

**Evaluation of condylar fractures management: open vs. closed.**

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**Abstract**

**Introduction:** Mandibular condylar fractures can be treated with either conservative or surgical methods. Both these treatment modalities have different indications and contraindications; and advantages and disadvantages. The present study was conducted with the purpose of

comparing the outcomes of both the treatment modalities for mandibular condylar fractures.

**Aims/Objective:** The aim of this prospective clinical study was to evaluate the management of mandibular condyle fracture by open vs. closed technique and the objective of the proposed research work is to evaluate the effectiveness

of the open vs. closed technique of management of mandibular condyle fracture.

**Materials and Methods:** The present study included 30 patients aged 16-70yrs with moderately displaced condylar fractures, who were randomly divided into nonsurgical and surgical groups and were managed accordingly. The outcomes of both the techniques were discussed in terms of various parameters, pain, swelling, infection, parathesia, post-operative radiological assessment (condylar angulation and vertical ramus height), mouth opening, facial asymmetry and occlusion. All patients were followed up at 1<sup>st</sup> and 3rd week, 3 and 6 months.

**Statistical Analysis Used:** Descriptive and analytical statistics were calculated using the Statistical Package for Social Sciences version 20.0. The level of significance was evaluated using one sample t-test.

**Results:** Patients treated surgically showed better improvement in pain, swelling, parathesia, condylar angulation and vertical ramus height, mouth opening, facial asymmetry and occlusion in comparison with the patients managed conservatively. The results were observed for follow-up period upto 6 months. Intergroup comparison revealed statistically insignificant relation with the value of  $P > 0.05$ .

**Conclusion:** Our study concluded that surgery is inarguably preferred over conservative management of moderately and severely displaced condylar fractures. The present study provided valuable information and mandated further studies with larger sample sizes to come to definitive conclusions.

**Keywords:** Condylar fractures, closed reduction, Open reduction, Functional outcome.

## Introduction

Trauma to the face causes injuries to various facial components i.e facial skeleton, soft tissues, teeth etc. The

facial skeleton includes naso-orbito-ethmoid complex, supra-orbital structures, zygoma, maxilla and mandible. A thorough knowledge of diagnosis and surgical management of facial injuries is required for proper treatment and rehabilitation of the patient with facial trauma. Mandible is largest and strongest facial bone, but because of its prominence and position, it is commonly fractured at the time of maxillofacial trauma.<sup>1</sup> Various studies have reported that fractures of the mandible occur twice as often as midfacial fractures.<sup>1-2</sup> Over a period of 20yrs, the treatment of mandibular fractures has been changed. The use of wire osteosynthesis and intermaxillary fixation is decreased with time. Treatment with open reduction and internal fixation with miniplates is becoming more popular. The new advancements have resulted in improved mouth opening, maintenance of good oral hygiene, reduced chances of malocclusion and decreased weight loss.<sup>3</sup> The treatment of mandibular fracture is aimed at restoring the anatomical form and function, with establishment of proper occlusion. Traditionally, fracture fragments are reduced and immobilized using maxilla-mandibular fixation to achieve satisfactory occlusion by closed reduction methods like dental wiring with Erich arch bar, ivy loops, gunning splints and MMF screws. Closed reduction with functional therapy is considered relatively safe, because of less chances of injury to nerves and blood vessels, and no postoperative complications like infection or scars.<sup>4</sup> This method is especially suitable in pediatric patients as various complications such as loss of tooth bud, and delayed eruption of the growing teeth can be avoided. The disadvantages of closed reduction are inconvenience to the patient, restricted airway, weight loss, delayed recovery in normal mouth opening and chances of periodontal damage. With conservative

treatment using closed reduction, an abnormal excessive growth of the injured mandible may occur due to inappropriate reduction of bone fragments. The displacement of mandibular ramus or mandibular deviation upon opening is also observed after conservative treatment.

In the past two decades, the principles of immobilization are combined with the more recent advances of open reduction and internal fixation to treat a variety of maxillofacial fractures. The various advantages of these methods are patient convenience, maintaining normal joint function and avoiding the complications of immobilization.<sup>3,5</sup> A comprehensive knowledge of the principles and various treatment options are a necessity for the maxillofacial surgeon.

