World Journal Of ENT & Head-Neck Surgery
(WJEHNS)

www.wjehns.com

MANAGEMENT OF MANDIBULAR FRACTURES: OUR EXPERIENCE

Dr. Najmun Nahar[1] , Dr. Prithvi Das[2] , Dr. Monoj Mukherjee[3]

[1] Specialist Medical Officer, Swasthya Bhawan, Kolkata
[2] Senior Resident, Department of ENT, Head & Neck Surgery, Calcutta National Medical College & Hospital, Kolkata
[3] Associate Professor & Head, Department of ENT, Head & Neck Surgery, Burdwan Medical College & Hospital, Burdwan

*Correspondence:
Dr. Prithvi Das
Email: prithvidas89@gmail.com
Phone: 9831257218

ABSTRACT:

Background: Mandibular fracture is one of the most common facial bone fractures associated with significant morbidity. Road traffic accidents are one of the leading causes of mandibular fractures. Radiology is an essential component in the workup of mandibular fractures. Fractures can be managed based on the principles of either rigid fixation or adaptive osteosynthesis.

Aim: To study the socio-demographic profile, etiology, classification, and postoperative outcome assessment of mandibular fractures at our institution.

Method: This is a prospective observational study. It was conducted on all cases of mandibular fractures excluding those with pan-facial and pathological fractures, attending our institution over a period of one year. All the patients were subjected to radiography (OPG and CT with 3D reconstruction) for classification of fracture based on location and number, and surgical management was planned based on the same. All patients underwent ORIF with MMF either by extraoral or intraoral approach. MMF was performed either with arch bar or eyelet wiring. Post-operatively, outcome assessment was done on the basis of union of mandible, occlusion, pain, infection, facial deformity, neurosensory disturbances and trismus.

Result: Males in the age bracket of 21-30 years was most commonly affected. 76.7% of the cases were caused by road traffic accidents and parasymphysis (19 cases) was the most common site followed by the body (13 cases). Post-operative outcome parameters like occlusion were assessed by Angle's classification, pain by visual analogue scale (VAS), and mouth opening by measuring inter-incisor distance. At the end of 6 months, the rate of overall complications was 3.3%.

Conclusion: Mandibular fracture is most common among young males, with road traffic accidents being the commonest etiology. Parasymphysis fracture is the most common site of fracture. CT with 3D reconstruction is helpful in the evaluation of complex fractures. Most of the patients had a normal bone union. ORIF provides optimal stability with precise reduction, superior aesthetic results and early restoration of functional life.

KEYWORD:
Mandibular fracture; parasymphysis; orthopantomogram (OPG); open reduction & internal fixation (ORIF); maxillomandibular fixation (MMF); inter-maxillary fixation (IMF); occlusion; trismus.

INTRODUCTION:

In the initial part of the last century, where the industry was at bay and the transport was slow, fracture in any part of the skeleton was a rarity. Since the turn of the last century, with the advancement of civilization, there has been a rapid boom in industrialization leading to exponential growth in the automobile industry. Growth in the automobile industry was met with an equally proportional growth in road traffic accidents which is one of the leading causes of facial bone fractures including mandibular fractures.

The fracture is defined as a "breach in the continuity of bone"[1] . The facial area is one of the most frequently injured areas of the body, accounting for 23-97% of all fractures[2]. The mandible is a horseshoe-shaped, mobile facial bone, which is strategically located as well as structured, to bear, the brunt of all sorts of stress and strain. Hence, it commonly fractures, when the limits of stress and strain cross normality. Mandibular fractures occur twice as often as mid-facial fractures[3] . The energy required to fracture the mandible is 44.6-74.4 kg/m2, which is about the same as zygoma, half of that for frontal bone and four times that required for maxilla[4] . Areas that exhibit weakness include the area lateral to the mental protuberance, mental foramen, mandibular angle, and the condylar neck[3].

Mandibular fractures occur most frequently in males during the third decade of life [5] . In the elderly, it is likely to be associated with falls[6] . All reports show a higher frequency in males aged 21-30 years[7] . In India, motor vehicle collisions are the leading cause of mandibular fractures [8] .

Fridrich et al. showed that most fractures occur in the body (29%), condyle (26%), and the angle of the mandible (25%). The symphysis accounts for 17% of mandibular fractures, whereas fractures of the ramus (4%) and coronoid process (1%) have lower occurrence rates. In automobile accidents, the condylar region, in motorcycle accidents, the symphysis, and in assault cases, the angle demonstrated the highest incidence of fracture. The study also reported that in patients with mandible fractures, 43% of the patients had an associated injury [9] . In patients with mandibular fractures, 53% of patients had unilateral fractures while 37% had 2 fractures and 9% had 3 or more fractures [10] .

