

Efficacy of 3-Dimensional plates over Champys miniplates in mandibular anterior fractures

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Abstract:

Background: Mandibular fractures are treated surgically by either rigid or semi-rigid fixation, two techniques that reflect almost opposite concept of craniomaxillofacial osteosynthesis. The shortcomings of these fixations led to the development of 3 dimensional (3D) miniplates. This study was designed with the aim of evaluating the efficiency of 3D miniplate over Champys miniplate in anterior mandibular fractures.

Materials & Methods: This study was done in 40 patients with anterior mandibular fractures. Group I consisting of 20 patients in whom 3D plates were used for fixation while in Group II consisting of other 20 patients, 4 holes straight plates were used. The efficacy of 3D miniplate over Champy's miniplate was evaluated in terms of operating time, average pain, post operative infection, occlusion, wound dehiscence, post operative mobility and neurological deficit.

Results: The mean operation time for Group II was more compared to Group I (statistically significant). There was significantly greater pain on day of surgery and at 2nd week for Group II patients but there was no significant difference between the two groups at 4th week. The post operative infection, occlusal disturbance, wound dehiscence, post operative mobility at fracture site, neurological deficit was statistically insignificant (chi square test).

Conclusion: The results of this study suggest that fixation of anterior mandibular fractures with 3D plates provides three dimensional stability and carries low morbidity and infection rates. The only probable limitation of these 3D plates may be

excessive implant material, but they seem to be easy alternative to champys miniplate.

Key Words: 3D miniplate, champys miniplate, mandibular fractures

Introduction

Maxillofacial trauma is a cause of grave concern due to the increasing road traffic accidents, violence and sports injury. The unique position of mandible on the face makes it one of the most commonly fractured facial bones. There are a number of methods used till date for the treatment of mandibular fractures. Traditionally, the treatment modalities have ranged from conservative measures such as splints or arch bar fixation to open reduction with fixation.^{1,2} Most authorities today, advise open reduction and fixation necessary for most of the mandibular fractures.^{3,4}

Recently new techniques using internal fixation have been introduced which allow immediate function not necessitating the need for additional maxillo-mandibular fixation. These techniques are based on precise alignment of the dentition along with the fractured segments and performing plate and / or screw osteosynthesis with or without compression. Generally, mandibular fractures are treated surgically, by either rigid or semi-rigid fixation, two techniques that reflect almost opposite concepts of craniomaxillofacial osteosynthesis. Rigid fixation is promoted by the AO/ASIF. In this concept, compression, tension, torsion and shearing forces which develop under functional loading, are neutralized by thick solid plates fixed by bicortical screws. In contrast, the Champy's method of semi rigid fixation uses easily bendable monocortical miniplate along an 'ideal osteosynthesis line'.⁵⁻⁷ The developing forces are neutralized by masticatory forces that produce a natural strain of compression along the lower border of the mandible. Both the techniques are associated with disadvantages. In semi-rigid fixation a doubt arises whether miniplate fixation is sufficiently stable for fractures that cannot be adequately reduced.

These shortcomings of rigid and semi-rigid fixation led to the development of 3 dimensional (3D) miniplates,



Figure 1: 3D miniplates used in Group I patients.

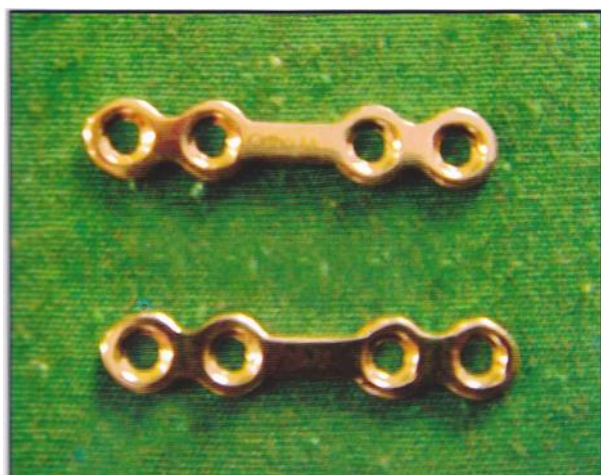


Figure 2: Champys miniplate used in Group II patients.

consisting of two 4-hole miniplates interconnected by vertical cross struts. Unlike compression and reconstruction plates their stability is not derived from the thickness of the plate. With the screws monocortically fixed to outer cortical plate, these rectangular plates form a cuboid which possess 3D stability. The 3D plating system is based upon the principle of obtaining support through geometrically stable configuration. The quadrangle geometry of plates assures a good stability in three dimensions of the fracture sites since it offers good resistance against torque forces.

