Open versus closed reduction of mandibular condyle fractures : A systematic review of comparative studies

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Abstract

Objective : The objective of this review was to provide reliable comparative results regarding the effectiveness of any interventions either open or closed that can be used in the management of fractured mandibular condyle

Patients and Methods : Research of studies from MEDLINE and Cochrane since 1990 was done. Controlled vocabulary terms were used. MeSH Terms were " Mandibular condyle" AND "Fractures, bone". Only comparative study were considered in this review using the "limit" function. According to the criteria, two review authors independently assessed the abstracts of studies resulting from the searches. The studies were divided according to some criteria, and following were measured: Ramus height, condyle sagittal displacement, condyle Towns' s image displacement, Maximum open length, Protrusion & Lateral excursion, TMJ pain, Malocclusion, and TMJ disorder.

Results : Many studies were analyzed to review the post-operative result of the two methods of treatment. Ramus height decreased more in when treated by closed reduction as opposed to open reduction. Sagittal condyle displacement was shown to be greater in closed reduction. Condyle Town' s image condyle displacement had greater values in closed reduction. Maximum open length showed lower values in closed reduction. In protrusive and lateral movement, closed reduction was less than ORIF. Closed reduction showed greater occurrence of malocclusion than ORIF. However, post-operative pain and discomfort was greater in ORIF.

Conclusion : In almost all categories, ORIF showed better results than CRIF. However, the use of the open reduction method should be considered due to the potential surgical morbidity and increased hospitalization time and cost. To these days, Endoscopic surgical techniques for ORIF (EORIF) are now in their infancy with the specific aims of eliminating concern for damage to the facial nerve and of reducing or eliminating facial scars.

Before performing any types of treatment, patients must be understood of both of the treatment methods, and the best treatment method should be taken on permission.

Key words
Mandibular condyle fracture, Open reduction, Close reduction, Systematic review

INTRODUCTION

The treatment options for mandibular condyle fractures include closed and open techniques for reduction and fixation. Open techniques can be accomplished with extraoral and transoral approaches, whereas closed methods include intermaxillary fixation with bone or dental ligations or both. And, Open reduction does not necessarily mean rigid fixation. Open reduction merely means that a fracture has been anatomically reduced with verification via direct visualization through an open approach. Subsequent to reduction, some form of fixation may be used to stabilize the fracture[1]. Although it has now been recognized that ORIF(Open reduction intermaxillary fixation) provides better functional reconstruction of mandibular condyle fractures than

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CRMMF(Closed reduction and maxillomandibular fixation), attempts have been made to limit the potential adverse postoperative sequelae associated with ORIF.

There is a lot of methods or fixation schemes that have been used to stabilize mandibular condyle fractures in open reduction. There are use of a urethral sound, condylectomy, intraosseous or transosseous wire fixation, intramedullary pins, traction screw osteosynthesis with combination nut at angle, long screw placement, onlay-inlay splint, miniaturized dynamic compression plates designed for zygoma fractures, free graft with wire fixation after extracorporeal avulsion, disk repair with silicone rubber implantation, axial anchor screws, rigid plates and screws, bioabsorbable plates and screws, etc.[1].

Today, for dislocated fractures, open approaches are considered as the treatment of choice in many units. However, for moderately displaced condylar fractures, open treatment is still controversial. Specific indications for open reduction based on the degree of dislocation and concomitant subjective symptoms[2]. Previously reported retrospective studies demonstrated a better anatomical position after operative treatment[3]. Haug RH et al. reported for the absolute indications of ORIF[4]. It was considerated patient preference, manipulation which can not re-establish pretraumatic occlusion and/or excursions, addressing other fractures affecting the occlusion, and stability of the occlusion limited.

