

THREE DIMENSION RHOMBIC PLATES VERSUS TWO MINIPLATES FOR FIXATION OF UNILATERAL LOW SUBCONDYLAR MANDIBULAR FRACTURES

Khaled A. Saad*, Ibrahim M. Nowair** and Emad F. Esa**

ABSTRACT

This study was designed to evaluate the use of three dimension miniplates (rhombic) versus two miniplates for fixation of displaced low subcondylar mandibular fractures both clinically and radiographically.

Patients and methods: this study comprised 16 adult patients who required open reduction and internal fixation of the subcondylar fracture of the mandible via retromandibular approach. The patients were randomly divided into two equal groups. Group (I) comprised (8) patients treated with three dimension rhombic plates and group (II) comprised (8) patients treated with two non-compression miniplates. All patients were evaluated clinically for intraoperative complications of hemorrhage and damage of the marginal mandibular branch of facial nerve. Postoperative complications as occlusal discrepancy, function of TMJ, presence of infection and parotid fistula formation were evaluated at intervals: immediately, one week, two and six weeks and three months. Radiographically, via panoramic views, CT scans at three and six months.

Results: none of the patients suffered from any major complication intra operatively and postoperatively. All patients showed great satisfactions about the results of their treatment by these means of internal fixation through the retromandibular approach.

Conclusion: open reduction and internal fixation of subcondylar fractures using three dimensional rhombic plates giving better and excellent stability and neutralizes the changing strains in the condylar region and associated with minimal morbidity when fixed via retromandibular approach allowing early restoration of function and avoids prolonged maxillomandibular fixation.

KEY WORDS: 3D rhombic plate, low subcondylar fracture, retromandibular approach

INTRODUCTION

Mandibular fractures considered to be the third most frequent maxillo-facial fractures after those of

the nasal and zygomatic bones. The most common mandibular fracture is the condylar fracture, and condylar neck. Subcondylar fractures account

* Ass. Professor, Oral & Maxillofacial Surgery Dept., Faculty of Dentistry, Tanta University.

** Lecturer, Oral & Maxillofacial Surgery Dept., Faculty of Dentistry, Tanta University

for 17.5% to 52% of all mandibular fractures, the main causes of this type of fracture are road traffic accidents (approximately 75%), personal violence (20%) and falls (5%)^{1,2}.

Displacement of the proximal and distal bone fragments in patients with subcondylar fractures depends on the direction, degree, magnitude and precise point of application of the force, as well as the state of dentition and the occlusion¹.

Subcondylar fractures most commonly result in medial displacement or dislocation of the head of the condyle with a subsequent loss of ramus height which causes open bite and facial asymmetry³.

The available treatment strategies for mandibular subcondylar fracture are open or closed reduction with maxillomandibular fixation (MMF), conservative treatment that includes observation, analgesics, anti-inflammatory, soft diet and early physical therapy exercise^{4,5}.

Closed reduction has been the preferred treatment, but it requires varying periods of maxillomandibular fixation (MMF) up to 4 weeks and it may cause long term complications such as pain, ankylosis, internal derangement of the temporomandibular joint (TMJ), as well as the inadequate restoration of the vertical height of the ramus, can possibly occur⁶.

Closed reduction of mandibular fracture with MMF can adversely affect bone, muscle, synovial joint and periarticular connective tissues. The changes in muscles of mastication system have been documented following immobilization of mandible. In addition cortical and trabecular thinning, vascular distention and increased osteoclastic activity have been also described following joint immobilization⁷⁻⁹.

The debate continuous until now over how to manage subcondylar fractures adequately and the question of which fractures should be treated surgically has yet to be answered, however, in recent years, due to the enormous development of

the osteosynthesis techniques and the refinement of surgical techniques, the attitude towards the treatment of a condylar neck fracture has changed from an exclusively nonsurgical approach toward surgical treatment^{10,11}.

Anatomic reduction and early mobilization of the jaw following surgery have been considered important issues for the functional rehabilitation of the TMJ. When we operate on a subcondylar fracture, the treatment plan depends on, 1) whether open or closed reduction must be performed, 2) which approach to the fracture site will be used, and 3) what type of osteosynthesis is required¹².

The single-plate fixation technique does not provide sufficient strength to withstand the strains occurring in subcondylar fractures. Therefore, the authors advocate the use of a two-plate fixation technique, which seems to have the beneficial effect of restoring the tension and compression trajectories in subcondylar fractures. It needs to select the high profile plate (DCP) in order to create a stable load when treating subcondylar fracture^{12,13}.