This study was designed with the aim of evaluating the efficiency of 3D miniplate in anterior mandibular fractures and to compare it with Champys miniplate and to report the complications during its use.

Materials and Methods

This study was done in 40 patients who reported to our dental college with anterior mandibular fractures. Surgery was performed in a standardized manner and patients were systematically followed up post operatively according to a prospective protocol. The selected patients were above 14 years of age, with no significant history of medical disorder, having no other fracture of facial skeleton except anterior mandibular fracture reported within seven days of trauma. For all the patients case history, detail clinical and radiological examination and other investigations were done followed by anaesthetic fitness.



Figure 3: Reduction and fixation using 3D miniplate.



Figure 4: Reduction and fixation using champys miniplate.

The operations were performed under general anesthesia or local anesthesia. Prior to open reduction archbars were placed for intraoperative intermaxillary fixation (IMF). All plates were placed through intraoral degloving incision and fixed with monocortical screws. Patients were divided into two groups. Group I consisting of 20 patients, in whom 3D plates were used for fixation [Figure 1] while in Group II consisting of another 20 patients, 4 holed straight plates [Figure 2] were used. For Group I patients, the 4 hole

2mm stainless steel 3D plates were adapted across the fracture line in such a way that, the horizontal crossbars were perpendicular to the fracture line and vertical struts were parallel to fracture line [Figure 3]. In cases with

bit perpendicular and under copious saline irrigation. The plates were fixed with 2x10 mm stainless steel screws. In Group II patients, 4 holed with gap 2mm straight stainless steel miniplate was adapted and fixed with 2x10 mm

Table 1: Comparison of operating time of 3D miniplates with Champys miniplate.

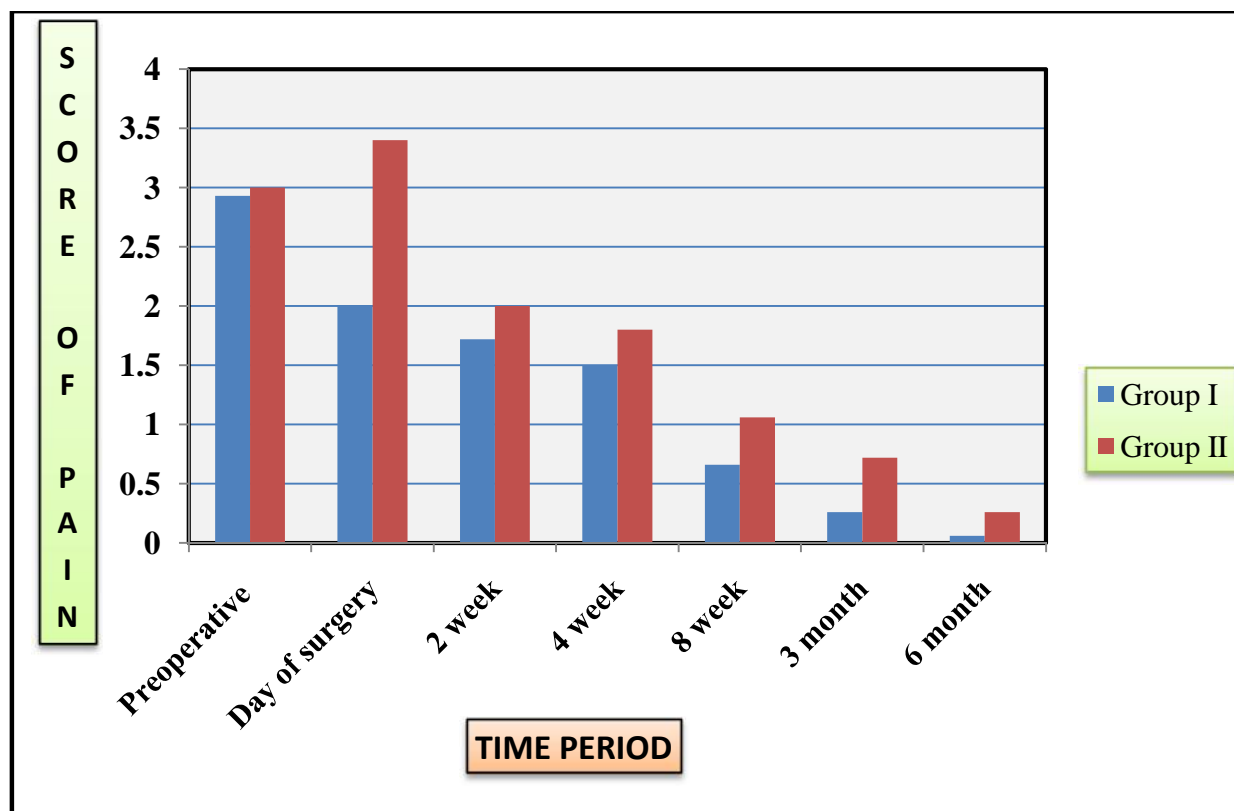
Group	N	Mean	Std. Deviation	t Value	p Value	Result
3 D Plate	20	50.60	3.83	5.13	0.0000	Sig P<0.05
Champys mini Plate	20	59.40	5.42			

