Post Traumatic Changes in TMJ Structure after unilateral Mandibular Fracture – a Longitudinal MRI Study

V. Senthilvelmurugan[1], U. Punitha Gnana Selvi[2], S. Rekha[3], P Nilofar Fathima[3]

ABSTRACT

Introduction: The condylar process of the mandible locates away from the direct traumatic insults; however it is a structure with frequent facial traumatic injury. The aim of the study was to evaluate the structural changes of TMJ (soft and hard tissues) immediately after unilateral condylar fracture using MRI and to evaluate their influence on the prognosis after closed treatment.

Materials and methods: Clinical, radiological and MRI evaluation of 20 patients with unilateral condylar fractures immediately after trauma and reevaluated after 3 months of closed treatment. The position, shape and signal intensity of the condyle, disc and retrodiscal tissue were analysed. Condylar head location, condyle shape, degree of resorption and bony changes are evaluated. Mandibular mobility, TMJ function, pain in masticatory muscle, TMJ pain and pain during movement, occlusal disturbances if any, lateral deviation more than 2mm when opening the mouth, restricted mouth opening, clicking were summarized.

Results: Mandibular dysfunction in the immediate post trauma was 85%, improved to 5% 3 months after closed treatment. Differences were found in the degree of displacement of fractured fragment between plain x-rays and MRI. The disc was placed anterior to condyle in 8 patients, posterior to condyle in 3 patients immediate posttrauma, where as re-evaluation after 3 months the condyle position as correlated to the disc as normal in 16 patients and anterior to condyle in 4 patients., signal intensity changes in the retrodiscal tissues were found to be high in 75% of the cases immediately after condylar fractures and repaired to normal after 3 months. During the immediate post trauma period the signal intensity of condyle was high in 6 patients and retrodiscal tissue was high in 5 patients, superior joint space was high in 18 patients and inferior joint space was high in 14 patients, signal intensity of mastoid was high in 2 patients out of 20 patients and re-evaluation of all bony structure were near normal after 3 months.

Conclusion: It can be concluded that, irrespective of the degree of trauma, the healing of the tissues were satisfactory after closed reduction and immobilisation of the joint structures as examined by MRI. Also, closed reduction treatment is a near ideal option of treatment strategy for all cases of unilateral mandibular condylar fracture.

Keywords: Post Traumatic Changes, TMJ Structure, unilateral Mandibular Fracture, Longitudinal MRI

INTRODUCTION

The forceful impact to the mandible brings the fracture at this long thin anatomical structure by the transmission of the traumatic forces. The frequency of the condylar fracture ranges from 17.5 to 52%. The existing methods of clinical and radiological examination donot allow a fully objective and differentiated evaluation of functional disturbances of a fractured mandibular condyle. Various imaging modalities for evaluating TMJ structures are CBCT, arthroscopy, ultra sonic visualisation, and supersonic shear imaging using viscoelastic properties of soft tissue. The limitations of routine radiography include diminished sensitivity, poor technique, and lack of patient cooperation. Often, the proximal portion of the mandibular condyle is not visualized on radiographs of any view. Sagittal fractures of the condyle are especially hard to identify.[1] As on routine radiographs, panoramic views may not fully demonstrate the condyles, which can be obscured. Endoscopic ultrasonography offers an alternative to MRI for evaluating the TMJ.[2] But ultrasonography is an invasive procedure, one that is usually performed with maxillofacial surgery. CT scanning is most valuable in the assessment of suspected high-condylar fractures that are difficult to see on plain radiographs. Whereas CT scanning is used to evaluate the position of a condyle relative to the TMJ, MRI can be performed to evaluate the position and morphology of the cartilage of the TMJ. MRI has become one of the most widely effective imaging modalities for TMJ as it allows visualisation of both hard and soft tissue structures of the joint in a precise manner.

However, preforming MRI scan in all patients with condylar fracture is not possible on a day to day basis. Hence, if a correlation can be derived between the MRI findings of traumatised TMJ and the respective clinical and radiographic findings, the type of management (open vs. closed reduction) and prognosis of treatment outcome can be assessed.