The two-plate technique seems to be a gold standard in subcondylar fracture fixation but the insertion of many screws in a small condylar fragment is often difficult, particularly in the case of high subcondylar fractures. Miniaturized osteosynthesis devices are essential for stabilization of subcondylar fractures because of the small size of the subcondylar fragments. Therefore, several kinds of plates have been specifically designed for the stabilization of subcondylar fractures, and they were subjected to rigorous experimental testing before clinical use¹⁴.

Three dimensional osteosynthesis plating systems had been used in maxillofacial surgery since 1990, because of its smaller size combined with greater stiffness¹⁵.

Many specialized designed three dimensional plates as delta, trapezoid rhombic plates were used for fixation of subcondylar fractures¹⁶.

When doing open surgical treatment of mandibular condyle fractures, surgeons must resolve problems such as how to expose the fracture site sufficiently while reducing surgical trauma as much as possible, and how to achieve excellent reduction and fixation while avoiding injury of vital anatomic structures as facial nerve and its branches. A number of approaches have been used to help address these problems. The transparotid approach is considered to be an easy way to gain direct access to fractures of the mandibular ramus and condylar neck, allowing proximal anatomical reduction to be manipulated and fixed with miniplates¹⁷.

The modified retromandibular approach was shown to be a simple, short surgical procedure compared to the traditional retromandibular approach. It completely exposes the operative field, which aids reduction and fixation and substantially reduces risk to the facial nerve¹⁸.

Recently, use of the retromandibular transparotid approach in treating 28 patients with condylar neck or condylar base fractures was described as having a short access route, easy reduction, short operating time and stable postoperative occlusion without permanent damage from facial nerve injury, salivary leakage, or preauricular hypoaesthesia¹⁹.

However, the authors advise patients preoperatively that there may be temporary complications after the surgery. We viewed the advantages of the retromandibular transparotid approach as important aspects to retain as we developed a novel modified transparotid approach using a parotid mini-incision, which we hypothesized would reduce complications and enhance aesthetic outcomes as well.

This study was designed to evaluate the use of three dimension rhombic plate versus two miniplates in fixation of low subcondylar fracture both clinically and radiographically.

MATERIALS AND METHODS

This study was conducted on 16 adult patients suffering from unilateral subcondylar mandibular fractures who required open reduction and internal fixation type II (displaced) & type IV (dislocated), selected and treated at the Department of Oral and Maxillofacial Surgery, Tanta University, Egypt.

The patients included in our study, adult patients, patients had to be of age 18 years or older. Unilateral low subcondylar fractures type II & type IV. Displaced or dislocated fractures not operable by closed methods and the patients excluded from our study, patients with one or more of the following criteria: high subcondylar fracture, edentulous patients, subcondylar fracture in children, patients with systemic diseases that will affect tissue healing, patients with neurological deficit affecting the facial nerve, patients unable for long term follow up.

Patients were randomly divided into two equal groups (8 patients each).

Group I:

Eight patients with low subcondylar mandibular fracture reduced and internally fixed using three dimension rhombic plates via retromandibular approach.

Group II:

Eight patients with low subcondylar mandibular fracture reduced and internally fixed using two non-compression miniplates via retromandibular approach.

The patients were evaluated clinically and radiographically. Clinically, the patients were assessed for malocclusion, lateral deviation on opening, infection. The preoperative radiographs comprised panoramic views and CT scans to determine the degree of condylar displacement, and also to determine presence of additional mandibular fractures degree of displacement and presence of any pathological entities.

Informed consent was obtained from all patients who were enrolled in the study, after they received explanation of the advantages and disadvantages of open and closed reduction in vernacular language.

Surgical procedure

All patients were operated under general anesthesia via nasoendotracheal intubation, upper and lower arch bars were applied to all patients, and other fractures of the mandible were stabilized firstly by miniplate osteosynthesis after achieving optimum occlusion via intermaxillary fixation.

The fracture site of the subcondylar region was exposed via extraoral retromandibular approach.

The skin incision of this approach is located just posterior to the mandibular ramus and the most proximal point of the incision is just below the ear lobe, runs parallel down to the posterior border of the mandible, and is limited to 25 mm in length (Fig. 1).