After treatment for condyle fractures, there were various complications. In the use of the open reduction method, potential surgical morbidity and increased hospitalization time and cost should be considera[15]. Whereas, After closed functional treatment, considerable malalignment (notably in the anterior posterior direction), distinctive changes in condylar form (flattening of the articular condylar surface) and resorption of the fractured condyle were frequently seen. De Riu et al. suggested that, in the long term, incomplete anatomical restoration in non-surgical methods can cause facial asymmetry and inclination of the occlusal plane, as well as functional occlusal problems, such as premature contact in protrusion and lateral protrusion[6]. Complications such impaired masticatory function and pain located to the affected joint or masticatory muscles were seen significantly more frequent in patients treated surgically[5]. Whereas, Patients treated by closed techniques had a significantly greater percentage of malocclusion compared with patients treated by open reduction. It is possible that the main reason for development of many of the complications was the inability of the patient to overcome the different neuromuscular and other functional problems induced by an unrepositioned subcondylar fracture[8].

There were a lot of controversies over a medical treatment in a condyle fracture than the other parts of trauma on a face. There have been many studies about the choices of the treatment compared with after effects, complications, etc. The objective of this review was to provide reliable comparative results regarding the effectiveness of any interventions either open or closed that can be used in the management of fractured mandibular condyle.

MATERIALS AND METHODS

1. CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

(1) Types of studies

Only comparative studies were considered in this review. Therefore, there were a number of types, as randomized clinical trials, controlled clinical trials, research report, and case report.

(2) Types of participants

There were no limits on age or gender. It did not classify or exclude according to reasons for the fracture. It also did not have any restriction by laterality or both sides of the fractures. It included the cases of having other fractures in other parts.

(3) Types of intervention

Any form of open and closed method of reduction and fixation was included.

2. SEARCH METHOD

(1) Database searched

We searched in MEDLINE and Cochrane (studies published after 1990).

(2) Search term

The controlled vocabulary terms (MeSH) were used

a. Pubmed : 1,040 studies was found by a computer search with the keywords, "Mandibular condyle" AND "Fractures, bone" [MeSH]. I have searched

again for a comparative study in the previous result using a search function 'limit' and I have found 65 of them.

b. Cochrane : I have searched with the keywords, "mandibular condyle" AND "mandibular fractures." As a result, I have gotten the same results as Pubmed.

(3) Language

There was a "English" language restrictions on the included studies.

3. METHODS OF THE REVIEW

(1) Evaluation for searching result

a. Description of studies

Two review authors independently assessed the abstracts of studies resulting from the searches. we have excluded the papers other than the ones compared with the results of open and closed operations like the ones that compared with fractures displaced and not displaced, condyle fix for each part, and operation materials such as a miniplate, etc. 17 papers have been selected by these standards(Table 1). In Table 2, it shows a list of the main inclusion criteria and exclusion criteria used in the included studies.

b. Characteristics of the interventions

The surgical methods for ORIF used in included studies show in Table 3.

(2) Assessment of methodological quality and quantity

The master data set included variables categorizing the quality and quantity

a. Study method

- Study quality (Table 4)

b. Participants

- Sample size categories (Table 5)
- Graph showing the quantity and quality of the studies used in the analyses (Fig. 1)
  - i) Follow-up losses (Table 6, Fig. 2)
  - ii) Evaluation by whether it has a clear statement of a reason for not having f/u in it or not
- There are 3 studies which have the statement of a reason for not having f/u among 17 in total (Table 7).

(3) Intervention

a. Treatment option

We have checked how ORIF and Closed reduction are described about participants. There are some papers which choose an operation method with clear standard. They have chosen whether they operate ORIF or not

