Different Treatment modalities for anterior mandibular fractures (A retrospective study)

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Abstract: Purpose: The aim of this study was aimed to evaluate the different methods of fixation used for fixation of anterior mandibular fractures as a retrospective study. **Patients and methods**: Seventy eight patients with anterior mandibular fractures were included in this study. (50 Males and 28 Females) the patient age range from 20-52y with mean of 37.5years. the intra and postoperative patient's data were collected to evaluate and compare the different methods of fixation used for these patients. **Results:** Patients with isolated anterior fractures (3 patients) were treated by open reduction one miniplate in addition to the solid arch bar which used as a tension band that removed after one month, 25 patients treated by using 2 miniplate at the Champy's lines, 13 using 3D miniplate, 10 patients using 2 titanium lag screws, 7 patients using one lag screw, 10 patients using single lag screw with single miniplate and 10 patients using low profile (1.5mm) locking reconstruction plate placed almost midway between the inferior border of the mandible and subapical region. Post-operative radiographic examination revealed no changes in the position of the fractured segments and the fracture line easily detected in cases with single miniplate and 2 miniplate but hardly detected in cases with 3D miniplates, lag screws and reconstruction plates. **Conclusion:** 1-Champy's miniplate system is a better and easier method for fixation of mandibular fractures. 2- The 3D miniplate system provides good stability in most cases and operative time is shorter because of simultaneous stabilization at both superior and inferior borders. 3- Lag scerw provides adequate compression to the fracture segments so that primary bone healing can be achieved and produced excellent adaptation and maximum stability. 4- Reconstruction plate
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Key Wards: Anterior Mandibular fracture, lag screw, 3D minipalates

1. Introduction

Anterior mandibular fractures are relatively common and approximately it represent about 20% of mandibular fractures [1]. Most commonly associated with indirect fractures especially in the subcondylar region [2]. Fractures of the symphyseal region are often associated with the clinical signs of a widened intragonial distance with resultant malocclusion [1].

Fractures of the symphysis/ parasymphysis are inherently unstable. The mandible subjected to rotation about the axis of the temporomandibular joint due to muscles of mastication insert into its posterior portions. On the other hand the suprahyoid muscles act directly on the anterior mandible produce inferior rotation around the axis of the temporomandibular joint and scissoring motion around a vertical axis through the symphysis resulted from the mylohyoid muscles action.

Fractures of the anterior mandible lack 2 of the stabilizing factors provided to fractures of the posterior tooth-bearing mandible: the splinting effects of the masseter and internal pterygoid muscles, which form a natural sling, and the interlocking cusps and fossae of bicuspid and molar teeth [3].

The keys to the successful management of these fractures include proper reduction of the fractures, maintenance of premorbid occlusion, and early return to function. The management of fractures will depend on the fracture pattern, fracture severity, and patient factors, such as residual dentition, coexistent lacerations, and associated injuries [4].

Treatment of anterior mandibular fractures were treated conservatively with closed reduction and a period of prolonged maxillomandibular fixation and with open reduction and internal fixation including lag screws and miniplates [5,6]. The approach to rigid plate fixation has likewise been modified with progressively smaller plates and less reliance on compression in the treatment of these fractures. The work of Champy and others has allowed for reliable fixation along lines of osteosynthesis hrough transoral approaches. [7]

Aim of the Study

This retrospective study was aimed to evaluate the different treatment modalities used for fixation of anterior mandibular fractures.

2. Patients and Methods

Seventy eight patients with anterior mandibular fractures were included in this study. the patients were received and treated in Oral & Maxillofacial Surgery Department, Faculty of Dentistry, Tanta University,

Egypt. In the period from December 2014 to December 2016. The management started with immediate resuscitation following the principles of advanced trauma life support (ATLS). Plain anteroposterior (AP) and lateral facial radiographs, and Orthopantomogram (OPG) were done in all the cases. An axial, coronal and 3-D CT scan were obtained in patients mandibular condyle or subcondylar fractures.