After exposing the superficial musculoaponeurotic system (SMAS), a vertical incision is made through the SMAS behind the parotid gland. Blunt dissection is made through the parotid gland and masseteric



Fig. (1) Intraoperative photograph showing skin incision (retromandibular approach)

fascia towards the posterior border of the mandible.

The pterygomasseteric sling is thinned out until the bone surface becomes visible. A sharp cut is made through the periosteum at the posterior border of the ascending ramus, opening access to the whole ramus, which is dissected subperiosteally. The periosteum at the posterior border of the ramus is then incised, and subperiosteal dissection is continued to the condylar area until the fracture line and the dislocated proximal fragment are identified.

The fragment is then repositioned under direct visualization of the fracture line. Anatomical adjustment can be facilitated by pulling the mandible downwards. After aligning the fragment, the posterior border of the ramus and the mandibular notch serve as reference lines for correct three dimensional repositioning.

Osteosynthesis were carried out in group (I) using rhombic three dimensional plate 1mm profile.

The narrow side of the plate was fixed cranially and the wide side was fixed caudally with 2 mm screws diameter and 5-9 mm length. (Fig. 2)

While osteosynthesis in group (II) were carried out using two non-compression miniplates 1mm profile and screws of 2 mm diameter and 5-9 mm length applied one at the posterior border and the other plate fixed medial to it at a 5mm distance. (Fig 3)



Fig. (2) Intraoperative photograph showing 3D rhombic plate fixation of subcondylar mandibular fracture.

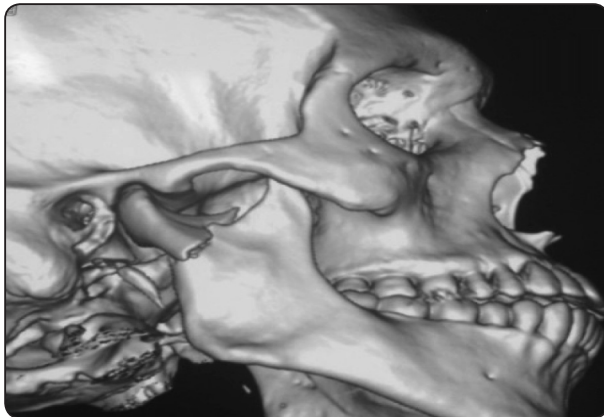


Fig. (3) Preoperative 3D C.T. showing right side subcondylar mandibular fractures (group 1).

Wound closure is performed in layers after checking mandibular mobility and dental occlusion. The skin sutures are removed one week postoperatively.

Postoperative medications for both groups: broad spectrum antibiotic; third generation cephalosporin (ceftriaxone 1gm vial IV twice daily for 5 days), analgesic (Epicotel vial IV twice daily), injection enzymatic anti-inflammatory α -chemotepsin vial intramuscularly twice daily, followed by oral medications three days. The patients were reviewed after surgery for six months.

Post-operative evaluation

The patients were assessed in terms of presence of infection at the operative site, signs of Fery's syndrome, parotid fistula formation, facial nerve palsy, postoperative scar discrepancy, occlusion, stability of fracture segments, TMJ function in the form of maximum mouth opening, restriction in the lateral movements, pain in periauricular region, clinically, crepitus or grating sounds and deviation at intervals of one week, two weeks, six weeks, and three months.

Patient's satisfaction concerning the treatment received was evaluated. The degree of satisfaction was quantified by asking the patient to rate the treatment received using a score from 0 to 10.

Radiographically

Panoramic views and CT scans with 3D reconstruction were done, three months and six months postoperatively

RESULTS

Sixteen patients with ages ranged between 18 and 45 years with a mean of 28.5 years old were treated with low subcondylar mandibular fractures via open reduction and internal fixation using either rhombic plates or two miniplates through extra oral approach. The time interval between trauma and operation was ranged from 3 to 15 days with a (mean of 7 days). The most common causes of fracture in all patients in our study of both groups were road traffic accidents (93.75%) except one case (6.25%) due to interpersonal fight. Postoperative follow up was done in all patients for a period of six months.

Twelve (75%) patients were male and four (25%) patients were female. Ten (62.5%) patients had left side subcondylar fractures and six (38.5%) had right side subcondylar fractures.