Table 1. List of the included studies

Author of study	Year of publication	Journel of publication
Ishihama K[18]	2007	Cranio
Eckelt U	2006	J Craniomaxillofac Surg
Stiesch-scholz et al	2005	J Oral Maxillofac Surg
Hlawitschka	2005	Int J Oral Maxillofac Surg
Throckmorton GS	2004	J Oral Maxillofac Surg
Yang WG	2002	J Trauma
De Riu G	2002	Int J Oral Maxillofac Surg
Haug RH	2001	J Oral Maxillofac Surg
Throckmorton GS[19]	2000	Int J Oral Maxillofac Surg
Ellis E 3rd	2000	J Oral Maxillofac Surg
Ellis E 3rd	2000	J Oral Maxillofac Surg
Palmieri C	1999	J Oral Maxillofac Surg
Santler G[20]	1999	J Oral Maxillofac Surg
Widmark G	1996	Int J Oral Maxillofac Surg
Worsaae N	1994	J Oral Maxillofac Surg
Konstantinovic VS[12]	1992	J Oral Maxillofac Surg
Takenoshita Y	1990	J Oral Maxillofac Surg

Table 2. list of the main inclusion criteria and exclusion criteria used in the included studies

List of the main inclusion criteria used in the included studies
● Age 16 to 70 years
● Medically able to undergo surgical intervention
● Sufficient bilateral dentition to allow maxillomandibular fixation (MMF) and assessment of occlusal relationships
● No history of TMJ dysfunction
● No gross pretraumatic skeletal malrelationship of the jaws
● Patient consent to participate
● Unilateral or bilateral condylar fracture
● Degree of displacement of the condylar fragment in the frontal or sagittal plane: 10-451
● Shortening of the height of the ascending ramus of the mandible: × 2 mm.
● Intracapsular condyle fx.
List of the main exclusion criteria used in the included studies
● Patients failed to appear at the 1- year follow-up
● High subcondylar fx.
● Pre-existing skeletal discrepancies with malocclusion
● Pre-existing pathological conditions of the temporomandibular joints.
● The study protocol required an informed and active decision by the patient.
● Patient with intracapsular fractures
● Patients not have recordings of unilateral chewing
● Hospital. Patients with age less than 16 years
● Patients associated midface fractures
● Bilateral condylar process fractures
● Patients did not show up for postoperative clinical examination
● Patients underwent open reduction without rigid fixation.
● Patients had infection of the condylar fragment
● Patients had maxillary fractures.
● Exclusion of condylar head, comminuted, medial pole fx.
● Intracapsular fx.

Table 3. The surgical methods for ORIF used in included studies

The surgical methods for ORIF used in included studies
● Internal bone plate and screw
● Transosseous wire osteosynthesis (0.3mm stainless steel wires)
● Titanium screw & compress screw, micromesh, absorbable polylactide screw
● Mini-dynamic compression plate & screw
● Endoscopie
● Miniplate, lag screw, osteosynthesis
● Short risdon / chamry miniplate, screws, stainless wires, Kirschner pin

based on a subjective symptom and excursion in a study[2]. Also, there are the cases that let a patient choose it. They have let their patients choose their operation method in a study[10].

b. Doctor

We evaluated them if it is operated in one hospital or multi-centre. In a study, Eckelt U et al. reported that they operated in 7 hospitals[3]. Also, We checked how many operating surgeons are there. All the operation were done by a senior author in a study[5].

Table 4. Study quality

Category		Definig property
Fair	Clinical Trials	Case report
Average		Retrospective study
Good		Prospective study
Better		RCT

Table 5. Sample size categories

Category	Defining
Small	30 이하
Medium	31 to 100
Large	101 이상

Table 6. Follow-up losses

Value	F/U Range included
Fair	4~ 8 Months
Average	12 ~ 18 Months
Good	24 ~ 30 Months
Better	36 ~ Months

Table 7. The statement of a reason for not having follow-up

Study No.	Reason for loss
2	Patient refusing
6	An error of measuring person number was seen
54	Died, not possible to locate, moved to other parts of the country, not respond to the f/u call

