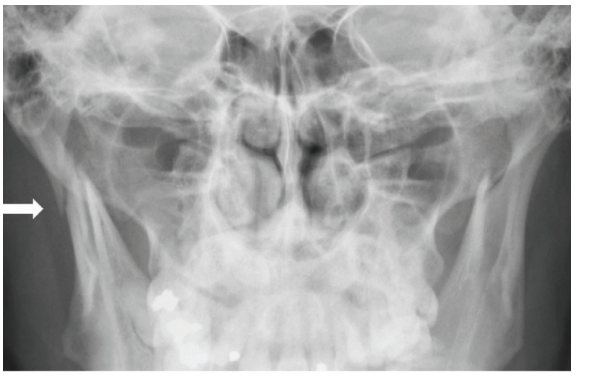

**Figure 2.** Demonstrated slightly displaced right subcondylar fracture (arrow) from skull postero-anterior view.

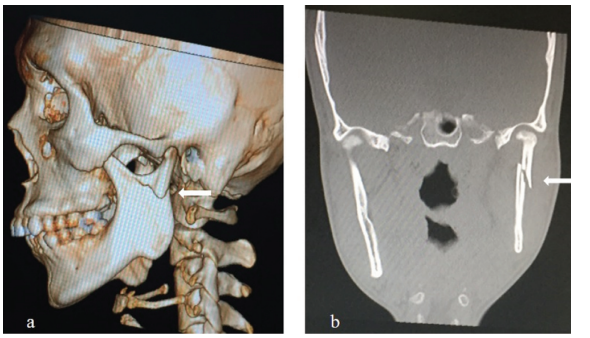


**Figure 3.** Demonstrated moderated displaced left subcondylar fracture (arrow): a) 3-dimension demonstration, b) coronal view in CT facial bone.

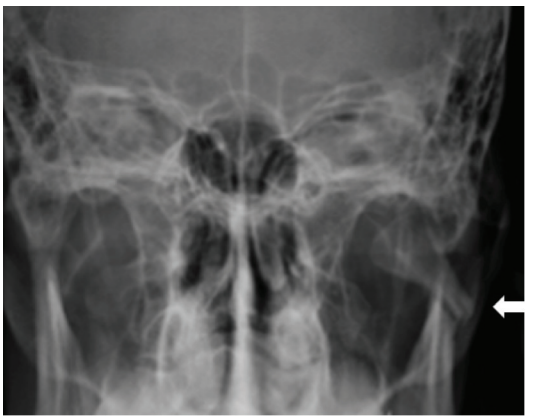

**Figure 4.** Demonstrated dislocated left subcondylar fracture (arrow) from mandibular Towne view.

(66.67%) with bilateral fractures (Table 3). None of the patients had pain at rest. Six patients (20.69%) and one patient (33.33%) with unilateral and bilateral fractures of the condyle reported pain when chewing, respectively. The clicking sound of TMJ was found among eight patients (27.59%) with unilateral and

**Figure 5.** Demonstrated the resorption and irregularity of the head of left condyle and shortening of left condylar neck in fracture neck of left condyle at 1 year follow-up (panoramic view).

one patient (33.33%) in bilateral fractures. Deviation of the mandible during open mouth was found among 21 patients (72.41%) with unilateral and one patient (33.33%) with bilateral fractures. Mean deviation of the mandible was 2.35 mm (1 to 4 mm). Means of interincisal distance was 35 mm (30 to 42 mm). Radiologic changes were found among 12 patients including resorption of the condylar head, narrowing, or irregularity of joint surface (Figure 5). However, none of the patients needed orthodontic treatment. No statistical significance was found between unilateral and bilateral fractures regarding outcome of fracture.

Malocclusion was found among four patients and one patient with unilateral and bilateral condylar fractures, respectively (Table 4). Concerning unilateral condylar fractures, three patients presented fractures of the neck of the condyle and one patient presented subcondylar fracture. Of these, three patients presented dislocated fracture and one patient presented moderately medially displaced. Regarding bilateral condylar fractures, one patient presented moderately medially displaced fracture of the neck of the condyle on the left side and dislocated subcondylar fracture on the right side. No statistical significance was found between malocclusion and each site and type of fracture for both unilateral and bilateral condylar fractures.

Pain when chewing was found among six patients and one patient with unilateral and bilateral condylar fractures, respectively (Table 5). Concerning unilateral condylar fracture, three patients presented fracture of the neck of the condyle, two patients had fracture of the head of the condyle, and one patient was subcondylar fracture. In these, three patients were dislocated fracture, while, moderate medially displaced, slightly, and non-displaced were found in one patient of each group. In bilateral condylar fracture, one patient was moderately medially displaced fracture of the neck of the condyle on the left side and dislocated subcondylar fracture on the right side. No statistical significance was found between pain when chewing and each site and type of fracture for both unilateral and bilateral condylar fractures.