The purpose of the study was to evaluate the patients with unilateral condylar fracture who had received closed functional treatment. We took MRI images for the condylar fractures immediately after the traumatic injuries and analysed them to evaluate the conditions of TMJ structures, both bony and soft tissue, which were injured and partly deformed by trauma with the fracture of mandibular condyle. Evaluation was clinical, radiological and by MRI of TMJ. The patients were reassessed after 3 months to compare clinical outcome with MRI findings of the joint structures.

MATERIAL AND METHODS

This study was conducted in MGMGH, Trichy. Institutional ethical committee approval was obtained. 20 patients with unilateral condylar fracture of average age range 15-50 years participated in the study based on the defined case selection criteria. (Table-1).

[1]Professor and Head, Department of Radiology, [2]Professor and Head, [3]Senior Intern, Department of Dental Surgery, KAPV, Government Medical College, Trichy, Tamil Nadu, India.

Corresponding author: Dr. D. Kamatchi, 135 Madurai Road, Manaparai - 621306, Tamil Nadu, India

How to cite this article: V. Senthilvelmurugan, U. Punitha Gnana Selvi, S. Rekha, P Nilofar Fathima Post traumatic changes in TMJ structure after unilateral mandibular fracture – a longitudinal MRI study. International Journal of Contemporary Medical Research 2017;4(2):545-549.

Inclusion criteria	Exclusion criteria
Patient group between 15-50years Unilateral fracture of mandibular condyle	Young patient less than 15years Old patient more than 50 yrs. Patients under chronic medication Pan facial trauma Immuno compromised patient

Table-1: Case selection criteria

Jaw mobility		
A Maximal opening of mouth (vertical incisal edge difference +overbite) B Maximal laterotrusion to the left aximal laterotrusion to the right C Maximal protrusion Sum of A+B+C+D, mobility index according to code		
Code	**Index**	**Range**
0 points	Mobility index 0	Normal range of movement
1-4 points	Mobility index 1	Slightly impaired movement
5-20 points	Mobility index 5	Severely impaired movement

Helkimo Dysfunction Index	N (no.of patients)
0 points	6
1-4 points	2
5-20 points	17

Table-2: Helkimo index

The cases were evaluated,

A. Clinically to ascertain the degree of functional disability
B. Radiologically to assess the level of condylar displacement
C. By MRI to estimate the actual soft tissue and hard tissue changes in the TMJ structures involving the fractured condylar segment.

A. Clinical examination

Clinical examination included inspection and palpation of the auricular region, palpation of the masticatory muscles, and patient interview regarding pain and disturbed mastication. Occlusal disturbances, lateral deviation more than 2 mm when opening the mouth, impeded mandibular movements when opening the mouth, protrusion, and laterotrusion were recorded as well. The clinical findings were summarized by applying the dysfunction index according to Helkimo[3] (Table-2).

B. Radiographic evaluation

Plain x-rays of PA view mandible were taken to assess the amount of displacement of condylar head. The amount of displacement of the fractured condylar segment was categorized as the dislocation, displacement, or no displacement based on position of the relative position between condylar head and articular fossa according to Lindahl.[4]

C. MRI evaluation

MRI scans of bilateral TMJ were taken as soon as possible within 48 hours after the traumatic injury and 3 months after conservative management using IMF. MRI was initiated with 1.5 Tesla Magnetom 63SP 4000 (Siemens medical system, Erlagen, Germany) using head surface coil. The protocol was set as follows: T1, T2, proton density with 3mm thickness in axial coronal and sagittal plane were constructed independently. The following parameters were assessed:

i. Degree of condyle displacement
ii. Degree of disc displacement

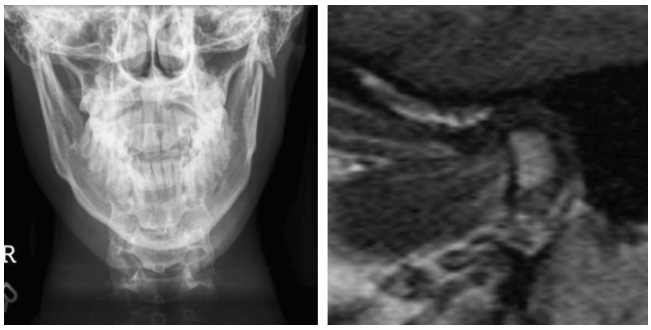

Figure-1: Plain x-ray (PA View mandible) showing fractured condylar segment with displacement; **Figure-2:** The closed-mouth position, the condylar head and disc show a normal condyle-disc relation and disc shape.