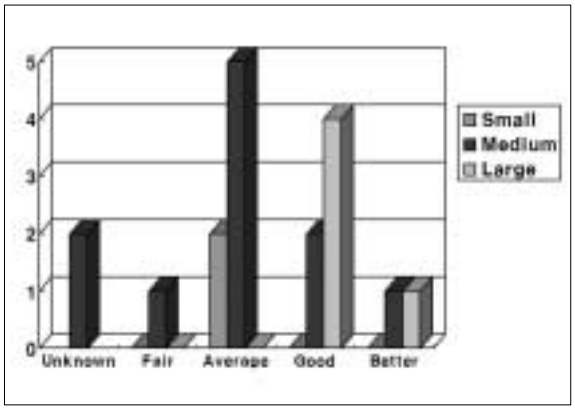

Fig. 1. Graph showing the quantity and quality of the studies used in the analyses.

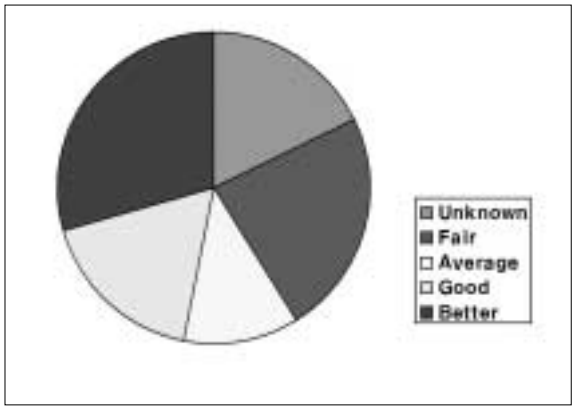

Fig. 2. Evaluation follow-up losses.

(4) Outcomes

Check how many surveyors are there and how many times they operate to reduce errors. Almost all studies did not mention surveyors. A physician and two surgeons did the evaluation in a study[7]. They blindly operated to reduce a bias.

4. STATISTICS ANALYSIS METHOD

(1) Analysis of a logistic recurrence

It is a popular method when analyzing a relationship between dependent and independent variables.

(2) Process

We compared with the average value of the results from each operation in various studies. We let ORIF (a

Table 8. Result Analysis

		B	S.E.	Wald	P-value	OR	95% confidence interval for EXP(B)	
							The Upper limit	The Lower limit
1. Ramus height	independent variable	.263	.264	.996	.318	.063	.045	1.289
	constant	1.143	1.556	.540	.462	.263		
2. Sagittal displacement	independent variable	-2.113	1.049	4.057	.044	.121	.015	.945
	constant	.866	1.406	0.379	.538	2.377		
3. Town's Image	independent variable	-0.279	.114	5.926	.015	.775	.605	.947
	constant	3.296	1.610	4.192	.041	.050		
4. TMJ pain	independent variable	.009	.010	.236	.013	.017	.002	.945
	constant	.021	1.633	.122	.023	.001		
5. Maximum opening	independent variable	8.246	4.467	.000	.991	.012	.000	.122
	constant	3.275	3.417	.000	.991	.		
6. protrusive movement	independent variable	12.590	1.818	.000	.991	.003	.000	.135
	constant	7.556	77.112	.000	.992	6		
7. lateral movement	independent variable	.008	.016	.233	.629	.092	.090	1.024
	constant	-1.075	.845	1.617	.204	.341		
8. malocclusion	independent variable	-0.701	.438	2.559	.110	2.016	.854	4.760
	constant	-12.076	6.762	3.189	.074	.000		

patient group) be 1 and Closed reduction (a comparative group) be 0, which is a basis for a dependent value. We presented OR value for a relationship between an operation and a measurement parts. The estimates of effect of an intervention were expressed as odds ratios (ORs) together with 95 % confidence intervals. (CIs)

RESULT

If you analyze a probability of heed in B and OR values from a result table, there is a big difference in an average value and a unit for each study. We did not think of them as a good average value from the result table as long as the values are somewhat different by a weight value of data in logistic recurrence analysis and it is analyzed with an average data to do recurrence analysis. It was not a good idea to understand that you make a recurrence analysis data logically fitting into an average value. It was needed to analyze how to see + and - and a size of B value generally. We thought of that as an increase if a calculation is + and a decrease if it is -. It shows OR value increases several times (Table 10).