Among all mandibular fractures, the prevalence of condylar fractures is around 17.5% to 52%.<sup>6</sup> Various authors revealed that fractures of condylar process can cause pain, facial asymmetry, reduced mouth opening, deviation of the mandible and open bite.<sup>6</sup> With suboptimal treatment, ankylosis and internal derangement of temporomandibular joint (TMJ) may occur. The development of facial asymmetries is because of interference in growth, that either result from injury to the condylar cartilage or destruction of the condyle. The destruction of condyle in adults results in more subtle asymmetries because growth has already stopped in adults.

It was observed that patients treated by open reduction and internal fixation had less facial asymmetry than patients treated with closed methods. Thus the present study was conducted to examine the vertical facial symmetry, occlusion, and mouth deviation in group of patients treated by either open or closed methods, to compare the effectiveness of both techniques.

## **Materials and Method**

The study was conducted on patients visiting the outpatients department of Oral and Maxillofacial surgery. The study was approved from the Institutional ethical committee and informed consent was taken from all patients selected for surgery. Cooperative patients with good general health, having adequate bilateral dentition to allow MMF, with no pretraumatic skeletal malrelationship of jaw, having significant shortening of ramus ( $>$ or = 2mm) and with degree of displacement (10-45degree) in coronal and saggital plane, were included in the study. Medically compromised patients, pregnant females and patients not willing to give follow-up were excluded from study.

A total of 30 patients aged 16-70yrs were included in study, with 19 patients having unilateral condylar fracture and 11 patients with bilateral condylar fracture. These patients (n=30) were randomly divided into two groups i.e. Group A and Group B (n=15). Group A consisted of 15 patients (unilateral condylar fracture-9 and bilateral condyle fracture-6) treated with closed reduction intermaxillary fixation by using Erich arch bar and wire followed by maintaining of the fixation of the Maxilla and Mandible(MMF) for 2 to 4 weeks. Group B consisted of 15 patients (unilateral condyle fracture-10 and bilateral condyle fracture-5) were treated with open reduction by using various approaches followed by Maxillo- Mandibular Fixation (MMF) for 2 to 8 weeks.

A thorough medical history was taken along with recording time, date and mode of injury, and time of reporting to the department with a detailed clinical examination. The oral cavity was cleared of blood clots, tooth fragments and debris. A temporary stabilization of fractured fragments was done where necessary. The face and the oral cavity were examined for signs of soft

tissue injuries and neurological deficit. All wounds were debrided and lacerated wounds were sutured. Inj. tetanus 0.5 ml IM was administered and patients were kept on antibiotics and analgesics. Diagnosis of the patients was made on the basis of clinical examination and radiographic study. Routine hematological and radiographic investigations were done. Patients were given 1.5gm ceftriaxone +sulbactam after antibiotic sensitivity done one hour prior to treatment intervention.

#### **Closed reduction and functional therapy method**

Erich arch bar was placed and fixed with 24 and 26 gauge soft stainless steel wires under local anaesthesia in complete aseptic conditions. Intermaxillary fixation was done with the help of elastic for 2 to 4 weeks in intracapsular and 2-8 weeks in extracapsular fracture patients. After achieving stable union of the fractured site, elastics were removed and soft diet is maintained for 2 weeks. Functional therapy with passive mandibular movement and mouth opening exercises were carried out and then clinical outcomes were observed (Figure 1 and 2).

**Open Reduction Method** (Figure 3, 4 and 5): Erich arch bars were placed preoperatively or intraoperatively in patients under General anaesthesia (Naso-Tracheal Intubation) or local anaesthesia maintaining complete aseptic conditions. The fracture sites were exposed through submandibular, extended submandibular, post ramal / hind's / retromandibular, preauricular or combined approach (submandibular +preauricular), as required. The incision was made with no. 15 surgical blade extending through the skin and subcutaneous tissue (Figure 4A). The skin was undermined with scissors in all directions for ease of retraction and blunt dissection was continued along the direction of facial nerve. The facial artery or vein encountered were retracted in the flap or ligated

wherever needed. The layer wise exposure was done to reach the fracture site (Figure 4B).