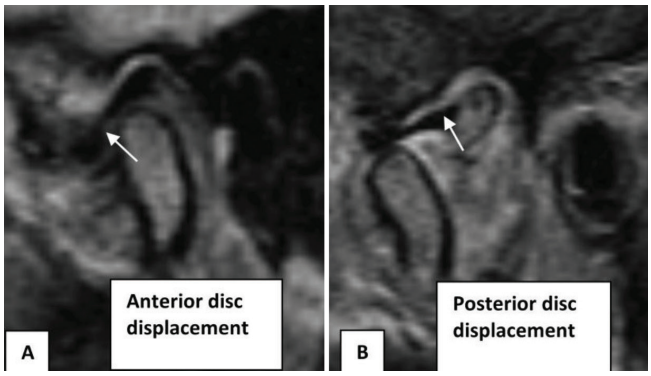

Figure-3: On proton density-weighted images in the closed-mouth position, the condylar head and disc show a dislocation that they are located near articular eminence, away from the fossa. Rather than normal condyle-disc relation, (A). it shows anterior disc displacement; (B). it shows Posterior displacement of disc.

iii. Relationship between disc and condyle (Figure 1)
iv. Shape of disc
v. Signal intensity-condylar area.

The results obtained by radiographic and MRI evaluation was tabulated in Table 1-8. The various changes are presented in Figure 3.

STATISTICAL ANALYSIS

The results were statistically evaluated with chi square test and the significance level was confirmed on the basis of the p value 0.05.

RESULTS

Clinical examination for evaluation of dysfunction in patients with unilateral condylar fracture was performed according to the 5 different criteria of the Helkimo dysfunction index, namely mandibular mobility, TMJ function, pain in masticatory muscle, TMJ pain, and pain during movement and classification of these findings in terms of the Helkimo index, led to the data presented in Table 2. The rate of moderate and serious dysfunction was

MRI	Radiograph		
	At eminence	Position of disc in anteriorly	Normal
Dislocation (n=6)	4	1	1
Displacement (n=8)	3	1	4
No displacement (n=2)	1	-	1
Lateral displacement (n=4)	1	-	3

Table-3: Degree of disc displacement in MRI correlation to degree of displacement in radiograph

	Disc position		
	Anterior to condyle	Normal	Posterior to condyle
Post trauma	8	9	3
Post treatment	4	16	-

Table-4: Relationship between the disc and the condyle on MRI

	Disc		Retrodiscal tissue	
	Deformed	Normal	Teared	Normal
Post trauma	11	9	20	-
Post treatment	-	20	-	20

Table-5: Shape of the disc and retrodiscal tissue at trauma on MRI

	Condyle			Retrodiscal tissue		
	High	Low	Normal	High	Low	Normal
Post trauma	6	-	14	5	-	15
Post treatment	2	-	18	-	-	20

Table-6: The Signal intensity of the Condyle and Retrodiscal tissue on MRI

	Superior			Inferior		
	High	Low	Normal	High	Low	Normal
Post trauma	18	-	2	14	-	6
Post treatment	-	-	20	-	-	20

Table-7: The Signal intensity of the Joint Space on MRI

	Normal	High	Normal
Post trauma	18	2	-
Post treatment	20	-	-

Table-8: The Signal intensity of the Mastoid on MRI:

42%.This improved to near normal value after 3 months in 89% of individuals. Remaining 11% showed moderate dysfunction such as restricted mouth opening and deviation on mouth opening even after 3 months.

Radiographic evaluation of the x-rays PA view mandible in immediate post trauma period revealed minimal displacement of condylar head in 3 cases (21%). Re-evaluation after 3 months radiographically showed near normal condyle in 16 (90%) patients, where 14 (10%) showed anterior displacement [Table 3].