The technique of rigid internal fixation was developed and popularized by Arbeitsgemeinschaft fur Osteosynthesefragen/ Association for the Study of Internal Fixation (AO/ ASIF) in Europe in the 1970s. The basic principles of the AO, outlined by Spiessl, call for primary bone healing under conditions of absolute stability [11] . This is accomplished by interfragmentary compression plates.

The four AO/ ASIF principles are: Anatomical reduction, functionally stable fixation, atraumatic surgical technique, and immediate active function.

During the same time that Spiessl was expounding the AO doctrine, Champy et al. in France were developing the concept of adaptive osteosynthesis. Champy advocated transoral placement of small, thin, and malleable stainless steel miniplates with monocortical screws along an ideal osteosynthesis line of the mandible. Champy believed that compression plates were unnecessary because of masticatory forces that produce a natural strain of compression along the inferior border [12] .

The above two methods revolutionized the treatment approach to mandibular fractures. Many fractures previously treated with closed reduction or open reduction with wire osteosynthesis are now commonly treated with open reduction with plate and screw fixation. An example of this evolution is the treatment of comminuted mandibular fractures which were thought to be treated best by closed reduction to minimize stripping of the periosteum of small bone fragments. Although this treatment modality is still used, rigid fixation now enables the clinician to avoid closed reduction with the use of reconstruction plates and good soft tissue coverage [13] .

The indications for closed versus open reduction have changed dramatically over the last century. The ability to treat fractures with ORIF has dramatically revolutionized the approach to mandibular fractures [14] . Traditionally, closed reduction and ORIF with wire osteosynthesis used to require an average of 6 weeks of immobilization by MMF for satisfactory healing. Difficulties associated with this extended period of immobilization include airway problems, poor nutrition, weight loss, poor hygiene, phonation difficulties, insomnia, social inconvenience, patient discomfort, work loss, and difficulty recovering normal range of jaw function. In contrast, rigid and semi-rigid fixation of mandible fractures allow early mobilization and restoration of jaw function, airway control, improved nutritional status, improved speech, better oral hygiene, patient comfort, and an earlier return to the workplace [15] .

MATERIALS AND METHODS:

This is a prospective observational study done on 30 patients who attended the department of ENT, Head & Neck Surgery at Nil Ratan Sircar Medical College & Hospital, Kolkata, over a period of one year.

This study was conducted after institutional ethical committee clearance was obtained and written consent taken from all the patients of mandibular fracture, recommended for open reduction and internal fixation after fulfilling the inclusion and exclusion criteria.

A. Inclusion criteria: Fractures due to road traffic accident, fall, assault, sports without any neurological deficit or hemodynamic instability.

B. Exclusion criteria: Mandibular fracture as a part of pan-facial fracture or pathological fracture.

Selected patients were then subjected to detailed history taking and physical examination. Dental evaluation was performed in patients with significant carious or periodontal destruction. Then patients were subjected to radiography (more commonly OPG & CT scan with 3D reconstruction). All investigations were done for general anesthetic fitness.

After CT scan with 3D reconstruction, mandibular fracture was classified according to the site and number of fracture and surgical management was planned accordingly. All the patients underwent ORIF after MMF. MMF was performed either by arch bar or by eyelet wiring

Surgical procedure:

1. All the patients underwent open reduction under general anesthesia by nasogastric intubation/ submental intubation.
2. Surgical evaluation of stability of teeth was performed under GA. Those teeth meeting the following criteria were extracted: (1) teeth with fractured roots (2) teeth that were unsalvageable as a result of caries or infection in the region of the fracture; and (3) teeth within the fracture line that were loose or unstable. Stable teeth within the fracture line were preserved for added reduction stability.
3. Arch bars or eyelet wires placed and MMF wires secured prior to incision.
4. Surgical approach was done through intraoral vestibular incision or extraoral incision or through the existing wound for access to the fracture line depending on the location of the fracture.

Intraoral approach- (Indication- fracture in symphysis, parasymphysis or body) incision is made leaving at least 1 cm cuff of tissue from the mucogingival junction for closure. Dissection is carried to bone. Freer's elevator is used to dissect below the periosteum up to the inferior border of the mandible. Mental nerves identified and preserved.