The fracture was reduced (Figure 4C), followed by maxillomandibular fixation with 26 or 24 gauge stainless steel wires to achieve proper occlusion. A delta plate or straight plate or L or Y plate was selected, contoured and placed along the ideal line of osteosynthesis as described by Champy et al.<sup>7</sup> In condylar and subcondylar fracture, either one point fixation using delta, straight, L or Y titanium plates in 2 mm or 1.5 mm system or two point fixation in combination of these plates was done (Figure 4D). The plate was adapted at the most posterior lateral border of condylar or subcondylar and ramus region of mandible keeping atleast two holes on each side of fracture line for single plate fixation and second miniplate at 45° to the first plate for two plate fixation. Holes were drilled using drill bit along with copious saline irrigation to prevent bone damage by excessive heat and screws were tightened in the drilled holes. IMF was released to check the occlusion by moving the mandible. The closure is done in layers with 3-0 vicryl and 4-0 prolene (Figure 4E). All patients were put on IMF from first postoperative day for 3-4 weeks.

Patients were assessed for pain, swelling, infection, parathesia, post-operative radiological assessment (condylar angulation and vertical ramus height), mouth opening, facial asymmetry and occlusion. All patients were followed up at 1<sup>st</sup> and 3<sup>rd</sup> week, 3 and 6 months. The data collected was subjected to statistical analysis using SPSS software version 20.0.

#### **Results**

A total of 30 patients, 25 males and 5 females, aged 16-70yrs old were selected for the study. The most common age group was 16-33yrs (40%), followed by 34-51yrs (33.33%) and 52-70yrs (26.66%). The present study revealed that the most common cause of injury was road

traffic accident (60%) followed by physical assault, fall and other types (13.3% each). The present study was conducted to examine and compare the vertical facial symmetry, occlusion, and mouth deviation in both the groups before and after treatment with either open or closed methods.

Pre-operative occlusion was found to be deranged in 4 patients out of 15 in Group A and 10 patients out of 15 in Group B. The occlusion was normal in 16 patients out of 30 in both the groups. Post-operatively patients in both the groups attained normal occlusion (Table no. 1). Pain status was analyzed using VAS scale and it was observed that level of pain got decreased from 1<sup>st</sup> week till 6<sup>th</sup> month post-operative. One sample t-test statistical analysis was conducted and an insignificant relation was observed between both the groups (Table no. 2). In group B, patients suffering with paraesthesia were less than Group A, showing a statistically insignificant relation between both the groups (Table no. 3).

In Group A, at 1st week follow up two patients were presented with infection and in Group B, three patients were presented with infection. At 3rd week, one patient presented with infection in Group A and two patients in Group B, which got resolved by giving IV antibiotics. At 3rd and 6th months follow up, none of patient presented with infection in any group. Statistically, an insignificant relation was observed between both the groups (Table no. 4).

The ramus height shortening was >2mm pre-operatively in 11 patients in Group A and 5 patients in Group B and <2mm pre-operatively in 4 patients in Group A and 10 patients in Group B. After regular follow up of 6 months the ramus height was <2mm in both treatment groups. Statistically in both the groups, relation was found to be insignificant (p-value>0.05), (Table no. 5).

The mean of inter-incisal distance pre-operatively in Group A was 27.87 mm and in Group B was 26.67mm (Table no. 6). After regular follow up of 6 months the mean mouth opening in Group A was 34.0mm and 34.67 mm in Group B, with statistically insignificant correlation between both the groups (Table no. 7).

### **Discussion**

The present study consisted of 25 male (83.3%) and 5 female patients, showing a male dominance. Similar findings were reported in a study by Erol B et al.<sup>8</sup> This shows that the males are more prone to situations in which there is high risk of trauma. The present study showed that road traffic accidents were the main cause of mandibular condylar fracture in 18 cases (60%). Similar findings were observed by Singh V et al.<sup>9</sup> in their study. In the present study, the age group commonly affected was 16-33 years (40%) followed by 34-51 years (33.3%). Zachariades N et al.<sup>10</sup> also observed that adults below 35yrs of age are more prone to mandibular fractures.