On analysing the joint structures of fractured condyle by MRI immediately after traumatic injuries, the disc was placed anterior to condyle in 8 patients, posterior to condyle in 3 patients and normal in 9 patients where as re-evaluation after 3 months the disc position as correlated to the condyle as normal in 16 patients and anterior to condyle in 4 patients [Figure 2, Table 4]. The shape of disc immediately after trauma is deformed in 11 patients and normal in 9 patients and retrodiscal tissue was torn in all patients [Table 5]. Re-evaluation after 3 months showed near normal discal tissues in all cases.

During the immediate post trauma period the signal intensity of condyle was high in 6 patients and retrodiscal tissue was high in 5 patients [Table 6], superior joint space was high in 18 patients and inferior joint space was high in 14 patients [Table 7], signal intensity of mastoid was high in 2 patients out of 20 patients [Table 8] and re-evaluation of all bony structures were near normal after 3 months.

DISCUSSION

TMJ is a bilateral joint structure where both rotational and translational movement occurs also it consists of surrounding structures like disc, articular eminence, retrodiscal tissue, joint space, mastoid. Though direct trauma to the TMJ is uncommon, any forceful impact on the bony mandible is transmitted to the TMJ through the bony trajectories resulting in both soft tissue damage and damage to the bony structures of the joint. The frequency of the condylar fracture ranges from 17.5 to 52%.[5-14] On the condylar fractures, the positional changes of the condylar head occur, in terms of the displacement or dislocation, and they in turn accompany inevitably the deformation or destruction of TMJ soft tissue structures. And, this suggests the possible problems of disc position or structure and also destructional changes to joint capsule and/ or surrounding ligaments.

The diagnosis of condylar fracture using done clinically by assessing the degree of mandibular dysfunction (Helkimo's index), radiographically by x-ray PA view mandible, OPG etc. CT scan of temporomandibular joint allows precise evaluation of bony injury to the joint structures; Patients with a suspected mandibular dislocation or limited excursion should undergo lateral imaging of the TMJs, with the acquisition of both open-mouth and closed-mouth views. This type of injury may also be examined by means of real-time fluoroscopy. Alternatively, open- and closed-mouth CT scanning may be performed. However the precise degree of soft tissue injury to the supporting structures of condyle could not be predicted. Soft tissue visualisation can be carried out by invasive procedures such as arthroscopy, ultra sonic visualisation, and supersonic shear imaging using viscoelastic properties of soft tissue. MRI is a simple, non-invasive technique to image the nature of condylar structure and the soft tissue component of TMJ, more effectively than plain radiographs. MRI is currently the most representative, reliable diagnostic method for the assessment of the hard tissue and soft tissue component of TMJ.[15] However, performing MRI scan in all patients with condylar fracture is not possible on a day to day basis because of its cost-effectiveness and availability in clinical setup. Hence, if a correlation can be derived between the MRI findings of traumatised TMJ and the respective clinical and radiographic findings, the nature of injury to the TMJ structure, the type of management (open vs. closed reduction) and prognosis of treatment outcome can be assessed.[16]

Mandibular dysfunction in the immediate post trauma was 85%, improved to 5% 3 months after closed treatment. Mac lennan[17] in1952 found that the occlusal disturbances resulting from closed treatment are usually subtle. Small deviation of chin, laterognathia, or modestly decreased range of motion is rarely

detected by the patient.

Park and colleagues[18] demonstrated that adverse outcome of closed treatment was dependent upon the location of fracture and the intracapsular condyle head fractures have the highest incidence of malfunction. Neizen[19] and associates evualuated closed treatment of condylar fractures. The result of closed treatment patients still complaining pain and describing their occlusion as fair or poor. However their average mouth opening was excellent at 52mm.

Ellis and Throckmorton[20] performed evaluation after closed and open reduction of condylar fractures and found that the mean shortening of ramus height in the closed reduction group was found to be only 2 to 5mm. This study does not indicate a functional shortening of the ramus in that the articulation of condyle simply moved further down the articular eminence and in general permitted maintenance of function and occlusion through a new articular position of the condylar head. This is effectively a neoarthrosis formation that permits adequate jaw function.

On comparing the degree of displacement of fractured fragment between plain x-rays and MRI we could find differences between the displacement degree on plain X-rays and MRI. This probably came from the lack of information obtained from plain X-rays with the limited disclosure of the degree of fractured fragment displacement. It also raised the possibility of more distant segmental displacement and also the need of more careful diagnosis and treatment planning when we rely on the plain X-rays.