Figure 1: Pre-operative OPG showing parasymphysis fracture of mandible

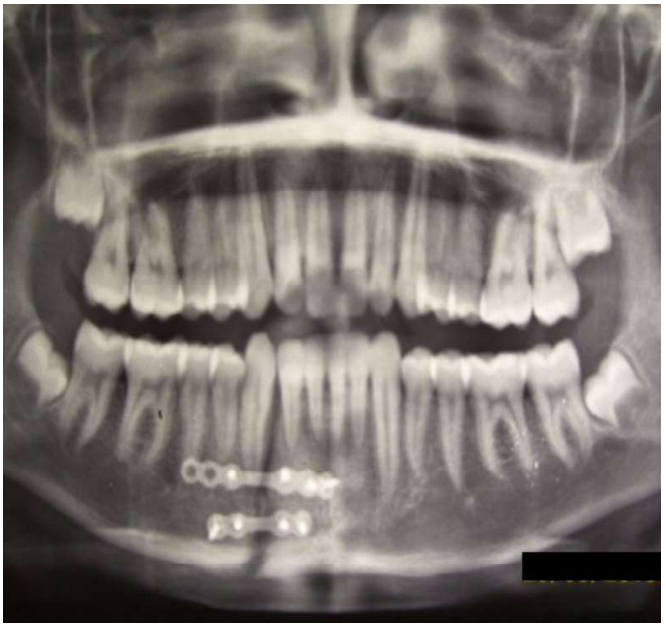


Figure 2: Post-operative OPG showing parasymphysis fracture of mandible

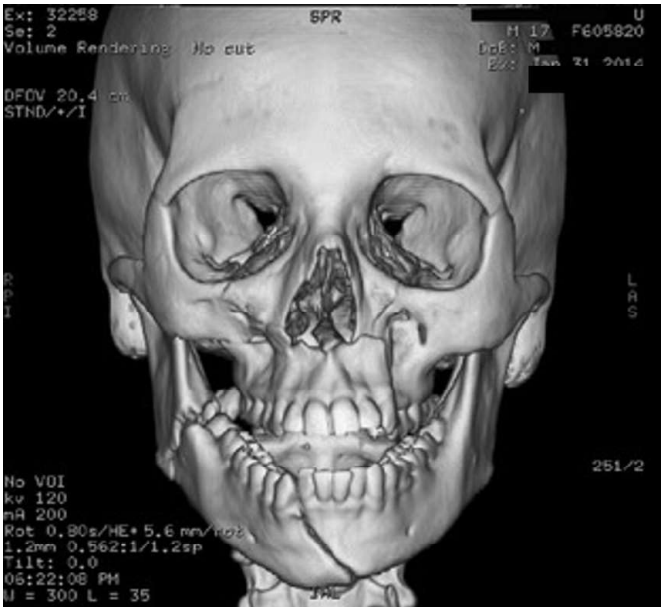


Figure 3: CT with 3D reconstruction showing parasymphysis & angle fracture of mandible

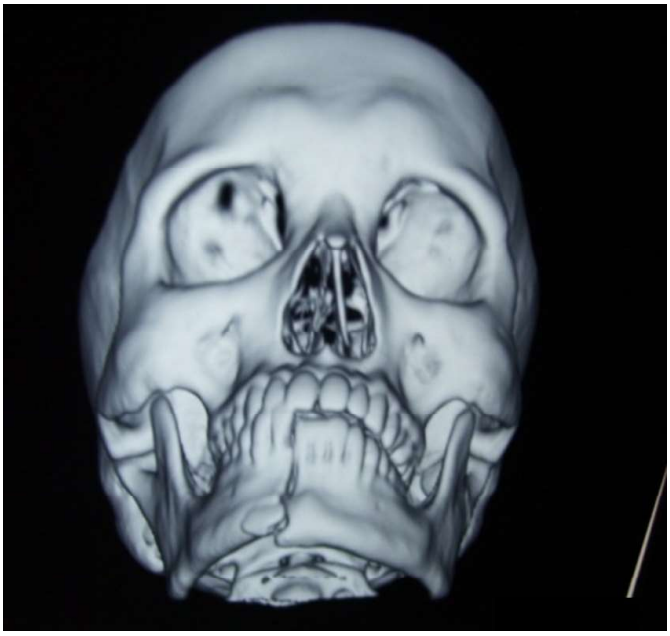


Figure 4: CT with 3D reconstruction showing symphysis fracture of mandible

Figure 5: Homan's retractor

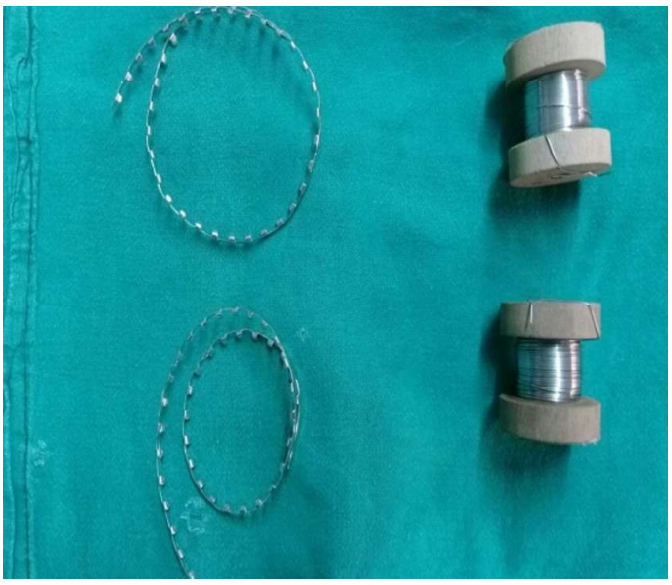


Figure 6: Arch bar and SS wire

External approach- (Indication- fracture in angle and ramus) 5 cm incision is made 2 to 2.5 cm below the angle of the mandible on a skin crease and extended postero-superiorly toward the earlobe. Platysma is incised 2 cm inferior to the skin incision. Dissection is carried down to the posterior belly of the digastric. Once the digastric is identified, dissection is carried superiorly up to the inferior border of the mandible. The periosteum is incised. Freer's elevator is used to elevate the periosteum to expose the fracture.