An accurate assessment of the fractures was made including the site and type of fracture, the amount of displacement, amount of pain or discomfort, anaesthesia in the distribution of inferior alveolar nerve, marginal mandibular nerve paresis, the status of dental occlusion, any associated temporomandibular joint (TMJ) injury, or any other functional deficits.

Technique

All operations were performed under general anesthesia by nasotracheal intubation. Erich-type arch bars were first applied to the upper and lower dentition.

Temporary IMF was applied in ORIF cases for aiding occlusion. The fracture was approached through a vestibular incision between the mental foramina. (Fig. 1). The fragments were reduced and fixed temporarily using a special reduction forceps [8]. Once the fracture has been reduced to the anatomic position, the fixation was done. Different forms of fixation modalities for fracture were used including, single miniplate with arch bar as a tension band, 2 miniplates, single lag screw, 2 lag screws, 3dimensional bone plates, single lag screw with single miniplate at the upper border (subapically) and single low profile (1.5mm) locking reconstruction plate placed almost midway between the inferior border of the mandible and subapical region (Fig 2).

Figure 1: The surgical approach to the anterior mandible. Note the generous cuff of the mucosa that is left attached to the gingiva to allow for accurate and watertight closure at the end of the case.

Figure 2(A-D): Photographs showing different methods of fixation used in this study.

Once the hardware has been placed, the occlusion is checked and attention is turned to closure. After copious irrigation, the intraoral incision was closed with care taken to reattach the mentalis muscle. A watertight closure of the mucosa is then performed with absorbable sutures. The patients were followed postoperatively for signs of malocclusion, wound breakdown, and infection. A postoperative panorex or computed tomography scan was frequently obtained to confirm and document accurate reduction of the fractures. Patients should be followed for at least 6 weeks to insure accurate reduction and occlusion during the fracture healing.

3. Results

Seventy eight patients with anterior mandibular fractures were included in this study. (50 Males and 28 Females) the patient age range from 20-52y with mean of 37.5y. Three patients with isolated anterior mandibular fractures, 44 patients had anterior mandibular fractures associated with subcondylar/ condylar fractures and 31 had anterior mandibular fractures associated with angular fractures.

Patients with isolated anterior fractures (3 patients) were treated by open reduction and one miniplate in addition to the solid arch bar which used as a tension band that removed after one month, 25 patients treated by using 2 miniplate at the Champy's lines, 13 using 3D miniplate, 10 patients using 2 titanium lag screw, 7 patients using one lag screw., 10 patients using single lag screw with single miniplate at the upper border (subapically) and 10 patients using single low profile (1.5mm) locking reconstruction plate placed almost midway between the inferior border of the mandible and subapical region. (Table 1)

Table 1: Different treatment methods used in this study and numbers of patients in each one

Treatment methods	Isolated anterior mandibular fractures	Anterior mandibular fracture with subcondylar/ condylar fractures	Anterior mandibular fracture with angle fractures	Total
Single miniplate	3	-	-	3
2 miniplate	-	16	9	25
3D miniplate	-	8	5	13
2lag screw	-	4	6	10
Single lag screw	-	3	4	7
Single lag screw + single miniplate	-	7	3	10
Single reconstruction plate +		6	4	10
Total	3	44	31	78

The follow up data (clinically and radiographically) for all patients were collected for 6 months postopertively. The data revealed that no signs of infection, problems of wound healing, swelling, discoloration, or discharge were seen during follow-up expect in three patients one treated with 2 miniplates fixation developed slight wound dehiscence with upper plate exposure at the second post-operative week. This patient was treated by continuous irrigation with warm normal saline, antiseptic mouthwash and keeping good oral hygiene until complete wound healing was achieved in two weeks. The other 2 patients treated with lag screw had local infection related to a devitalized tooth in the fracture line and could not be related to the type of osteosynthesis (Fig.3).