Table 2: Cross tabulation of groups and Infection at 2nd week and 4th week.

	Infection at 2 Week		Total		Infection at 4 week		Total
	No Infection	Infection			No Infection	Infection	
3D Plate	18	2	20	3D Plate	19	1	20
Champys mini Plate	17	3	20	Champys mini Plate	18	2	20
Chi Sq Value	0.238			Chi Sq Value	1.15		
p Value	0.21			P Value	0.28		
Result	NS, p>0.05			Result	NS, p>0.05		

oblique fractures, the plates were fixed to the lower border of mandible. In symphyseal / parasymphyseal fractures, the upper crossbar was placed in subapial position. The drilling was then performed by 1.5 mm stainless steel drill

screws [Figure 4]. After plate fixation, in all cases surgical site was copiously irrigated with 5% povidine iodine followed by normal saline. Hemostasis was achieved and suturing was done with 3-0 vicryl and 3-0 silk in layers.



Graph 1: Average scores of pain preoperatively and post operatively on day of surgery, 2 weeks, 4 weeks, 8 weeks, 3 months and 6 months.

Pressure pack was applied and patients were prescribed antibiotics and analgesics for 5 days. The IMF was removed and the patients were advised to maintain the oral hygiene and to perform oral rinses with betadine. Patients were prescribed soft diet for six weeks. Panoramic radiographs for evaluation of adequacy of surgical reduction and plate localization were taken before discharge. Planned follow-up intervals were done at 1, 2, 3, 4, 6, 12 and 24 weeks post-operatively. The efficacy of 3D miniplate in mandibular anterior fractures was evaluated and compared with Champy's miniplate in terms of operating time (average time from incision to closure of wound), average pain with visual analog scale, post operative infection, occlusion, wound dehiscence, post

inflammation and pus discharge were considered as indicators for presence of infection. The post operative infection was seen in 2 cases of Group I and 3 cases in Group II after 2nd week and 1 case of Group I and 2 cases of Group II after 4th week (Non significant with chi square test) shown in Table 2. Occlusion of the patients was evaluated preoperatively and postoperatively at the end of 1st week and 2nd week. Preoperatively in Group I there was no occlusal disturbance in 5 patients, minor occlusal disturbance in 12 patients and severe occlusal disturbance in 3 patients. Preoperatively in Group II there was no occlusal disturbance in 4 patients, minor occlusal disturbance in 13 patients and severe occlusal disturbance in 3 patients. At 2 weeks period, Group I had no occlusal

Table 3: Cross tabulation of occlusion in both groups at 2 weeks.

	Occlusion		Total	Chi Square Value	p Value	Result
	No Disturbance	Disturbance				
3D Plate	19	1	20	1.67	0.19	NS p>0.05
Champys mini Plate	16	4	20			

operative mobility at fracture site and neurological deficit.