On observing the positional relationship between the condyle and disc, shape of the disc, and signal intensity of condyle, retrodiscal tissue, joint space, mastoid in MRI, the disc was placed anterior to condyle in 8 patients, posterior to condyle in 3 patients [Figure 3] and normal in 9 patients [Figure 2, Table 4] where as re-evaluation after 3 months the condyle position as correlated to the disc as normal in 16 patients and anterior to condyle in 4 patients. Dwivedi et al.[15] reported a significant relationship between the extent of condylar fracture and the degree of impairmentto the disc. But, it also indicated that the final positional relationship between the displaced condylar and discal structure were not always identical.

The retrodiscal tissues are found to be highly susceptible to damage associated with condylar fractures.[21] In our study, signal intensity changes in the retrodiscal tissues were found to be high in 75% of the cases immediately after condylar fractures. It could be diagnosed as the hemarthrosis, which might be mixed with bleeding and synovial fluid within the joint cavity. With closed reduction of fracture the tissues repaired to their normal structure after 3 months. The retrodiscal tissues were torn in 100% of the cases immediately after trauma and recovered to normal three months after injury. Direct trauma to the mandible (mostly the chin), causes damage to the articular cartilage, tear of the retrodiscal lamina and an anterior acute disc displacement. Because of the backward force to the condyle, the disc is severely extruded, which may result in a retrodisc or lateral disc ligament rupture and the squeezing of the disc body to the anterior part of the condyle, causing acute disc displacement Their significances are definitely related to the possible adhesion or ankylosis of the joints in case we fail to manage them properly. Similar results were obtained by Dwivedi et al[16], who concluded that higher condylar fracture tends to cause the greater injury to retrodiscal tissue, and to cause the lower capsular tears with the minimally displaced condylar fracture.

During the immediate post trauma period the signal intensity of condyle was high in 6 patients and retrodiscal tissue was high in 5 patients [Table 6], superior joint space was high in 18 patients and inferior joint space was high in 14 patients [Table 7], signal intensity of mastoid was high in 2 patients out of 20 patients [Table 8] and re-evaluation of all bony structure were near normal after 3 months. Kim et al[22] evaluated 34 subjects of condylar fractures with MRI and concluded that the changes of signal intensity at the retrodiscal tissue were found but less related to degree of fracture displacement. However, high signals were observed almost at all fractured joint spaces and even at some contralateral joints. The authors claimed that the displaced disc as well as the increased signal intensity of joint space,condylar head and retrodiscal tissue demands more attention to prevent the possible sequel of joint. Nogami et al studied 25 joints in 23 patients to determine the relationship between MRI evidence of joint effusion and concentrations of cytokines in synovial fluid samples from patients with mandibular condyle fractures. The results showed a higher MRI evidence of joint effusion in high condylar fractures.[23]

Correlating the above findings, it could be concluded that closed reduction of mandibular condyle fractures by IMF is adequate to provide clinically satisfactory results with normal restoration of function and joint structure in 89% of cases irrespective of the degree of trauma to the bony and soft tissue structures of TMJ.

CONCLUSION

This study aimed in evaluating the soft tissue and hard tissues of temperomandibular joint structures in unilateral condylar fractures of mandible and the degree of recovery after closed reduction. It can be concluded from this study that, irrespective of the degree of trauma, the healing of the tissues were satisfactory after closed reduction and immobilisation of the joint structures as examined by MRI. Also, MRI is not necessary in all cases because of cost efficiency, time consuming and inability to perform as routine outpatient procedure. It can also be concluded that closed reduction treatment is a near ideal option of treatment strategy for all cases of unilateral mandibular condylar fracture. This study can be further proceeded to evaluate changes following bilateral condylar fractures and/or assessing the prognosis following open reduction.