There was no clinical evidence of neurosensory deficits due to surgery in all cases. Paresthesia of the lower lip encountered in three cases before surgery, these patients followed up until regained normal neurosensory function spontaneously after four weeks in two cases and after six weeks in the last case.

Postoperative clinical evaluation of the segments mobility showed that no mobility between fracture segments in all cases.

Postoperative assessment of occlusion was good except in three patients with subcondylar fractures and treated with single lag screw. Malocclusion that was acquired in these patients was treated by elastic traction and simple selective teeth griding.

Figure 3: Patient treated with 2miniplate there was wound dehesince and exposure of superior plate.

In immediate post-operative radiographs taken within two days, reduction of the anterior fractures was assessed as exact in cases treated with 2 miniplates, 3D miniplate, 2 lag screw and low profile locking reconstruction plate. Radiolucencies representing the fracture lines were still noted in cases treated with single miniplate and one lag screw.

Radiographic examination at the first month post-operatively revealed no changes in the position of the fractured segments and the fracture line easily detected in cases with, single or 2 miniplate but hardly detected in cases with 3D miniplates, lag screws and low profile locking reconstruction plate. (Fig.4 A-C). At the end of the follow up period all patients showed complete bone healing.

Comparison of bone density immediately postoperative and at different follow up periods among patients was done. In regarding to the cases tearted by 2 miniplate the mean value of bone density immediate postoperatively was 720.34±67.5. One month after operation the mean value increased to 960.22±45.2. Further increase in bone density was observed three month later to reach 1135.45±77.43. The increase in bone density continued at six months postoperatively to reach 1280.5±55.7. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). table (2)