1. Changes in radiographic images

(1) Ramus

As a result, closed reduction reduces after an operation showing B = .063 and OR = 3.138 to look at ORIF and closed reduction in Ramus height through a logistic recurrence analysis.

Hlawitschka M et al. performed to evaluate and compare the results of open and closed treatments of diacapitular fractures of the mandible. Following ORIF patients showed better radiological results with regard to the mandibular ramus height, resorption and pathological changes to the condyle, compared to the patient group after closed functional treatment[9].

Yang WG et al. compared the functional results of unilateral mandibular condylar process fractures treated either by open reduction or by closed treatment[5]. Comparison of displacement parameters in subcondylar fractures between open reduction and closed treatment groups revealed a statistically significant difference in vertical shortening and coronal angulation[5]. Patients undergoing open reduction had more severe displacement than those undergoing closed treatment[5]. Ellis E 3rd et al. reported that patients whose were treated by closed methods had significantly shorter posterior facial

and ramus heights on the side of injury, and more tilting of the occlusal and bigonial planes toward the fractured side, than patients whose fractures were treated by open methods[10].

(2) Displacement in Sagittal view

Closed reduction is higher after an operation showing B = -2.113, OR = .121 by looking at ORIF and closed reduction in Sagittal displacement.

Palmieri et al. compared mandibular and condylar mobility after open or closed treatment for fractures of the mandibular condylar process[11]. Measures of condylar process displacement at the initial (pretreatment) time showed that patients who subsequently were in the open treatment group had, on average, twice the amount of displacement in the coronal plane than those who subsequently underwent closed treatment[11]. The condylar displacement was surgically eliminated. Therefore, the initial (post-traumatic, pretreatment) amount of displacement does not seem to affect motion outcomes for patients with condylar neck or subcondylar fractures treated by open reduction if the normal condylar position can be restored with surgery.

(3) Displacement in Town' s image

Closed reduction is higher after an operation showing OR = .775 by looking at ORIF and closed reduction of a malposition angle in Town' s image.

In Palmieri et al. study, Comparison of displacement variables between the closed and open groups showed that there was still a statistically significant difference in the coronal position of the condylar processes and in the amount of vertical overlap[11]. Konstantinovic et al. reported that The radiographic examinations showed a statistically better position of the surgically reduced condylar process fractures[12]. However, There was no significant clinical difference between patients with surgically and those with conservatively treated unilateral condylar process fractures[12].

2. Temporomandibular joint disorder

Closed reduction is frequently after an operation showing B = 0.009, OR = .017 by looking at ORIF and Closed reduction in TMJ pain. Yang WG at el. Reported that the closer the fracture site is to the TMJ, the greater the probability of TMJ injuries. Temporomandibular joint injuries, such as capsular rupture, disc disruption, and condylar head dislocation, often accompany condylar fractures[5]. Therefore, TMJ symptoms occurred more frequently in the condylar subgroups than in the subcondylar subgroups[5]. In this study, patients treated with open reduction or closed treatment did not reveal a significantly functional difference[5]. For subcondylar fractures, open reduction provides satisfactory functional results in patients with severely displaced fractures[5]. In the patients treated open reduction, the incidence of TMJ pain and significant chin deviation seemed less compared with closed treatment[5].

3. Changes in motion

(1) Maximum opening

Closed reduction is lower after an operation showing B = -8.246 and OR = .012 by looking at ORIF and closed reduction in a maximum opening.