5. Intervening soft tissue is removed from the fracture line.
6. Fracture reduced, occlusion checked and MMF wires tightened.
7. The normal four hole miniplate with screws of 6-8 mm length was preferred in most cases. Alternatively, four-hole plates with bar, six hole plates with or without bar was used especially where there is involvement of mental foramen, danger of injury to root tips, or there are comminuted fracture.
8. Intraoral incisions closed with chromic catgut or vicryl suture. For external approach, drain is placed platysma is closed with a running locking vicryl suture, deep dermal interrupted monocryl sutures are placed, and the skin is closed with nylon/ prolene running suture.

Postoperative care:

Wire cutter is kept at bedside upon leaving the operating room for removing MMF wires if patient vomits to prevent aspiration. Post operative antibiotics continued for 10 days. Oral hygiene is stressed, including daily brushing of the teeth and arch bars. Dental wax was used to protect the buccal mucosa from the sharp edges of the wires and arch bars, where applicable. MMF and arch bars were removed after 1 and 6 weeks respectively. Patients' post-operative diet was restricted to liquids in the first week followed by a soft diet for 1 month.

Follow up:

Patients were followed up clinically after 1 week, 2 weeks, 4 weeks, 8 weeks, 3 months, and 6 months to assess the outcome of the ORIF

Outcome assessment was done according to the following parameters:

1. Union of mandible-
   Nonunion was assessed by mobility at fracture site.
   Malunion was assessed by malocclusion.

Figure 7: Mandible tray containing multiple sizes of screws, plates & drill bits

Figure 8: Securing of arch bars

Figure 9: Maxillomandibular fixation

2. Occlusion- Occlusion is the way in which one's maxillary and mandibular teeth relate to each other when the jaw is closed. When treating fractures of the mandible, the first and primary objective is to re-establish the patient's pre-injury occlusion. Angle's classification is most commonly used to define a patient's occlusion and has three classes.

In Class 1 occlusion the mesio-buccal cusp of the maxillary first molar rests within the mesio-buccal groove of the mandibular first molar.

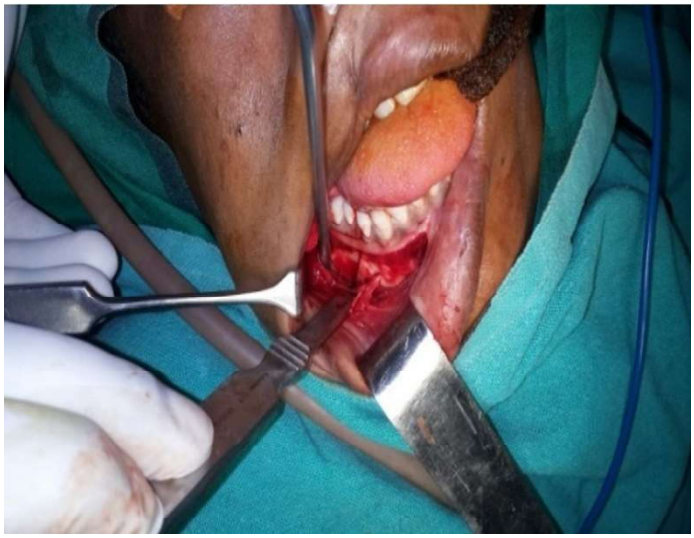


Figure 10: Vestibular approach

Figure 11: External approach

In Class 2 occlusion (retrognathism) the maxillary first molar is more anterior in relation to the mandibular first molar.

In Class 3 occlusion (prognathism) the maxillary first molar is more posterior in relation to the mandibular first molar. Two other malocclusions are open bite and cross bite.

3. Pain- Duration and intensity of postoperative pain is assessed with visual analogue scale (VAS). No pain- 0, mild pain- 1 to 3, moderate pain- 4 to 6, severe pain- 7 to 10.

4. Infection- Assessed by pain, swelling, redness, raised temperature and if any discharging sinus at the site of fracture.

5. Facial deformity- Facial appearance to include profile considerations, restoration of symmetry and post-operative scarring.

6. Neurosensory disturbances- The most commonly injured nerve associated with mandibular fractures is the inferior alveolar nerve and its branches especially, the mental nerve.

The prominent sign of inferior alveolar nerve deficit is numbness or other sensory changes in the lower lip and chin. A rare but impressive nerve deficit is that the marginal mandibular branch of the facial nerve.