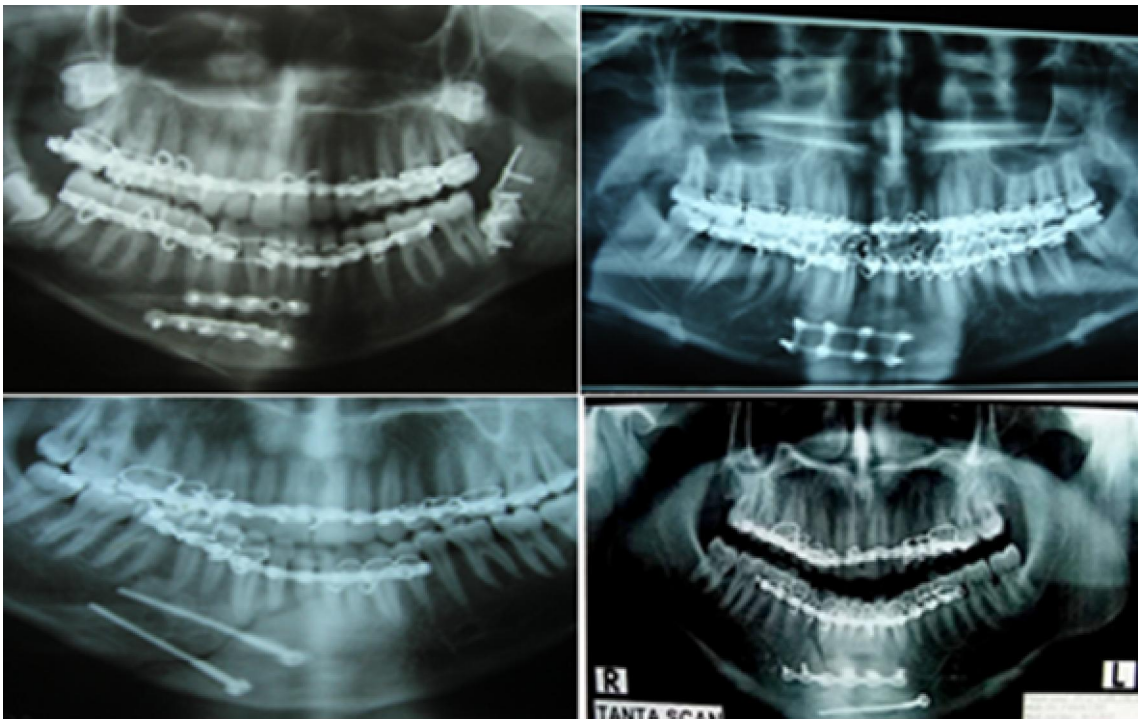

Figure 4: postoperative radiographs showing different fixation methods

The mean value of bone density immediate postoperatively in cases treated with one miniplate plus solid arch bar was 659.21±64.5. One month after operation the mean value increased to 910.22±46.4. Further increase in bone density was observed three month later to reach 1105.14±76.49. The increase in bone density continued at six months postoperatively to reach 1250.7±65.4. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). In comparison to the two miniplate cases at different follow up periods there was no statistical significant diferernces as the t test was 0.643, 0.321, 0.421 and 0.562. table (2)

The mean value of bone density immediate postoperatively in cases treated with one lag was 700.314±43.6. One month after operation the mean value increased to 900.32±32.8. Further increase in bone density was observed three month later to reach 1100.6±54.49. The increase in bone density continued at six months postoperatively to reach 1255.4±15.8. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). In comparison to the two miniplate cases at different follow up periods there was no statistical significant diferernces as the t test was 0.217, 0.745, 0.321 and 0.267. table (2)

The mean value of bone density immediate postoperatively in cases treated with one lag screw

plus one miniplate was 780.54±85.3. One month after operation the mean value increased to 990.29±96.7. Further increase in bone density was observed three month later to reach 1190.46±87.63. The increase in bone density continued at six months postoperatively to reach 1270.6±85.4. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). In comparison to the two miniplate cases at different follow up periods there was no statistical significant diferernces as the t test was 0.362, 0.318, 0.691 and 0.128. table (2)

The mean value of bone density immediate postoperatively in cases treated with two lag screw was 800.96±72.9. One month after operation the mean value increased to 1000.82±47.1 Further increase in bone density was observed three month later to reach 1200.69±11.49. The increase in bone density continued at six months postoperatively to reach 1290.3±85.7. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). In comparison to the two miniplate cases at different follow up periods there was no statistical significant diferernces as the t test was 0.389, 0.215, 0.752 and 0.534. table (2)

The mean value of bone density immediate postoperatively in cases treated with 3D miniplate was 740.22±61.5 One month after operation the mean value increased to 960.57±64.9Further increase in bone density was observed three month later to reach 1120.16±85.73. The increase in bone density continued at six months postoperatively to reach 1270.2±85.9. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). In comparison to the two miniplate cases at different follow up periods there was no statistical significant diferernces as the t test was 0.093, 0.327, 0.078 and 0.543. table (2)

The mean value of bone density immediate postoperatively in cases treated with one reconstruction locking plate was 805.14±57.3One month after operation the mean value increased to 985.75±71.8Further increase in bone density was observed three month later to reach 1125.96±67.93The increase in bone density continued at six months postoperatively to reach 1275.3±54.8. These changes were found statistically significant as the p1, p2 and p3 was ≤0.001*). In comparison to the two miniplate cases at different follow up periods there was no statistical significant diferernces as the t test was 0.064, 0.075, 0.832 and 0.073. table (2).