The clicking sound was found among eight and

**Table 3.** Descriptive of the outcome variables

| | Unilateral (n = 29), n (%) | Bilateral (n = 3), n (%) | *p*-value* |
|---|---|---|---|
| Malocclusion | 4 (13.79) | 1 (33.33) | 0.37 |
| Pain at rest | 0 (0.00) | 0 (0.00) | NA |
| Pain when chewing | 6 (20.69) | 1 (33.33) | 0.61 |
| Clicking sound | 8 (27.59) | 1 (33.33) | 0.83 |
| Deviation | 21 (72.41) | 1 (33.33) | 0.16 |

NA = not available

* Chi-square test

**Table 4.** Analysis of malocclusion in unilateral and bilateral condylar fractures

| | Unilateral | | *p*-value* | Bilateral | | *p*-value* |
|---|---|---|---|---|---|---|
| | Yes | No | | Yes | No | |
| Malocclusion | 4 | 25 | | 2 | 4 | |
| Fracture site | | | 0.36 | | | 0.68 |
| Head of condyle | 0 | 6 | | 0 | 1 | |
| Neck of condyle | 3 | 10 | | 1 | 2 | |
| Subcondylar | 1 | 9 | | 1 | 1 | |
| Fracture type | | | 0.06 | | | NA |
| Non-displaced | 0 | 2 | | 0 | 0 | |
| Slightly displaced | 0 | 11 | | 0 | 2 | |
| Moderately displaced (medially) | 1 | 8 | | 1 | 1 | |
| Dislocated | 3 | 4 | | 1 | 1 | |

NA = not available

* Chi-square test

**Table 5.** Analysis of pain when chewing in unilateral and bilateral condylar fractures

| | Unilateral | | *p*-value* | Bilateral | | *p*-value* |
|---|---|---|---|---|---|---|
| | Yes | No | | Yes | No | |
| Pain on chewing | 6 | 23 | | 2 | 4 | |
| Fracture site | | | 0.13 | | | 0.68 |
| Head of condyle | 3 | 3 | | 0 | 1 | |
| Neck of condyle | 2 | 11 | | 1 | 2 | |
| Subcondylar | 1 | 9 | | 1 | 1 | |
| Fracture type | | | 0.20 | | | NA |
| Non-displaced | 1 | 1 | | 0 | 0 | |
| Slightly displaced | 1 | 10 | | 0 | 2 | |
| Moderately displaced (medially) | 1 | 8 | | 1 | 1 | |
| Dislocated | 3 | 4 | | 1 | 1 | |

NA = not available

* Chi-square test

**Table 6.** Analysis of clicking sound in unilateral and bilateral condylar fractures

| | Unilateral | | p-value* | Bilateral | | p-value* |
|---|---|---|---|---|---|---|
| | Yes | No | | Yes | No | |
| Clicking sound | 8 | 21 | | 2 | 4 | |
| Fracture site | | | 0.004 | | | 0.68 |
| Head of condyle | 4 | 2 | | 0 | 1 | |
| Neck of condyle | 3 | 10 | | 1 | 2 | |
| Subcondylar | 1 | 9 | | 1 | 1 | |
| Fracture type | | | 0.19 | | | NA |
| Non-displaced | 1 | 1 | | 0 | 0 | |
| Slightly displaced | 1 | 10 | | 0 | 2 | |
| Moderately displaced (medially) | 3 | 6 | | 1 | 1 | |
| Dislocated | 3 | 4 | | 1 | 1 | |

NA = not available

* Chi-square test

one patients with unilateral and bilateral condylar fractures, respectively (Table 6). The most common fracture sites for clicking sound with unilateral fractures were head of the condyle (four patients) and neck of the condyle (three patients). Most common fracture types were moderately medially displaced (four patients) and dislocation (three patients). Concerning bilateral condylar fractures, one patient with moderately medially displaced fracture of the neck of the condyle and subcondylar dislocation was found. Statistical significance was found between clicking sound and fracture site for unilateral condylar fractures.

## Discussion

Although condylar fracture is one of the most common facial fractures, guidelines for treatment are still controversial and remain inconclusive especially indication for open reduction. Some surgeons have attempted to develop an algorithm for open reduction[12]. Walker and Kerr reported the indication for open reduction was patients with dislocated condylar fracture concurrent with multiple and comminuted facial fractures[17]. In 1990, Zide and Kent revealed the indications for open reduction were displacement in the middle cranial fossa, tympanic plate injury, impossibility to obtaining adequate occlusion, lateral extracapsular displacement, invasion by foreign body, failure to obtain segment contact because of intervening soft tissue, blocked mandibular opening, facial nerve paresis secondary to initial injury, contraindicated MMF, and open wounds from initial injury[18]. However, Haug and Assael argued that the only indication for open reduction was condylar displacement while ramus instability, and intracapsular fracture were contraindicated in all circumstances[19].