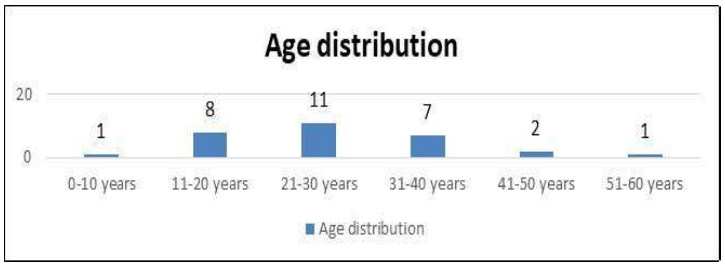
7. Mouth opening (trismus) - maximal mouth opening checked by inter-incisor distance.

Trismus is assessed according to the average inter-incisor vertical mouth opening (between the upper and lower central incisors). Normal: 40 to 50 mm, Functional: 25 to 35 mm and Limited: 10 to 24 mm.

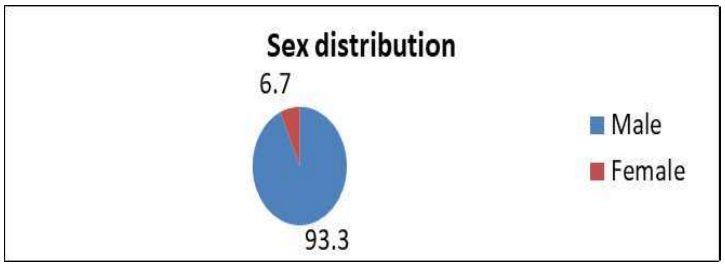
Radiological assessment, preferably with OPG was done postoperatively to assess healing process.

RESULT AND ANALYSIS:

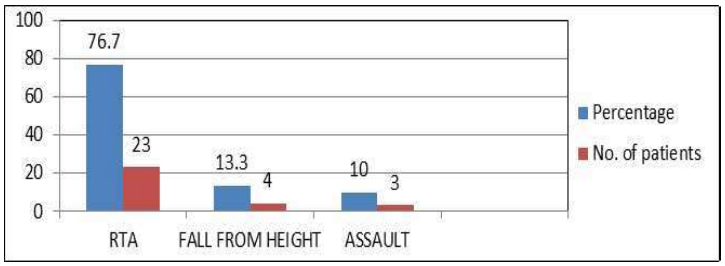
Age distribution:



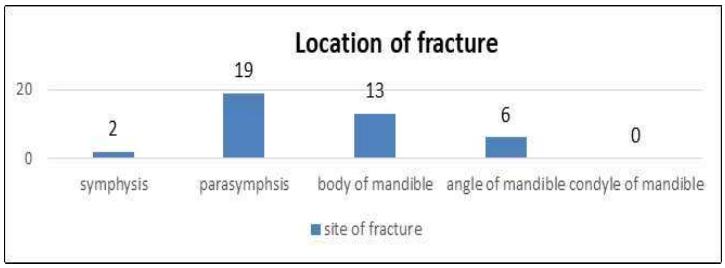
Sex distribution:



Etiology of mandibular fractures:



Distribution of location of fractures of mandible:
Out of 30 patients the total number of fractures was 40.



Surgical approaches:
Table 1: Surgical approaches

Surgical approaches	Number of patients	Percentage
Intra oral	18	60%
Extra oral	10	33.33%
Both intra oral and extra oral	1	3.33%
Through existing scar	1	3.33%
Total	30	100%

Overall outcome measures:
Table 2: Overall outcome measures at the end of six months

Outcome	Pre-operative	Post-operative (6 months)
Union of mandible	0%	96%
Occlusion	13.4%	100%
Pain	100%	0%
Infection	0%	0%
Facial deformity	100%	0%
Neurosensory disturbances	0%	0%
Trismus	86.6%	0%

Figure 12: Post-operative malocclusion

Figure 13: Post-operative ORIF showing discharging sinus with infected skin

DISCUSSION:

Historical references regarding mandible fracture diagnosis and treatment date back to 1650 BC as evidenced by the Edwin Smith Surgical Papyrus [16]. Hippocrates was the first to describe reapproximation and immobilization through the use of circumdental wires and external bandaging. Most fracture treatment, however, involved some form of external bandage or wrap, occasionally used in conjunction with a bridle wire, until the 19th century, when Gilmer reformed the treatment of fractures by fixated full arch bars on the mandible and the maxilla [17]. In 1888, Schede was the first to use a solid steel plate held by 4 screws for fixation [18].

The two management principles of AO rigid internal fixation and the Champy method of monocortical miniplates revolutionized the treatment approach to mandibular fractures. The treatment of mandibular fractures has changed significantly in the past century. The uses of a Barton bandage or a Gunning splint has evolved to the use of MMF alone, MMF plus open reduction with intrabony stainless steel wire fixation and MMF with open reduction using bone plates and screws.