Now-a-days, open reduction and internal fixation are considered as the treatment of choice for dislocated fractures. However, for moderately displaced condylar fractures, open reduction is still controversial.<sup>11</sup> In the present study, we observed that there was no significant change in shortening of the ascending ramus and angulation of fragments even after 6 months. In open reduction group, both these parameters were significantly improved. The present study revealed that various functional parameters like pain, discomfort, paraesthesia etc., reduced significantly in patients of open reduction group. Similar findings have been observed in previously reported retrospective studies that also demonstrated better outcome with open treatment.<sup>12</sup>

Restoration of the pre-morbid occlusion is one of the most important goals of the management of fractures of mandibular condyle. Functional outcomes with closed and



open reduction were compared in various studies. In present study, we observed better occlusal stability with open reduction method than closed reduction. Similar findings were observed by Ellis E 3<sup>rd</sup> et al.<sup>13</sup> who observed a higher rate of occlusal disturbance after closed treatment. Throckmorton GS et al.<sup>14</sup> also reported more favourable outcomes after open reduction.

In this study, level of paraesthesia reduced in both the groups with time. Statistically it was found to be insignificantly correlated. Similar findings were observed in study by Niezen ET et al.<sup>15</sup> In this study, it was observed that treatment with open reduction caused more chances of infection than closed reduction. Similar results were found in study by Chrcanovic BR.<sup>16</sup>

The operative approaches and method of internal fixation used in our study differed depending on the degree of displacement and location of the fracture. With any of method used, a clear trend for better results was observed in the open treatment group. Similar results were observed by Hide N *et al.*<sup>17</sup> who reported that there was no difference in functional outcomes with different operative options. In contrast, few studies found functional outcome varies with different operative options.<sup>18</sup>

It has been observed that the development of stable osteosynthesis modalities with miniplates and lag screws and the further development of surgical approaches have reduced the operative treatment and gave functional advantage of earlier mobilization of the traumatised tissues.<sup>19-21</sup> In terms of facial asymmetry, similar to findings of our study, Ellis E 3<sup>rd</sup> et al.<sup>22</sup> observed a shorter facial height on the injured side after closed treatment.

We observed that the ramus height shortening was observed in patients treated with closed reduction. The ramus height was calculated by drawing horizontal line passing through most prominent part of mandibular angle and two vertical lines drawn perpendicular to this

horizontal line, connecting the most prominent part of mandibular angle to the highest point of condyle.<sup>19</sup> The degree of angulation was measured by drawing a midline axis of ramus\neck stump which is the centre line parallel to best fitting border of condylar process. The mean mouth opening increased in both the groups, with an insignificant statistical difference. Similar findings were observed by Hlawitschka M et al.<sup>23</sup>

We used titanium plates that are the most biocompatible material known so far. Thus, it was not a wise decision to remove plates and screws at such a short duration. However, AO/ASIF recommended that metallic implants should be removed. Various studies advocated that with miniplates, there is no need to remove the plates.<sup>22-24</sup>

The results of our study suggest that ORIF leads to better functional and subjective outcomes in case of moderately and severely displaced fracture as compared to closed reduction. We also observed that in case of undisplaced and moderately displaced fractures, closed reduction is a better choice of treatment. Whereas, open reduction and internal fixation of condylar fractures, lead to better condylar stability, stable occlusion, early return of TMJ functionality and improved aesthetics. In this study, the complications with the closed treatment were chronic pain, greater shortening of the ramus height, facial asymmetry, altered occlusal planes and higher percentage of malocclusions. Thus our study revealed that open reduction and internal fixation gives better and earlier results than closed reduction.

#### **Limitations of study**

1. The present study was conducted on limited number of patients. Thus, further studies should be conducted with more sample size.
2. Future studies should be conducted comparing biological and radiological outcomes of both the techniques.

3. More studies should be conducted to evaluate the outcome of both the techniques for various other types of facial fractures.



Figure 1: A) Pre-operative facial profile view; B) Panoramic radiograph depicting fracture line; C) Disturbed occlusion preoperatively; D) Reduced interincisal opening in Group A.