Thoma reported that open reduction was indicated for unilateral fractures (to prevent contralateral derangement), bilateral fractures with an open bite, gross malalignment, fracture dislocations, partly or completely healed fractures with arthralgia, and abnormal function or malocclusion[20]. Raveh et al stated that open reduction is indicated when the condyle is displaced out of the glenoid fossa[21]. Undt et al showed that if a medial tilt of the condylar fragment was more than 14 degrees, shortening of ramus more than 5%, insufficient contact of the fragment, minor dislocation, or other fractures, then general anesthesia is required to avoid MMF[22]. Takenoshita et al considered that indication included luxation of the condylar head out of the glenoid fossa, where an anterior open bite exists, when significant deviation exists between bone and fragments, or when conservative therapy has failed[23]. As a general rule, internal fixation is considered in cases where MMF is contraindicated (e.g., poorly controlled seizure disorder), fracture in which an acceptable occlusion cannot be reestablished, and bilateral fractures in panfacial injury (to reestablish appropriate facial height)[24].

Most of the reports did not suggest the indication for open reduction for pure condylar fractures. Haug and Brandt demonstrated that the fractured head of the condyle should not be opened, and open reduction was preferred for displaced condylar fractures with reduced posterior ramus height and unstable occlusion[12]. Most of the indications for open reduction concerned the occlusion and facial height and the indication usually occurred among patients with multiple facial fractures. Immediate results are the main indications for open reduction in most previous reports. However, the exact indication for open reduction remains inconclusive.

Some reports have shown the superior results of open reduction over closed reduction such as Hidding et al demonstrated that 64% of the deviation of the mandible were done in closed reduction, while 10% were done in open reduction. However, no statistical significant difference was found concerning headaches, mastication, or MIIO[10]. Worsaae et al showed the complications including facial asymmetry, malocclusion, reduced MIIO, pain, and headache was present in 39% for closed reduction, compared with 4% for open reduction[11]. Overall complications occurred in 20.69% of unilateral and 33.33% of bilateral fractures.

Many studies have reported that no statistical significant difference exists in occlusion, ROM, contour, and maximum bite forces[12-14]. The greatest

disadvantages of open reduction were facial nerve injury and facial scarring. Facial nerve paresis occurred in 17% to 18%[15,16], although, patients recovered at six months. The risk of facial nerve injury included condylar neck fracture, fracture dislocation, and operator inexperience[16]. Moreover, 7.5% of facial scarring showed hypertrophic scar. The present study revealed that complications from closed technique included malocclusion, pain when chewing, and clicking sound. Usually, the most serious complication is malocclusion. In the present study, the occlusion was restored to pre-injury in 86.21% and 66.67% of unilateral and bilateral fractures, respectively. In addition, pain when chewing was found in 20.69% of unilateral and 33.33% of bilateral fractures. Although deviation of the mandible was found in 72.41% of unilateral fractures, the deviation was only minor (1 to 4 mm).

Endoscopy has been developed to assist surgeons treating condylar fracture. The techniques include extraoral and intraoral approaches[1-4] and materials for fixation to avoid MMF such as adaptation miniplate, dynamic compression plate, double miniplate, and lag screw have been developed[25-29]. However, no statistical significant data have demonstrated the best fixation methods.

In the present study, we were interested only in pure condylar fracture that has never established the standard absolute indication for open reduction. Disadvantage of this study is the small sample size in bilateral fracture condyle, no comparison with open method. Further study with more sample size and comparison with open reduction will give more information and conclusion of the indication for open reduction.

In summary, open reduction still has complication and is usually related to operative technique. No previous study has reported the long-term outcome between open and closed method in each site of the condyle. The results should be weighed between early complications of the open method and late complications of the closed method.

## Conclusion

Closed reduction of condylar fracture in unilateral fracture has favorable long-term outcome. The factor of malocclusion is dislocated subcondylar bilateral fractures of condyle. The factor of clicking sound is in unilateral fracture head of condyle.

## What is already known on this topic?

Treatments of condylar fracture are either closed reduction with MMF or open reduction with internal fixation. Although they are common fractures of facial bones, no gold standard exists to treat condylar fractures and management remains controversial. The advantage of open reduction with internal fixation is that patients do not have to suffer with MMF but the disadvantages are prolonged operative time, difficult procedures, risk of facial nerve injury, and facial scar from surgery. In contrast, the advantages of closed reduction with MMF are short operative time, common procedures, and no risk of facial nerve injury or facial scarring. The main disadvantage is patients suffer from MMF. Hence, no comparative study has shown the best result of these methods and outcome remains inconclusive.

## What this study adds?

Closed reduction is the main treatment method in Phramongkutklao Hospital but the predictive factor of long-term outcome has never been conducted. The objective was to establish the predictive factor of long term outcome of closed reduction of condylar fractures of the mandible including occlusion, pain at rest and when chewing, interincisal distance, clicking sound of TMJ, facial asymmetry, and radiologic change. The results of this study showed closed reduction of condylar fracture in unilateral fracture has favorable long-term outcome. The predictive factor of malocclusion is dislocated subcondylar bilateral fractures of condyle. The predictive factor of clicking sound is unilateral fracture head of condyle.

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## Potential conflicts of interest

The author declares no conflict of interest.

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