Eckelt U et al. compared operative and conservative treatment of displaced condylar fractures of the mandible. The range of movement was assessed by maximal mouth opening, protrusion and lateral excursion (Fig. 8). In the closed treatment group the average interincisal distance postoperatively was 40.9 mm(SD 6.7) and in the operatively treated group 46.5mm (SD 5.3). Throckmorton GS et al. determined the rate of recovery of mandibular motion in patients treated for fractures of the mandibular condylar process[13]. Patients treated open will have reduced maximum opening initially, but may reach normal levels of opening sooner than patients treated without surgery. Patients treated open recover more of their maximum opening, and recover more quickly than patients treated closed[13]. Widmark G et al. compared the results between two groups of patients in 1 year after trauma[2] Surgical correction normalized faster in opening incisor pathways during mastication[4].

(2) Protrusive movement

Closed reduction is lower after an operation showing B = 12.59 and OR = .003 by looking at ORIF and closed reduction in a protrusive movement.

Eckelt U et al. observed that in the closed treatment group the average range of protrusion was significantly less (p0.0005) with 4.7mm (SD 2.5) when compared with 7.3mm (SD 2.0) in the operatively treated group[3].

(3) Lateral movement

Closed reduction is lower after an operation showing B = .008 and OR = .092 by looking at ORIF and closed reduction in a lateral movement.

Haug RH et al. reported no statistically significant differences were noted between groups for range of right and left lateral excursion[4]. However, Throckmorton GS et al. reported that lateral excursion toward the non-fracture side remained significantly smaller in all patients treated closed at 3 years after fracture[13].

4. Malocclusion

Closed reduction is frequent after an operation showing B = -.701 and OR = 2.016 by looking at ORIF and closed reduction in a malocclusion.

Yang WG et al compared the functional results of unilateral mandibular condylar process fractures treated either by open reduction or by closed treatment[5]. Generally, acceptable facial symmetry and occlusion were obtained in all patients no matter which treatment was used[5]. However, De Riu G et al. Reported that open reduction gave better occlusal results, anatomic restoration and faster recovery rates than non-surgical techniques[6]. And In this study, there was no difference greater than 2 mm between maximum intercuspation and centric relationship (MI-RC) in the surgically treated group[6].

DISCUSSION

The objective of this review was to provide reliable comparative results regarding the effectiveness of any interventions either open or closed that can be used in the management of fractured mandibular condyle[9]. Because the condylar displacement was surgically eliminated and fixed anatomically by open reduction, we could expect to have more good result than closed reduction. In a study, neither the degree of dislocation of the proximal fragment, concomitant mandibular fractures, nor the absence of posterior occlusal support seemed to influence the results of comparison between open and closed reduction[8].

In our study, Ramus height decreased more in when treated by closed reduction as opposed to open reduction. Sagittal condyle displacement was shown to be greater in closed reduction. Condyle Towns' s image condyle displacement had greater values in closed reduction. Maximum open length showed lower values in closed reduction. In protrusive and lateral movement, closed reduction was less than ORIF. Closed reduction showed greater occurrence of malocclusion than ORIF. However, post-operative pain and discomfort was greater in ORIF.

In almost all categories, we could know that ORIF showed better results than closed reduction. However, the use of the open reduction method should be considered due to the potential surgical morbidity and increased hospitalization time and cost. Therefore, Endoscopic surgical techniques for ORIF (EORIF) are now in their infancy with the specific aims of eliminating concern for damage to the facial nerve and of reducing or eliminating facial scars. Lee et al.[16] found that 37 of 40 patients treated with EORIF went on to uneventful healing. However, Lauer and Schmelzeisen[17] noted that in 1 of 3 patients, loose hardware required early removal due to insufficient fixation.

At present, in temporomandibular joint problems, there were not sufficient long-term data to support open reduction to prevent future joint problems. Patients treated for condylar process fractures by closed methods frequently develop a new articulation more inferiorly in the fossa, often at the bottom of the articulareminence[15]. In fact, arthritic changes, including remodeling, could occur with both open and closed reduction with about the same degree of frequency[15].

To these days, there is a number of technical and surgical controversies relating to the type of interventions that could be used. We should consider that before our performing any types of treatment, patients must be understood of both of the treatment methods, and the best treatment method should be taken on permission.

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