The mean time from starting the retromandibular incision to skin closure, including fixation showed significant difference as it was (80±12) min with a range of 80–100 min (SD 12) in group I, while it was (100±15) min with a range of 100-130 min (SD 16) in group II 87% of the patients of Group (I) presented with no any postoperative occlusal disturbance while the other remaining patients (12.5%) show mild postoperative occlusal disturbance due to premature dental contact, which corrected by postoperative intermaxillary fixation using gradual elastic traction for a period of two weeks. While in group II there were two patients, (25%) reported postoperative occlusal disturbance, were put also in postoperative intermaxillary fixation using gradual elastic traction for a period of three weeks, whereas the remaining six cases (75%) presented with normal occlusion, during the follow up periods.

All patients in both groups showed satisfactory centric occlusion after three months. None of the patients of both groups had facial nerve paralysis or paresis at the first clinical follow up.

Regarding soft tissue healing and skin scarring, there was uneventful soft tissue healing, of all patients in both groups except the first case in group II, linear scar was noticed but not developed into a keloid.

All cases showed no incidence of postoperative sialoceles that was because of the watertight closure of the parotid capsule.

TABLE (1) Post-operative mandibular motion values

Physiological values of the mandibular motion	Number of patients (16)
Maximal mouth opening (mm)	
> 40 mm	10 (62.5%)
< 40 mm	6 (37.5%)
Lateral movement contralateral to the side of the fracture (mm)	
> 8 mm	9 (56.25%)
< 8 mm	7 (43.75%)
Lateral movement homolateral to the side of the fracture (mm)	
> 8 mm	8 (50%)
< 8 mm	8 (50%)
Maximal protrusion (mm)	
> 8 mm	1 (6.25%)
< 8 mm	15 (93.75%)

Ten patients (62.5%) out of sixteen showed maximal mouth opening > 40 mm and six patients (37.5%) showed maximal mouth opening < 40 mm.

The lateral movement toward side contralateral to the fractured side was ranged between 3mm and 12mm (average, 8mm), nine patients (56.25%) out of sixteen showed lateral movement >8 mm, while the remaining seven patients (43.75%) showed lateral movement < 8 mm.

The lateral movement toward the fractured side was between 5 mm and 13 mm (average, 10 mm), eight patients (50%) out of sixteen showed lateral movement > 8 mm while the other (50%) patients showed lateral movement < 8 mm. with no statistically significant difference between the two sides.

The protrusion movements was ranged between 3 mm and 8 mm (average, 4.5 mm), one patients (6.25%) out of sixteen showed maximal protrusion > 8 mm while the other fifteen patients (93.75%) showed maximal protrusion < 8 mm. (**Table 1**)

All the sixteen patients showed a maximum opening without pain and it was between 25 and 50 mm (average, 37 mm) with no statistically significant difference.

In comparing the two groups regarding the lateral and protrusion movements and maximal mouth opening there was no statistically significant difference between the two groups.

Panoramic views, axial, coronal and 3D CT scan showed that the osteosynthesis is relatively stable. In all cases the radiographs revealed proper approximation of fracture fragments with good bone healing. All the patients treated with rhombic plates system were functionally stable and well rehabilitated (Fig. 4-6).



Fig. (4) Postoperative orthopantomogram showing proper reduction and fixation of the subcondylar fracture right side using two miniplates (GII).

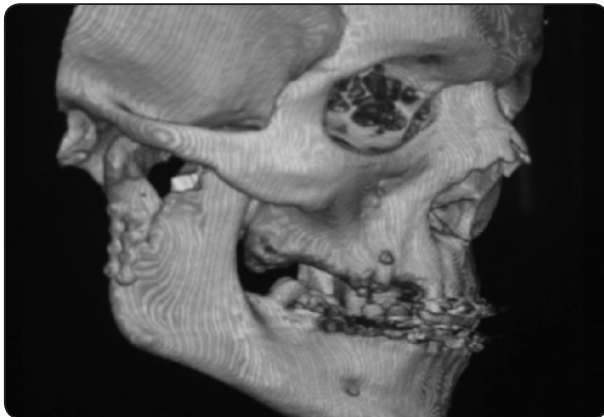


Fig. (5) Postoperative 3D C.T. scan showing 2 miniplate fixations at the subcondylar mandibular fracture (right side).