In this study, the incidence of mandibular fracture was highest in 21 to 30 years of age (36.7%) which was in conformity with Adi et al. [19], Bataineh [20], Dongas and Hall [21], Ahmed et al. [22], Brasileiro and Passeri [23], but contradictory to Shapiro et al. [24] who reported 34.1 years as mean age range.

Males predominate with 93.3% od the cases, while females constitute a minor percentage of 6.7%, that is, in a ratio of 14: 1. This conforms with Adi et al. [19], Bataineh [20], Dongas and Hall [21], Ahmed et al. [22], Brasileiro and Passeri [23] and Shapiro et al.[24].

The most common etiologic factor in this study is road traffic accident (76.6%) which is in accordance with Bataineh [20], Ahmed et al. [22], Brasileiro and Passeri [23] and Shah et al. [25]. Adi et al. [19] and Dongas and Hall [21] reported assault as the main cause. Road traffic accident is still the major cause probably due to reckless and high-speed driving, reluctance to use helmets and seat belts and inadequate enforcement of traffic safety rules.

In this study, out of 30 subjects, 22 (73.3%) were reported as unilateral while bilateral accounted for 8 cases (26.7%). In an epidemiological study, Natu et al. reported 56.1% of patients had a unilateral mandibular fracture while 43.9% patients had bilateral fractures [8].

In the present study, 73.3% patients had one fracture, 20% patients had two fractures and 7.7% patients had more than two fractures. Hai-Won Jung et al. reported single fracture line in 47.5% patients, two fracture lines in 51.35 % patients and 1.2% patients had three fracture lines 26 .

The parasymphysis being the commonest site of fracture in this study, is contrary to Adi et al. [19], Bataineh [20], and Shah et al. [25] who reported body as the commonest. While Dongas and Hall [21] reported angle as the commonest, in a different study Ahmed et al. [22], and Brasileiro and Passeri [23] stated condyle as the most common site of fracture. The parasymphysis is probably the commonest site due to the presence of permanent tooth buds in the pediatric mandible presenting a high tooth to bone ratio, while in adults it is partly due to the length of canine root weakening the structure.

Both OPG and CT scan with 3D reconstruction were done in our study as an essential part of management workup. The panoramic radiograph can provide a good initial evaluation of mandibular trauma allowing visibility of the entire mandible, including the condyles, dento-alveolar complex and dentition. In this study, CT scan was done to assess the angulations and/or displacement of the fractures better. Multislice computed tomography (MSCT) is progressively replacing the panoramic radiograph for mandibular trauma, and is increasingly being performed to detail and classify mandibular trauma [27]. CT is being increasingly applied to define the fracture location and the degree of dislocation in mandibular trauma. The great advantage of CT in comparison with panoramic radiography is the ability to image soft tissue [28].

Traditional teaching has been that mandible fractures should be reduced within 24 hours of injury. In our study the time taken between injury and open reduction was 7 days because our institution is a tertiary referral centre where patients are referred from other hospitals

In the meantime, callus formation occurred and we had to freshen the fracture line to remove the callus. Recent studies have shown no increase in complications with a delay beyond 24 hours [29].

In our study, we used miniplates for internal fixation. Miniplates are less palpable externally and less thermally sensitive to the patient. A higher incidence of complications has been noted in fractures treated with compression plates [30]. Use of micro miniplates for mandibular surgery is limited because of their inability to provide rigid fixation and tendency for plate fracture during the healing process [31]. Laughlin et al. showed in their study that resorbable plates are equivalent to titanium 2 mm plates with regards to fracture healing [32]. A study showed that there is no major difference in terms of treatment outcome between conventional and 3D miniplates [33].

In a prospective randomized clinical trial comparing the 2 mm locking plates versus 2 mm standard plates, Agarwal et al reported that there was a significant decrease in postoperative pain measured in visual analogue scale (VAS) scores [34].

Malunion may occur as a result of plate bending or poor intra-operative reduction of fractured segments. The malunion encountered in this study was minor in nature and required no surgical intervention. In a prospective study, Umar Khitab et al. reported malunion in their study was minor in nature [35].

In our study, preoperative trismus was present in most of the (26 patients out of 30) patients and 3 months after surgery, all patients achieved normal mouth opening. In a study Mohammad Waheed El-Anwar et al. reported normal mouth opening 8 weeks after surgery [36].

In our study infection was the commonest complication (10%). The pattern of fracture, technical errors, lack of prophylactic antibiotics, mobility at the fracture site and the non compliance of patients are considered the predisposing factors for infection [37]. Two patients responded to antibiotics and one patient required plate removal. The second most common complication noted was post-surgical malocclusion (6.2%). Malocclusion was based on evaluation of occlusion, checked for maximum interdigitation, midline relationship, molar relationship and patient complaints. Previous reports of Dodson TB et al. [38] (7.7%) also coincides with the present study.