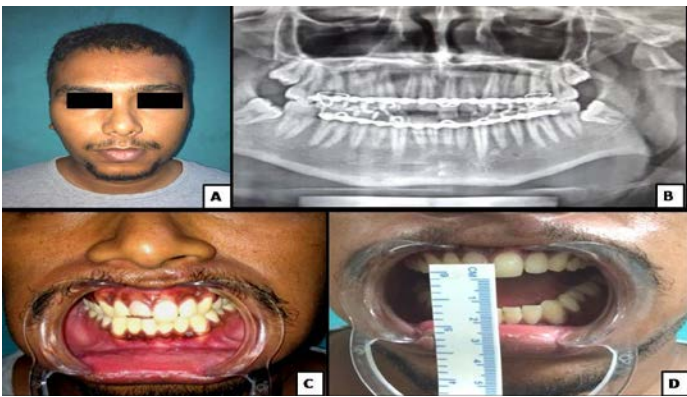


Figure 2: A) Post-operative facial profile view; B) Panoramic radiograph maxillomandibular fixation; C) Corrected occlusion postoperatively; D) Corrected interincisal opening in Group A.



Figure 3: A) Pre-operative facial profile view; B) 3D CBCT reconstructed image depicting fracture line; C) Disturbed occlusion preoperatively; D) Reduced interincisal opening in Group A.

Maxillomandibular fixation before surgery; D) Reduced interincisal opening in Group B.

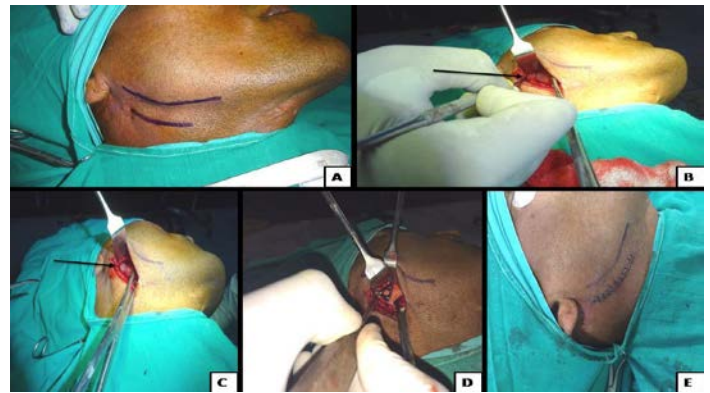


Figure 4: A) Marking the incision; B) Exposure of fracture site; C) Reduction of fracture; D) Fixation of fractured fragments; E) Closure of surgical site in Group B.

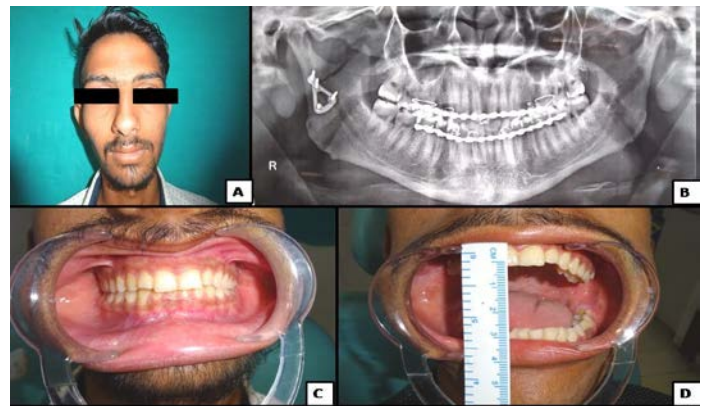


Figure 5: A) Post-operative facial profile view; B) Panoramic radiograph maxillomandibular fixation; C) Corrected occlusion postoperatively; D) Corrected interincisal opening in Group B.

Table 1: Distribution of study subjects and intergroup comparison using t-test according to pre and post-operative evaluation of occlusion

Occlusion	Pre – Op		Post – Op	
	Group A	Group B	Group A	Group B
Normal	6(40%)	10(66.6%)	15(100%)	15(100%)
Cross bite	6(40%)	4(26.6%)	0(0%)	0(0%)
Anterior Open bite	3(20%)	1(6.6%)	0(0%)	0(0%)
P-Value	0.128(NS)		1(NS)	

Table 2: Distribution of study subjects and intergroup comparison using t-test according to evaluation of pain at different time intervals.

Follow up period at (time interval)	Group A		Group B		p-value t-test
	Mean	SD	Mean	SD	
1 Weeks	1.87	2.03	3.13	2.416	0.131(NS)
3 Weeks	0.67	1.29	1.73	2.06	0.085(NS)
3 Months	0.20	0.414	0.53	1.125	0.029(S)
6 Months	0.07	0.258	0.07	0.258	1.00(NS)

Table 3: Distribution of study subjects and intergroup comparison using t-test according to evaluation of Paraesthesia at different time intervals.