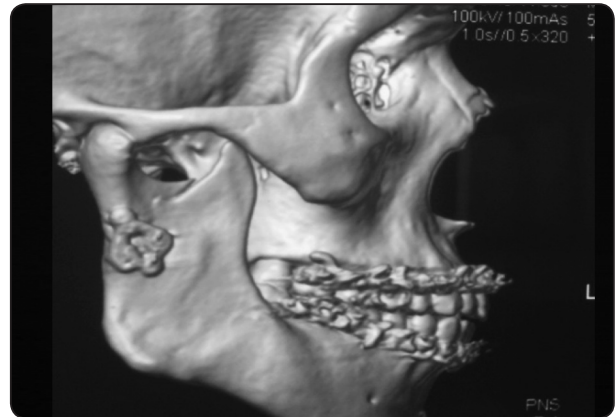


Fig. (6) Postoperative 3D C.T. scan showing 3d rhombic plate fixation at the subcondylar mandibular fracture (right side).

DISCUSSION

Mandibular condyle fracture is the most common fracture among mandibular fractures and it is considered the most controversial subject in the field of maxillofacial trauma.^{1,2} Mandibular condylar fractures occurs by various causative factors and has various treatment option, the purpose of treatment of mandibular condyle fracture is to recover normal TMJ function via the reconstruction of the appropriate anatomical position. So, assessment of treatment success depending upon the outcomes of complications such as TMJ derangement, ankylosis of TMJ or growth disorder via long term follow up.^{3,4}

The goal of the treatment lies in the achievement of occlusal stability, normal mouth opening, normal TMJ movement, prevention of TMJ derangement and pain, prevention of growth disorders in patients with mandibular fracture by selecting an appropriate treatment method between closed and open reduction.^{3,4}

In the treatment of mandibular condyle fracture, conservative treatment using closed reduction and surgical treatment using open reduction are used, however it is still controversial over indications. Thus, treatment type should be selected considering

patient's age, fracture type, patient systemic status, other fractures, teeth, and possibility of occlusal restoration by intermaxillary fixation and existence of foreign materials.²⁰

The treatment for subcondylar fractures still considered one of the most controversial topics of mandibular surgery despite the high incidence of these fractures. Subcondylar fractures have some clinical problems in common regarding diagnosis and treatment. The fracture can be treated via a conservative or a surgical approach, on the basis of several factors: degree and direction of displacement, level of fracture, position of the condylar head in relation to the glenoid fossa, position of the fractured bone segments of the subcondylar region with possible loss of vertical ramus height, patient age, dental status, accompanying fractures of the facial skeleton and of the body, potential for good occlusion and the patient's general condition.^{8,26,27}

*Chossegras et al., 1996,*²³ emphasized that the potential risks of open reduction and internal rigid fixation must be weighed carefully against its potential benefits, although the correct therapy for condylar fractures in adult patients is still a topic of debate. Many surgeons now favor open treatment of displaced condylar fractures as the method involving reduction and rigid fixation allows for

good anatomical repositioning. Surgical therapy is generally adopted in cases where a conservative method would not ensure a suitable restitution and integrum” of the morphofunctional site of the fracture.

Treatment of subcondylar fractures can follow two different routes: conservative or surgical. Previously, conservative management of condylar fractures was favored. However, open reduction was first applied to a low subcondylar fracture in 1925, and recently it has become more common, probably because of the introduction of plate and screw fixation devices allow for the stabilization of such injuries.²¹

Today, many surgeons prefer open reduction of displaced fractures, because such reduction and rigid fixation enables good anatomic repositioning and immediate function. Although there is still debate concerning therapy for subcondylar fractures, a number of reports have now suggested that, compared with non-operative treatment, the treatment of condylar fractures by open reduction and rigid fixation creates more favorable results^{2,5}.

The predominant surgical indication for adults is a dislocated or displaced condylar fracture, as it is generally impossible to attain anatomic reduction via conservative treatment^{3,22}.

According to the *Zide and Kent, 1983*¹⁰ criteria, the indications for open reduction were limited, because the techniques and materials available at that time were limited. Over time, however, with the development of improved materials for fixation and the refinement of surgical techniques, the concept of rigid internal fixation has been increasingly applied to the injured craniomaxillofacial skeleton. Therefore, new considerations regarding the indications and advantages of open reduction have evolved.

In our research we used retromandibular approach which show a low incidence of facial nerve injury, so it is the preferable approach if there is an indication for ORIF in mandibular subcondylar

fractures as none of the patients showed permanent damage of the facial nerve, this was in agreement with *Chossegras et al 1996*²³ and also with *Bindra et al 2010*²⁴ who adopted this approach for open reduction of mandibular condylar fractures as it is associated with low morbidity and adequate exposure of the fracture site.