Table (2): The changes in bone density (mean) for different fixation hardware

Bone density	Two miniplates		one miniplate and solid arch bar		t-test	One lag		t-test	One lag and miniplate		t-test	two lags		t-test	3D miniplates		t-test	Reconstruction plate		t-test
	Mean± SD		Mean± SD			Mean± SD			Mean± SD			Mean± SD			Mean± SD			Mean± SD		
Imm postop	720.34±67.5		659.21±64.5		0.643	700.314±43.6		0.217	780.54±85.3		0.362	800.96±72.9		0.389	740.22±61.5		0.093	805.14±57.3		0.064
After1 m	960.22±45.2		910.22±46.4		0.321	900.32±32.8		0.745	990.29±96.7		0.318	1000.82±47.1		0.215	960.57±64.9		0.327	985.75±71.8		0.075
After 3 ms	1135.45±77.43		1105.14±76.49		0.421	1100.6±54.49		0.821	1190.46±87.63		0.691	1200.69±11.49		0.752	1120.16±85.73		0.078	1125.96±67.93		0.832
After 6 ms	1280.5±55.7		1250.7±65.4		0.562	1255.4±15.8		0.267	1270.6±85.4		0.128	1290.3±85.7		0.534	1270.2±85.9		0.543	1275.3±54.8		0.073
p-value	P1	≤0.001*	P1	≤0.001*		P1	≤0.001*		P1	≤0.001*		P1	≤0.001*		P1	≤0.001*		P1	≤0.001*	
	P2	≤0.001*	P2	≤0.001*		P2	≤0.001*		P2	≤0.001*		P2	≤0.001*		P2	≤0.001*		P2	≤0.001*	
	P3	≤0.001*	P3	≤0.001*		P3	≤0.001*		P3	≤0.001*		P3	≤0.001*		P3	≤0.001*		P3	≤0.001*	

4. Discussion

Evaluation of the methods of osteosynthesis may be not only by the reduction achieved and the stability of fixation, but also by their technical application, economic aspects, and also by the extent of trauma resulting from the used surgical approach. Osteosynthesis methods should be selected only if they ensure early full rehabilitation of the patient in combination with minimally invasive surgery and economic use of materials and less time consuming. The less technical input required for a particular method, the more it will be accepted. Beside, adequate knowledge of biomechanics of static and dynamic forces acting in the region being restored considered as important factors for successful management. Many factors are usually taken in consideration when selecting the methods of fixation of mandibular fractures. The presence of other associated fractures, nature of injury, medical and economic status of the patient and surgeons experience are some of these factors. Also the site of injury dictates to great extent the selected method of fixation [10].

Open reduction and internal fixation (ORIF) of anterior mandibular fractures through an intraoral approach was done in our study provided the advantage of simultaneous visualization of the fracture line and occlusion relation. It also eliminated extraoral incision and the risk of scar formation [11-14].

Fixation of anterior mandibular fracture using transosseous wiring can be use in simple single fractures as it more simple and economic method not need especial instruments but it need long period of maxillomandibular fixation and so affect the patient's quality of life.

Rigid internal fixation with metal plates and screws is used extensively to secure bone fragments in fracture surgery. Development of more biocompatible osteosynthesis materials such as titanium has led some to recommend leaving these materials in situ forever. [15]

The lag screw used in the current study was combined with biconcave washer which acts as anti-crack. This washer was converting the wedging forces underneath the screw head into pressure forces which the bone able to tolerate without fracture and preventing the lag screw head to penetrating the cortical bone into the underling spongiosa losing its support. This was the same explanation of Krenkel, 1994 & Terheyden, 1999[16, 17] who concluded that, the anti-crack character of the washer had broaden the indication of lag screw in the maxillofacial region.

It is important to understand that the stability of this kind of osteosynthesis relies solely on compression between the fragments. If there is fragmentation, this single stabilizing factor is lost, and the fracture must be treated with bone plates and screws in a neutral position. [18]

In lag-screw osteosynthesis, interfragmental compression is the main factor stabilizing the fracture. Axial stresses inside the screw are, therefore, the forces most needed to counter the displacement. These are generated by torsion of the screw.

In this study, 2 lag screws were used successfully in anterior mandibular fractures and this was in agreement with Terheyden [18] who denote that, lag screw fixation of anterior mandibular fractures is an extremely simple and successful means of rigidly securing bone segments through small intraoral incision also permitting active use of the mandible during healing but its technique sensitive depends on skillful operator. Although lag screw allow good stability and maximum compression at the fracture line but when use one lag in anterior mandible it may allow some degree of rotation at the fracture line if one lag is used, this was clear in two cases treated with one lag and showed some sort of malocclusion which was corrected using elastic traction and selective grinding.