In this study sensory disturbances were recorded in one patient as the disturbances of inferior alveolar nerve. In postoperative OPG, there was no inferior dental canal penetration by screw. It may be due to the elevation of flap and stretching of the nerve. The sensory disturbances disappeared after 3 months follow up of the patient. In our study, there was no record of any involvement of the mandibular branch of the facial nerve as has been reported by Dodson TB et al. [38]

Jaques B et al. [39] reported 1.45% sensory disturbances in the mental nerve while Gabrielli MA et al. [40] reported 0.89% paresthesia in the inferior alveolar nerve after applying rigid fixation.

CONCLUSION:

This prospective observational study was performed on 30 patients of mandibular fractures who attended the OPD and Emergency in the department of ENT, Head & Neck surgery at Nil Ratan Sircar Medical College & Hospital, Kolkata within a time frame of 1 year. Panfacial and pathological fractures were excluded from this study. All the cases were treated by ORIF with MMF for 1 week. In this study, most of the patients were male between ages 20 to 30 year. The commonest cause of mandibular fracture was road traffic accident. The commonest sites of fracture were as follows- parasymphysis, body, angle and symphysis respectively. The following outcomes were measured and evaluated for 6 months- pain (VAS score), trismus, occlusion, union of fracture, facial deformity and neurosensory disturbances. At the end of 6 months, the rate of overall complications was 3.3%, with pain score coming down zero with no trismus and neurosensory disturbances and facial deformity.

REFERENCES:

1. G. O. Kruger, Textbook of Oral & Maxillofacial Surgery, Jaypee Brothers, 6th edition, 1990.
2. T. J. Edwards, D. J. David, D. A. Simpson, and A. A. Abbott, "Patterns of mandibular fractures in Adelaide, South Australia," Australian and New Zealand Journal of Surgery, vol. 64, no. 5, pp. 307–311, 1994.
3. J. A. Halazonetis, "The "weak" regions of the mandible," British Journal of Oral Surgery, vol. 6, no. 1, pp. 37–48, 1968.
4. V. R. Hodgson, "Tolerance of the facial bones to impact," American Journal of Anatomy, vol. 120, pp. 113–122, 1967.
5. Adeyemo WL, Iwegbu IO, Bello SA, Okoturo E, Olaitan AA, et al.Management of mandibular fractures in a developing country: a review of 314 cases from two urban centers in Nigeria. World Journal of Surgery 2008;32(12): 2631–5.
6. Nishiike S, Sakata Y, Kato T, Nagai M, Konishi M. 35 mandibular fracture cases. Nihon Jibiinkoka Gakkai Kaiho 2002;105(10):1065–70.
7. Van Hoof RF, Merkx CA, Stekelenburg EC. The different patterns of fractures of the facial skeleton in four European countries. Int J Oral Surg. 1977 Feb. 6(1):3-11.