The stability of osteosynthesis is influenced by the mechanical strains arising in the condylar region during mastication due to the action of the muscles acting on the mandible. So, the presence of compressive stress patterns along the posterior border of the ramus and tensile stress patterns parallel and inferior to the sigmoid notch. These studies imply a need for new concepts for the application of osteosynthesis plates at the posterior and anterior border of the condylar neck in order to restore tension and compression trajectories^{13,14}.

The use of three dimension plate technique may be considered a useful means for fixation in order to reduce the postoperative intermaxillary fixation period and achieve early mobility of the jaw. It has already been proposed by *Ellis and Dean, 1993*²⁵ that the plate used in the management of condylar neck fractures should be stronger and thicker than the adaptation miniplate. Although surgical management has been attempted in the hope of obtaining better results, through the use of one three dimension plate that reduces the time of soft tissue retraction and hence prevents facial nerve affection and also reduces postoperative edema. Therefore, careful reconsideration between the treatment efficacy and overall patient comfort is needed when we develop a treatment plan for subcondylar fractures.

The single-plate fixation technique does not provide sufficient strength to withstand the strains occurring in subcondylar fractures. Therefore, more authors advocate the use of a two-plate fixation technique, which seems to have the beneficial effect of restoring the tension and compression trajectories in subcondylar fractures. Ideally, two miniplates should be applied at the posterior and

anterior borders of the condylar neck in a triangular fashion with one plate below the sigmoid notch and another plate along the posterior border of the ramus¹⁰. There are several options for plate selection that can be used in subcondylar fractures, but we used the 2 miniplates.

In our cases, we always use the functionally stable two-plate fixation technique via mini-retromandibular and modified retromandibular incision in subcondylar fractures. Open reduction can restore the anatomic position of the condyle, thus yielding better function of the TMJ compared to closed reduction. A follow-up study of open reduction and internal fixation using single three dimension plate showed better clinical and radiologic results with regard to the mandibular ramus height, resorption, and pathologic change to the condyle comparable with two plates.

In patients with unilateral subcondylar fractures, the average lateral movement of contralateral side of the fracture was 7.1 mm, and the average homolateral movement of the fracture side was 9.3 mm, with no substantial differences between the 2 sides. These data indicate good restoration of the lateral movements of the mandible, with a slight deficit in the lateral movement of the contralateral side when treated by 3D plate “rhombic” and also the two plates.

The average value of protrusion in patients with a unilateral fracture was 4.5 mm, while in patients with bilateral condylar fracture, it was 4.3 mm. In all 25 patients, the average value of the maximum opening was 40.8 mm.

Open reduction and rigid internal fixation of dislocated mandibular condylar fractures has become more prevalent because it provides the possibility to the fracture healing including restoration of early function, and avoids prolonged maxillomandibular fixation. Many studies have shown that open reduction and rigid internal fixation of unilateral condylar fractures provides similar or better functional outcome when compared with closed treatment.

In our study, it seems that 2d plating systems are effective in the treatment of mandibular fractures and over all complications are less when compared with the conventional miniplates.

CONCLUSION

Fracture reduction of condyle is best treated with the new 3D rhombic plates, which gives excellent stability and neutralizes the changing strains in the condylar region allowing early restoration of function and avoids prolonged maxillomandibular fixation.