REFERENCES

1. Mandibular Fracture Imaging Updated: Jul 01, 2015 WC Soule,FS Chew; Medscape, available at http://emedicine.medscape.com/article/1283150-overview
2. Patonay L, Nagy K, Engelke W. Real-time endoarticular ultrasound imaging of the TMJ--a new diagnostic possibility? A cadaver study. Int J Oral Maxillofac Surg. 2002;31:553-7.
3. Helkimo M:studies on function and dysfunction of the masticatory system:Index for anamnestic and clinical dysfunction ond occlusal state.Swed Dent J. 1974;67:101.
4. Lindhal L. condylar fracture of mandible:I. classification

and relation to age,occlusion,and concomitant injuries of teeth and teeth-supportin structures, and fractures of the mandibular body.Int J Oral Surg. 1977;6:12-21.
5. Zachariades N, Papavassiliou D, Papademetriou I, Koundouris I. Fractures of the facial skeleton in Greece. A retrospective study covering 1971 cases in 10 years. J Max-Fac Surg. 1983;11:143.
6. Bochlogyros PN. A retrospective study of 1,521 mandibular fractures. J Oral Maxillofac Surg. 1985;43:597–599.
7. Zachariades N, Papavassiliou D, Koumoura F. Fractures of the facial skeleton in children. J Cranio-Maxillofac Surg. 1990;18:151–153.
8. Stylogianni L, Arsenopoulos A, Patrikiou A. Fractures of the facial skeleton in children. Br J Oral Maxillofac Surg. 1991;29:9–11.
9. Silvennoinen U, Iizuka T, Lindqvist C, Oikarinen K. Different patterns of condylar fractures: an analysis of 382 patients in a 3-year period. J Oral Maxillofac Surg. 1992; 50:1032–1037.
10. Newman L. A clinical evaluation of the long-term outcome of patients treated for bilateral fracture of the mandibular condyles. Br J Oral Maxillofac Surg. 1998;36:176–179.
11. Marker P, Nielsen A, Bastian HL. Fractures of the mandibular condyle. Part 1: patterns of distribution of types and causes of fractures in 348 patients. Br J Oral Maxillofac Surg. 2000;38:417–421.
12. 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;30:384–389.
13. Miloro M. Endoscopic-assisted repair of subcondylar fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;96:387–391.
14. Villarreal PM, Monje F, Junquera LM, Mateo J, Morillo AJ, González C. Mandibular condyle fractures: determinants of treatment and outcome.J Oral Maxillofac Surg. 2004; 62:155–163.
15. Dwivedi AND, Tripathi R, Gupta PK, Tripathi S, Garg S. Magnetic resonance imaging evaluation of temporomandibular joint and associated soft tissue changes following acute condylar injury. J Oral Maxillofac Surg. 2012;70:2829–2834.
16. Sullivan SM, Banhart PR, Anderson Q. Manetic imain assessment of acute soft tissue injuries to the temporomandibular joint. J Orak Maxillofac Sur. 1995; 53:763-766.
17. Mac Lennan W consideration of 180 cases of typical fractures of the mandibular condylar process.
18. Park JM, Jang YW, Kim SC et al. Comparative study of the prognosis of the extracorporeal reduction and a closed treatment in mandibular condyle head and/or neck fracture, J oral Maxillofac surg. 2010:2986-2993.
19. Niezen ET,Bos RR,de Bont LG et al,complaints related to mandibular functional impairment after closed treatment of the fractures of mandibular condyle.Int J Oral Maxillofac Surg. 2010:39:660-665.
20. Ellis E,Throckmorton G Facial symmetry after closed treatment of fractures of the mandibular condylar process J Oral Maxillofac Surg. 2000:58:719-728.
21. Takaku S, Yoshida M,Sano T, Toyoda T. Manetic resonance imaes in patients wih acute traumatic injury of temporomandibular joint:a preliminary report.J Cranio-Maxillofac Surery. 1996;24:173-177.
22. Bong Chul kim, Yoon Chang Lee, Hyung Seok Cha, Sang-Hwy Lee. Characteristics of temporomandibular joint structures after mandibular condyle fractures revelaed by magnetic resonanace imaging.Maxillofacial Plastic and Reconstructive Surgery. 2016;38:24.
23. Nogami S, Takahashi T, Ariyoshi W, Yoshiga D. Increased levels of interleukin-6 in synovial lavage fluid from patients with mandibular condyle fractures: correlation with magnetic resonance evidence of joint effusion. J Oral Maxillofac Surg. 2013;71:1050-8.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 11-02-2017; **Published online**: 17-03-2017