Results

The mean age of the 40 patients was 35 years (range 20 to 50 years). There were 34 males (85%) and 6 females (15%). The most common etiology was road traffic accidents (60%), followed by fall (24%) and assault (16%). The most common fracture was at parasymphysis (85%) followed by symphysis (15%). The mean operation time from incision to wound closure was 50.60 min for Group I and 59.40 min for Group II (Significant difference as per statistical t test) as shown in Table 1.

As per the Visual Analogue Scale, the average preoperative pain score in Group I was 2.93 and for Group II were 3.0. Mann-Whitney U test was applied to compare the average pain scores between the two groups on the day of surgery (day 0), at 2 weeks and at 4 weeks interval. There was significantly greater pain on day of surgery and at 2nd week for Group II patients but there was no significant difference between the two groups at 4th week as shown in Graph 1.

Patients were evaluated preoperatively and postoperatively at 2 weeks, 4 weeks, 3 months and 6 months for signs of infection. Swelling, local rise in temperature, local

disturbance in 19 cases and minor occlusal disturbance in 1 case while Group II had stable occlusion in 16 cases and minor disturbances in 4 cases depicted in Table 3. (Non significant as per chi square test)

In Group I, 3 patients had good oral hygiene, 16 had fair oral hygiene, 1 had poor oral hygiene. In Group II, 5 patients had good oral hygiene, 15 had fair oral hygiene (Not significant). No wound dehiscence was reported in any of the 20 patients of Group I. In Group II, 3 patients showed wound dehiscence. The post operative mobility at fracture site was found in 2 patients of Group I and 4 patients of Group II which was statistically insignificant (chi square test). The neurological deficit was reported in one patient of each group.

Discussion

In open osteosynthesis technique, there has been a metamorphosis and a change in trends from rigid fixation in 1968 to semi-rigid fixation in 1973. Michelet et al⁸ began experimenting with monocortical non-compression miniplates. He described the treatment of mandibular fractures using small, easily bendable, non-compression miniplates, anchored with monocortical screws. Using a simple cantilever beam model, Champy et al^{5,6} showed that

the superior mandibular border was subjected to tension and splaying, and the inferior border was subjected to compression. Plates placed along ideal lines of osteosynthesis were thought to provide optimal fixation and stability. As these plates were small and the screws monocortical, it simplified surgery and reduced surgical morbidity. However they have failed to surpass the predictability of rigid fixation using 2.4mm compression and reconstruction plates.

Farmand et al⁹ in 1992 developed the concept of 3D miniplates. Their shape is based on the principle of the quadrangle as a geometrically stable configuration for support. Since the stability achieved by the geometric shape of these plates surpasses the standard miniplates, the thickness can be reduced to 1 mm. The basic form is quadrangular with 2 × 2 hole square plate and 3×2 or 4×2 hole rectangular plate. The 3D miniplates itself was a misnomer as the plates themselves were not 3-dimensional, but holds the fracture segments rigidly by resisting the 3-dimensional forces namely shearing, bending and torsional forces acting at the fracture site in function. The use of 3D miniplates in mandibular fracture fixation has not yet become established. In recently published survey by Gear et al¹⁰ among 104 AO/ASIF surgeons, only 6% use this type of plate.

Based on the selection criteria this study included only anterior mandibular fractures in which parasymphysis was the most common site of fracture in 34 cases followed by symphysis in 6 cases .

The average operating time required for 3D plate was 50.60min. (range 48 to 59 min.) and that of miniplate was 59.40 min. (range 57 to 69 min). Student t-test was applied to compare both the groups and the results were statistically significant for Group I. These findings were similar to the results of a study by Feledy et al,¹¹ Jain MK et al¹² and Zix et al¹³ on 3D plate who reported reduced average operating time. Easy application, simplified adaptation to the bone as well as simultaneous stabilization at both the superior and inferior borders, makes the 3D plate a time-saving alternative to conventional miniplates.

The higher pain scores on day of surgery for Group II patients were perhaps due to the wide surgical exposure required for adaptation and manipulation of the Champy's miniplate and more working time required for the surgical procedure. The higher pain scores on 2 weeks for Group II

as compared to Group I were due to higher incidence of infection and mobility at the fractured segments.