REFERENCES

1. Zachariades N, Mezitis M, Mourouzis C.: Fractures of the mandibular condyle: a review of 466 cases. Literature review, reflections on treatment and proposals. *J Craniomaxillofac Surg* 2006;34:421-32.
2. Sawazaki R, J-onior SM, Asprino L.: Incidence and patterns of mandibular condyle fractures. *J Oral Maxillo fac Surg* 2010;68:1252-9.
3. Ebenezer V, Ramalingam B.: Comparison of approaches for the rigid fixation of sub-condylar fractures. *J Oral Maxillofac Surg.* (Jan-Mar 2011) 10(1):38-44.
4. Motamedi MHK: A textbook of advanced oral and maxillofacial surgery. Croatia. InTech; 2013.
5. Ministry of Health Malaysia: Clinical Practice Guidelines: Management of unilateral condyle fracture of the mandible. Malaysia. Ministry of Health Malaysia; Dec 2005.
6. Jang JY, Kang DH.: Comparison study of open reduction and closed reduction in treatment of mandibular subcondylar fractures. *J Korean Cleft Palate-Craniofac Assoc* 2008;9:51-4.
7. Ellis E, Carlson DS: The effects of mandibular immobilization on the masticatory system. A review. *ClinPlast Surg.* 1989 Jan;16(1):133-46.
8. Geiser M, Trueta J: Muscle action, bone rarefaction and bone formation; an experimental study. *J Bone Joint Surg Br.* 1958 May;40-B(2):282-311.
9. Ongole B, Praveen N: Textbook of Oral Medicine, Oral Diagnosis and Oral Radiology. India: Elsevier; 2009.
10. Zide MF, Kent JN: Indications for open reduction of mandibular condyle fractures. *J Oral Maxillofac Surg* 1983;41: 89-98.

11. Kleinheinz J, Meyer C: Fractures of the mandibular condyle: basic considerations and treatment. London: Quintessence Publishing Company; 2009.
12. Lee W, Kang DH: Study of the plating methods in the experimental model of mandibular subcondyle fracture. *J Korean Cleft Palate-Craniofac Assoc* 2011;12:12-6.
13. Choi BH, Kim KN, Kim HJ.: Evaluation of condylar neck fracture plating techniques. *J Craniomaxillofac Surg* 1999;27:109-12.
14. Antoniadis K, Karakasis D, Elephtheriades J: Bifid mandibular condyle resulting from a sagittal fracture of the condylar head. *Br J Oral Maxillofac Surg* 1993, 31:124-126.
15. Jacobovicz J, Lee C, Trabuly T: Endoscopic repair of mandibular subcondylar fractures. *Plast Reconstr Surg* 1998;101: 437.
16. Haim D, Muller A, Leonhardt H: Biomechanical study of the delta plate and the trilock delta condyle trauma plate. *J Oral Maxillofac Surg* 2011;10:26-31
17. González-García R, Sanromán JF, Goizueta-Adame C, Rodríguez Campo FJ, Cho-Lee GY: Transoral endoscopic-assisted management of subcondylar fractures in 17 patients: An alternative to open reduction with rigid internal fixation and closed reduction with maxillomandibular fixation. *Int. J Oral Maxillofac Surg* 2009, 38:19-25.
18. Pereira MD, Marques A, Ishizuka M, Keira SM, Brenda E, Wolosker AB: Surgical treatment of the fractured and dislocated condylar process of the mandible. *J Craniomaxillofac Surg* 1995, 23:369-376.
19. Iizuka T, Lädach K, Geering AH, Raveh J: Open reduction without fixation of dislocated condylar process fractures: long-term clinical and radiologic analysis. *J Oral Maxillofac Surg* 1998, 56:553-561.
20. House JW, Brackmann DE: Facial nerve grading system. *Otolaryngol Head Neck Surg* 1985, 93:146-147.
21. Baryza MJ, Baryza GA: The Vancouver Scar Scale: an administration tool and its interrater reliability. *J Burn Care Rehabil* 1995, 16:535-538.
22. Research Diagnostic Criteria for Temporomandibular Disorders. <http://www.rdc-tmdinternational.org/>.
23. Chossegros C, Cheynet F, Blanc JL, Bourezak Z: Short retromandibular approach of subcondylar fractures: clinical and radiologic long-term evaluation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1996, 82:248-252.
24. Bindra S, Choudhary K, Sharma P, Sheorain A.: Management of mandibular sub condylar and condylar fractures using retromandibular approach and assessment of associated surgical complications. *J. Oral Maxillofac. Surg.* (Sept-Dec 2010) 9(4):355-362
25. Ellis E. 3rd, Dean J.: Rigid fixation of mandibular condyle fractures. *J Oral Surg Oral Med Oral Pathol.* 1993; 76(1):6-15.
26. Lee HC, Kang DH, Koo SH, et al. Outcome of open reduction via retromandibular approach for mandibular subcondyle fracture. *J Korean Soc Plast Reconstr Surg* 2005;32: 739-43.
27. Croce, A. Moretti, F. Vitullo, A. Castriotta, M. De Rosa, L. Citraro: Transparotid approach for mandibular condylar neck and subcondylar fractures *ACTA Otorhinolaryngologica italiana* 2010;30:303-309.