8. Natu, S. S.; Pradhan, H.; Gupta, H.; Alam, S.; Gupta, S.; Pradhan, R.; Mohammad, S.; Kohli, M.; Sinha, V. P.; Shankar, R.; Agarwal, A. (2012). "An Epidemiological Study on Pattern and Incidence of Mandibular Fractures". Plastic Surgery International 2012: 1.
9. Fridrich KL, Pena-Velasco G, Olson RAJ. Changing trends with mandibular fractures: A review of 1067 cases. J Oral Maxillofac Surg. 1985. 59:120.
10. Olson RA, Fonseca RJ, Zeitler DL, Osbon DB. Fractures of the mandible: a review of 580 cases. J Oral Maxillofac Surg. 1982 Jan. 40(1):23-8.
11. Spiessl B. Rigid internal fixation of fractures of the lower jaw. Reconstr Surg Traumatol. 1972. 13:124-40.
12. Champy M, Loddé JP, Schmitt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. J Maxillofac Surg. 1978 Feb. 6(1):14-21.
13. Ellis E 3rd, Miles BA. Fractures of the mandible: a technical perspective. PlastReconstr Surg. 2007 Dec. 120(7 Suppl 2):76S-89S.
14. Terris DJ, Lalakea ML, Tuffo KM, Shinn JB. Mandible fracture repair: specific indications for newer techniques. Otolaryngol Head Neck Surg. 1994 Dec. 111(6):751-7. [Medline].
15. Schneider M, Erasmus F, Gerlach KL, Kuhlisch E, Loukota RA, Rasse M. 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 Dec. 66(12):2537-44. [Medline].
16. Lipton JS. Oral surgery in ancient Egypt as reflected in the Edwin Smith Papyrus.Bulletin of the History of Dentistry 1982; 30: 108.
17. Gilmer TL: A case of fracture of the lower jaw with remarks on the treatment. Arch Dent 4:388, 1887.
18. DorranceGM, BransfieldJW:The history of treatment of fractured jaws,Washington, 1941.
19. M. Adi, G. R. Ogden, and D. M. Chisholm, "An analysis of mandibular fractures in Dundee, Scotland (1977 to 1985)," British Journal of Oral and Maxillofacial Surgery, vol. 28, no. 3, pp. 194–199, 1990.
20. A. B. Bataineh, "Etiology and incidence of maxillofacial fractures in the north of Jordan," Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics, vol. 86, no. 1, pp. 31–35, 1998.
21. Dongas and G. M. Hall, "Mandibular fracture patterns in Tasmania, Australia," Australian Dental Journal, vol. 47, no. 2, pp. 131–137, 2002.
22. H. E. A. Ahmed, M. A. Jaber, S. H. Abu Fanas, and M. Karas, "The pattern of maxillofacial fractures in Sharjah, UAE: a review of 230 cases," Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology, vol. 98, no. 2, pp. 166–170, 2004.
23. B. F. Brasileiro and L. A. Passeri, "Epidemiological analysis of maxillofacial fractures in Brazil: a 5-year prospective study," Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology, vol. 102, no. 1, pp. 28–34, 2006.
24. A. J. Shapiro, R. M. Johnson, S. F. Miller, and M. C. McCarthy, "Facial fractures in a level I trauma centre: the importance of protective devices and alcohol abuse," Injury, vol. 32, no. 5, pp. 353–356.
25. A. Shah, A. S. Ali, and S. Abdus, "Pattern and management of mandibular fractures: a study conducted on 264 patients," Pakistan Oral & Dental Journal,vol.27, no. 1, pp. 103–106, 2007.
26. Hai-Won Jung,Baek –Soo Lee And Joo-Young Ohe,Retrospective Clinical Study of Mandible Fractures Korean Assoc Oral Maxillofacial Surg.2014; 40(1): 21-26.
27. Dos Santos DT , Costa e Silva AP, Vannier MW, Cvalcanti MG. Validity of multislice computed tomography for diagnosis of maxillofacial fractures using an independent workstation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004; 98(6): 715-720.
28. Schuknecht B, Graetz K. Radiologic assessment of maxillofacial, mandibular, and skull base trauma. Eur Radiol 2005; 15(3): 560-568.
29. Barker DA, Oo KK, Allak A, Park SS. Timing for repair of mandible fractures. Laryngoscope. 2011 Jun. 121(6):1160-3.
30. Iizuka T, Lindqvist C. Rigid internal fixation of fractures in the angular region of the mandible: an analysis of factors contributing to different complications. Plast Reconstr Surg 1993; 91:265–271.
31. Potter J, Ellis E. Treatment of mandibular angle fractures with a malleable noncompression miniplate. J Oral Maxillofac Surg 1999; 57:288–292.
32. Laughlin RM, Block MS, Wilk R, Malloy RB, Kent JN. Resorbable plates for the fixation of mandibular fractures: a prospective study. J Oral Maxillofac Surg. 2007 ;65(1): 89-96.
33. Singh V, Puri P, Arya S, Malik S, Bhagol A. Conventional versus 3-Dimensional Miniplate in Management of Mandibular Fracture -A Prospective Randomized Study. Otolaryngol Head Neck Surg. May 2012 (Online Published).
34. Agarwal M, Mohammad S, Singh RK, Singh V. Prospective randomized clinical trial comparing bite force in 2-mm locking plates versus 2-mm standard plates in treatment of mandibular fractures. Journal of Oral and Maxillofacial Surgery 2011;69(7):1995–2000.
35. Umar Khitab, Ahmad Khan, Mohammad Tariq Khan, Outcome Of Rigid Internal Fixation Of Mandibular Fractures: A Prospective Study Pakistan Oral & Dental Journal Vol 29, No. 2 (December 2009) pp 207-210.

36. Mohammad Waheed El-Anwar MagdyAbdalla Sayed El-Ahl HazemSaed Amer . Open Reduction and Internal Fixation of Mandibular Fracture without Rigid Maxillomandibular Fixation. Int Arch Otorhinolaryngology 2015 Oct; (4) :314-8.
37. Manor Y, Chaushu G, Taicher S. Risk factors contributing to symptomatic plate removal in orthognathic surgery patients. Br J Oral Maxillofac Surg 1999; 57: 679-82.
38. Dodson TB, Perrott DH, Kaban LB, Gordon NC. Fixation of mandibular fractures: A comparative analysis of rigid internal fixation and standard fixation techniques. J Oral Maxillofac Surg 1990; 48: 362-6.
39. Jaques B, Richter M, Arza A. Treatment of mandibular fractures with rigid osteosynthesis: using the AO system. J Oral MaxillofacSurg 1997; 55: 1402-6.
40. Gabrielli MAC, Gabrielli MFR, Marcantonio E, Hochuli-VieiraE. Fixation of mandibular fractures with 2.0-mm miniplates:review of 191 cases. J Oral MaxillofacSurg 2003; 61: 430.