The occlusion of patients was checked preoperatively and during the follow up stages after surgery. In the present study, 19 patients of 3D plate osteosynthesis had normal preoperative occlusion postoperatively. Only 1 patient had postoperative occlusal discrepancy which was treated successfully by applying intermaxillary fixation for a period of 10 days and selective occlusal grinding. On the other hand, 16 patients of Champy's miniplate osteosynthesis had normal postoperative occlusion. Of the remaining 4 patients with occlusal discrepancy, 3 patients had to undergo intermaxillary fixation for 10 days along with selective occlusal grinding and 1 patient was corrected by simple selective occlusal grinding. All patients with post-operative occlusal discrepancy were patients with oblique fracture. This incidence of occlusal discrepancy was compared between the two groups and the results showed no statistically significant association. 3D plates and miniplates – a semi rigid method of fixation reported less occlusal disturbances. As these plates are self adaptable and non-compressive, they do not fix the fragments rigidly hence self correction due to action of oro- facial musculature can take place. The operator plays an important role and the incidence of failure is seen to decrease as the surgeon's experience. Post reduction infection at the fractured site is not only the result of contamination but is also related to reduced stability of fracture i.e. mobility of fractured segments.

In our study, there wasn't any statistically significant difference between Group I and Group II with respect to infection rates at 2 weeks and 4 weeks. The incidence of infection for Group I was 2 cases at 2 week and 1 case at 4 week. The incidence of infection for Group II was 3 cases at 2 week and 2 cases in 4 weeks. With the use of open reduction and internal fixation, the reported incidence of infection ranged from 3% to 32%.¹³ Guimond et al¹⁴ reported an infection rate of 5.4% (2 out of 37 patients) with the use of 3D plates, Feledy et al¹¹ reported 9% infection rate (2 out of 22 patients) and Zix et al¹³ reported 0% (0 out of 20) infection rate in their study. It has been claimed that mobility of fractured segments is a causative factor in post-operative infections. Because infection is the most common complication in mandibular fractures, the improvement of plate stability might be a way to minimize this problem. Guimond et al¹⁴ also experienced the low

incidence of wound dehiscence and plate exposure with 3D plate in comparison to Champy's miniplate.

In the present study, it was observed that 2 cases out of 20 in Group I had immediate postoperative mobility present at the fractured site which persisted and later decreased over a period of 4 weeks and by the 3rd month postoperatively, none of the patients showed any mobility in fractured segments. In Group II, 4 of 20 patients had immediate postoperative mobility present at the fracture site and similar to Group I none of the patient in Group II showed mobility in fracture segment by 4th week. No statistically significant difference was found among the two groups. Rigidity of fractured segments produces a stable foundation for soft tissue growth and improved vascularity to the area improves and allows better healing of wound. It also prevents bacteria from being continually pumped through the fracture site thereby decreasing the chance of osteitis. It is seen that more the mobility present at the fracture site, greater the chances of infection. This is why the semi-rigid monocortical fixation was questioned for its use in infected fracture and contraindicated.

There was no case of wound dehiscence found in Group I and in Group II, 3 cases showed wound dehiscence. The cases of dehiscence were due to the presence of infection in the particular cases, patients were kept on antibiotics for a week and continuous follow up in the OPD for normal saline irrigations which led to satisfactory healing. The comparative statistical analysis showed no significant difference between the two groups.

One patient in each group had mental nerve damage at the time of trauma which led to complete loss of sensation throughout the treatment, thus the statistical analysis showed no difference in the two groups.

Oral hygiene was also one of the important parameters of this comparative study and played a very important role in the post-operative healing of the patients of both the groups. All the patients underwent oral prophylaxis before the plating was done and on discharge the patients were advised to continue chlorhexidine mouth rinses for regular use. Oral hygiene was assessed at every visit of the follow up, and the comparison done in both the groups showed no significant differences.

The results of this study suggest that fixation of anterior mandibular fractures with 3D plates provides three dimensional stability and carries low morbidity and infection rates. The only probable limitation of these plates

may be excessive implant material due to the extra vertical bars incorporated for countering the torque forces. The small sample size and limited follow up could be considered as the limitations of this study. It is hence recommended to have a multicentre study with large number of patients and correlation among these studies to authenticate our claims.

Conclusion

The 3D plate was found to be standard in profile, strong yet malleable, facilitating reduction and stabilization at both the superior and inferior borders giving three dimensional stability at fracture site. They seem to be an easy alternative to conventional champys miniplates.

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