Follow up period at (time interval)	Group A (n=15)		Group B (n=15)		p – value*
	No. of patients	%	No. of patients	%	
1 Weeks	2	13.3	1	6.6	0.550
3 Weeks	1	6.66	1	6.6	1
3 Months	0	0	0	0	1
6 Months	0	0	0	0	1

\*p-value>0.05 is insignificant.



Table 4: Distribution of study subjects and intergroup comparison using t-test according to evaluation of infection at different time intervals.

Follow up period at (time interval)	Group A (n=15)		Group B (n=15)		p – value*
	No. of patients	%	No. of patients	%	
1 Weeks	2	13.3	3	20	0.63
3 Weeks	1	6.6	2	13.33	0.550
3 Months	0	0	0	0	1
6 Months	0	0	0	0	1

\*p-value>0.05 is insignificant.

Table 5: Distribution of study subjects and intergroup comparison using t-test according to pre and post-operative evaluation of ramus height at different time intervals.

Group	PREOP		POST OP	
	A	B	A	B
>2mm	11(73.3%)	5(33.33%)	0(0%)	0(0%)
<2mm	4(26.7%)	10(66.7%)	15(100%)	15(100%)
P-value*	0.3		1	

\*p-value>0.05 is insignificant.

Table 6: Distribution of study subjects and intergroup comparison using t-test according to pre and post-operative evaluation of inter-incisal distance at different time intervals.

Mouth opening	Group	Mean	Std. deviation	P value*
Pre-Op	A	27.87	6.947	0.606
	B	26.67	5.563	0.606
Post-Op	A	34.0	4.706	0.679
	B	34.67	3.994	0.679

\*p-value>0.05 is insignificant.

Table 7: Distribution of study subjects and intergroup comparison using t-test according to pre and post-operative evaluation of facial asymmetrical at different time intervals

Group	PRE-OP		POST- OP	
	A	B	A	B
Present	2(13.3%)	4(26.7%)	0(0%)	1(6.7%)
Absent	13(86.7%)	11(73.3%)	15(100%)	14(93.3%)
P-value*	0.369		0.317	

\*p-value>0.05 is insignificant.

**Conclusion:** The treatment of mandibular condyle fracture should be selected considering patient’s age, fracture type, patient’s systemic status, associated fractures, status of dentition, and restoration of appropriate occlusion and existence of foreign materials. The advantages, disadvantages, and risk of each treatment, and complications should be discussed with patients and patient’s guardians before proceeding for treatment.

We also observed that in case of undisplaced and moderately displaced fractures, closed reduction is a better choice of treatment. Whereas, open reduction and internal fixation of condylar fractures, lead to better condylar stability, stable occlusion, early return of TMJ functionality and improved aesthetics in moderately and severely displaced fractures. Thus our study revealed that open reduction and internal fixation gives better and earlier results than closed reduction.

**Ethical Approval:** The study is approved by institute ethical board and IRB approval number is No.Dean/2018/EC/380.

**Patient Consent:** The subject gave informed to the work.

**References**

1. Liu Y, Bai N, Song G, et al. Open versus closed treatment of unilateral moderately displaced mandibular condylar fractures: a meta-analysis of randomized controlled trials. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2013;116:169–173.
2. Eckelt U, Hlawitschka M. Clinical and radiological

evaluation following surgical treatment of condylar neck fractures with lag screws. *J Cranio Maxillofac Surg* 1999;27:235–242.

3. Schneider M, Erasmus F, Gerlach KL, et al. Open reduction and internal fixation versus closed treatment and mandibulomaxillary fixation of fractures of the mandibular condylar process: a randomized, prospective, multicenter study with special evaluation of fracture level. *J Oral Maxillofac Surg* 2008;66:2537–2544.
4. Andersson J, Hallmer F, Eriksson L. Unilateral mandibular condylar fractures: 31- year follow-up of non-surgical treatment. *Int J Oral Maxillofac Surg* 2007;36:310-4.
5. Ellis III E, Throckmorton GS. Treatment of mandibular condylarprocess fractures: biological considerations. *J Oral Maxillofac Surg* 2005;63:115-134.
6. De Riu G, Gamba U, Anghinoni M, Sesenna E. A comparison of open and closed treatment of condylar fractures: a change in philosophy. *Int J Oral Maxillofac Surg* 2001;30:384-9.
7. Champy M, Loddé JP, Schmitt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. *J Maxillofac Surg* 1978;6(1):14-21.
8. Erol B, Tanrikulu R, Gorgun B. Maxillofacial fractures. Analysis of demographic distribution and