In regarding to cases treated with single lag scerw with single miniplate for fixation this method had the advantages of lag scerw which compess the fracture segments together giving more fixation stabiliy as well as the advatages of miniplate placed in subapical reiogn that prevent risk of roots injury when placed lag scerw in subapical reiogn.

The survey of 104 North American and European AO/ASIF surgeons, that published recently showed, only 6% stated that they use 3D plates. Moreover, only a few follow-up series are presented in the literature, with few studies [20-23] emphasizing the hardware-related advantages over conventional miniplates and reconstruction plates, including easy application, simplified adaptation to the bone without distortion or displacement of the fracture, simultaneous stabilization at both superior and inferior borders, and hence less operative time. Our study agrees with them, with a short operative time for 3D plating when comparing with other methods of fixation. But not to that of simplified adaptation as a geometric plate is much more difficult to perfectly adapt than a linear plate this is in agreement with Jain et al [24] as he stated that a geometric plate is much broader and has to be bent in 3 dimensions, whereas a linear plate has to be bent only in 2 dimensions and so it is trying to adapt a “plane” rather than a “line” to a curved surface Another advantage of 3D plates is their improved biomechanical stability compared with conventional miniplates. In this study, stability was adequate in most cases except that of oblique fractures. This might be due to difficulty in achieving principles of 3D plate fixation (horizontal bar perpendicular and vertical bar parallel to fracture line1) using 4-holed rectangular plates where probably the use of 6-holed plates would have been more beneficial. In addition the limitation of 3D plates in this study was excessive hardware material resulting from extra vertical bars incorporated for countering the torque forces which is in agreement with the study Barde et al [25] who stated that, the 3D plate was found to be standard in profile, strong yet malleable, facilitating reduction and stabilization at both the upper tension and lower compresion borders giving three dimensional stability at fracture site. They seem to be an easy alternative to conventional champys miniplates

The using of single low profile locking recontsruction plate in fixation of anterior mandibular fractures provide suiefficent stabilty with redcution of the amont of hardware this was in agreement with Hang etal [26] as he stated that, the most significant advantges of adding a locking system is that, it is unneessary for the plate to initimatly contact the underlying bone in all areas. As the screws are lightened they lock to the plate thus stabilizting the segments without the need to compress the plate to the bone.

In regading to the bone density in different methods at follow up period there was

Conclusion

Methods of fixation for anterior mandibular fractures should be selected only when they ensure early full rehabilitation of the patient in combination with minimally invasive surgery and economic use of materials and time. The stability with lag screw osteosynthesis relies solely on compression between

the fragments. If there is fragmentation, this single stabilizing factor is lost, and the fracture must be treated with bone plates and screws in a neutral position.

To conclude,

1- Champy's miniplate system is a better and easier method for fixation of mandibular fractures.
2- Lag scerw provides adequate compression to the fracture segments so that primary bone healing can be achieved and produced excellent adaptation and maximum stability.
3- Single lag scerw with single miniplate placed subappically provide sufficient stability and aviod risk of roots injury.
4- The 3D miniplate system provides good stability in most cases and operative time is shorter because of simultaneous stabilization at both superior and inferior borders. But there is limitation to use in cases of oblique fractures and those involving the mental nerve as well as there is excessive implant material because of the extra vertical bars incorporated for countering the torque forces.
5- Low profile (1.5mm) locking reconstruction plate placed almost midway between the inferior border of the mandible and subapical region can provied sufficientstability for displased anterior mandibular fractures but it doesn'tpermit elastic yraction for fracture after fixation and so anatomic alignment of fracture segments must be achieved.

Conflict of interest

This paper has no conflict of interest.

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