- treatment in 2901 patients (25 year experience). *J Craniomaxillofac Surg* 2004;32:308-12.
9. Singh V, Bhagol A, Dhingra R. A comparative clinical evaluation of the outcome of patients treated for bilateral fracture of the mandibular condyles. *J Craniomaxillofac Surg* 2012;40(5):464-6.
  10. Zachariades N, Mezitis M, Mourouzis C, Papadakis D, Spanou A. Fractures of the mandibular condyle: a review of 466 cases. Literature review, reflections on treatment and proposals. *J Craniomaxillofac Surg*. 2006;34(7):421-432.
  11. Smets LM, Van Damme PA, Stoelinga PJ. Non-surgical treatment of condylar fractures in adults: a retrospective analysis. *J Craniomaxillofac Surg*. 2003;31(3):162-167.
  12. Takenoshita Y, Ishibashi H, Oka M. Comparison of functional recovery after nonsurgical and surgical treatment of condylar fractures. *J Oral Maxillofac Surg* 1990;48(11):1191-1195.
  13. Ellis E 3rd, Throckmorton G. Facial symmetry after closed and open treatment of fractures of the mandibular condylar process. *J Oral Maxillofac Surg* 2000;58(7):719-28.
  14. Throckmorton GS, Ellis E 3rd, Hayasaki H. Masticatory motion after surgical or nonsurgical treatment for unilateral fractures of the mandibular condylar process. *J Oral Maxillofac Surg* 2004;62(2):127-38.
  15. Niezen ET, Bos RRM, de Bont LGM, Stegenga B, Dijkstra PU. Complaints related to mandibular function impairment after closed treatment of fractures of the mandibular condyle. *Int J Oral Maxillofac Surg* 2010;39(7):660-665.
  16. Chrcanovic BR. Surgical versus non-surgical treatment of mandibular condylar fractures: a meta-analysis. *Int J Oral Maxillofac Surg* 2015;44(2):158-79.
  17. Hyde N, Manisali M, Aghabeigi B, Sneddon K, Newman L. The role of open reduction and internal fixation in unilateral fractures of the mandibular condyle: a prospective study. *Br J Oral Maxillofac Surg*. 2002;40(1):19-22.
  18. Yao S, Zhou J, Li Z. Contrast analysis of open reduction and internal fixation and non-surgical treatment of condylar fracture: a meta-analysis. *J Craniofac Surg* 2014;25(6):2077-80.
  19. Eckelt U, Schneider M, Erasmus F et al. Open versus closed treatment of fractures of the mandibular condylar process-a prospective randomized multi-centre study. *J Craniomaxillofac Surg* 2006;34(5):306-314.
  20. Leon M, Ulloa C, Nunez C, Gazitua G, Cerda P: Surgical and non-surgical treatment of mandibular condylar fracture: a comparison of results. *Int J Oral Maxillofac Surg* 2011:1034.
  21. De Riu G, Gamba U, Anghinoni M, Sesenna E. A comparison of open and closed treatment of condylar fractures: a change in philosophy. *Int J Oral Maxillofac Surg* 2001;30(5):384-9.
  22. Ellis E 3rd, Throckmorton GS. Bite forces after open or closed treatment of mandibular condylar process fractures. *J Oral Maxillofac Surg*. 2001;59(4):389-95.
  23. Hlawitschka M, Loukota R, Eckelt U. Functional and radiological results of open and closed treatment of intracapsular (diacapitular) condylar fractures of the mandible. *Int J Oral Maxillofac Surg* 2005;34(6):597-604.
  24. Danda AK, Muthusekhar MR, Narayanan V, Baig MF, Siddareddi A. Open versus closed treatment of unilateral subcondylar and condylar neck fractures: a prospective, randomized clinical study. *J Oral Maxillofac Surg* 2010;68(6):1238-41.