

## Original Research Article

# Primary reconstruction of depressed skull fracture

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### ABSTRACT

**Background:** Depressed fracture poses a specific challenge to neurosurgeon. Aim of our study is to analyze benefits of primary reconstruction of depressed skull fracture and to compare various methods of fracture reconstruction with that of titanium miniplates. The concept of primary reconstruction was to close the defect and preserve the anatomical barrier, to avoid later cranioplasty and to prevent further complications like CSF leak, pneumocephalus, brain fungus and meningitis etc. The second reason for rigid fixation was to achieve good cosmetic results.

**Methods:** This is observational study carried out in Department of General Surgery, Hamidia hospital Bhopal on 36 patients over period of 18 months from January, 2016 to July, 2017.

**Results:** Depressed skull fracture is more prevalent in second and third decade of life with male to female ratio of 5:1. Most of the patients (72%) presented with open fracture skull and majority of them (89%) presented with underlying brain injury. Out of total 36 patients of depressed fracture skull, 18 patients (50%) underwent fixation with titanium miniplate and rest underwent fixation with nylon suture, Poly-L-Lactide and primary elevation of depressed skull fracture. The correction of deformity was more than 90% compared to contralateral side and better cosmetic results were obtained on patients treated with titanium mini-plates. Post operative infection rate was nil in patient treated with titanium mini-plates compared to 8.2% of total infection rates in patients treated with other methods.

**Conclusions:** The concept of primary reconstruction of depressed skull fracture to achieve better cosmetic results and minimum post operative complications. Cosmetic results that were obtained with titanium mini-plates were excellent with nil post operative infection rates and complete neurological recovery. Hence titanium mini-plates are cost effective and better than any other methods.

**Keywords:** Head injury, Depressed fracture, Primary reconstruction, Titanium miniplate

### INTRODUCTION

About 25% of skull fractures are compound and merit immediate attention. Skull fracture is any break in continuity of cranial bone also known as skull. A fracture isn't always easy to see. However, symptoms that can indicate a fracture include:

- swelling and tenderness around the area of impact
- facial bruising

- bleeding from the nostrils or ears

Treatment depends on the severity of the fracture. Pain medication may be the only treatment necessary in mild fractures, while neurosurgery may be required for more serious injuries. There are four major types of skull fractures:

- Linear
- Depressed

- Diastatic
- Basilar

A depressed skull fracture is a type of fracture usually resulting from blunt force trauma, such as getting struck with a hammer, rock or getting kicked in the head. These types of fractures which occur in 11% of severe head injuries are comminuted fractures in which broken bones displace inward. Depressed skull fractures present a high risk of increased pressure on the brain, or a hemorrhage to the brain that crushes the delicate tissue. Compound depressed skull fractures occur when there is a laceration over the fracture, putting the internal cranial cavity in contact with the outside environment, increasing the risk of contamination and infection. In complex depressed fractures, the dura mater is torn. Depressed skull fractures may require surgery to lift the bones off the brain if they are pressing on it by making burr holes on the adjacent normal skull.<sup>1</sup> In a depressed skull fracture, the outer table of one or more of the fracture edges lies below the normal anatomical level of the inner table as determined by the surrounding intact skull.<sup>2,3</sup> At the site of impact mostly the inner table fracture first and get depressed inside. The fracture segment produces dural tear and underlying brain damage.

A free piece of bone should be depressed greater than the adjacent inner table of the skull to be of clinical significance and requiring elevation. Most surgeons prefer to elevate depressed skull fractures if the depressed segment is more than 5 mm below the inner table of adjacent bone. Elevation of bone fragments occasionally improves a focal neurological deficit originating in the cortex directly under a depressed bone fracture. The brain dysfunction generally undergoes a neurological recovery over a period of several weeks to months, similar to that after a stroke or a head injury without a depressed fracture.<sup>4</sup> The treatment of serious cranial defects has always been a fascinating and controversial issue for craniofacial surgeons.<sup>5</sup> Reconstruction of the craniofacial defects can be carried out with autogenous tissue (calvarium, rib and iliac crest), allogeneic implants (AAABone, lyophilized cartilage) or alloplastic material (methacrylate, hydroxyapatite, titanium implants and mesh systems). Selection of the implant material used for reconstruction is still controversial.<sup>6</sup> Primary titanium mesh reconstruction helps to prevent a second operation of cranioplasty and the risk of infection is not significantly higher by such retention.<sup>7</sup> For simple depressed fractures of the skull, elevation is usually sufficient. However, complex depressed fractures of the skull in which the bone is smashed into several fragments are difficult to reconstruct by wiring. Therefore, bone flaps tend to be mobile and may result in deformed appearance. We have used titanium mesh to repair open depressed skull fracture.

Similarly, the titanium micro-mesh was used by Kutenberger et al, with the following indications:

- Immediate reconstruction in the primary treatment of comminuted fractures with bone loss in non load-bearing areas,
- Treatment of contour irregularities.<sup>6</sup>

Setsuko et al, had described bone flaps that were broken into fragments.<sup>8</sup> They could achieve sufficient stability, to resume the original cranial shape by using titanium miniplates. An extra advantage is that titanium mesh rarely interfere with postoperative imaging. Frontal bone contour defects causes marked facial deformity, which is instantly obvious to the observer.<sup>8</sup> Reconstruction of large defects of the frontal bone may be required following trauma.<sup>9</sup>

Criteria to elevate depressed skull fracture in adult

- > 8-10 mm depression (or > thickness of skull).
- Deficit related to underlying brain.
- CSF leak (i.e. dural laceration).
- +ve or -ve open (compound) depressed skull fracture.
- More conservative treatment recommended for fracture overlying major dural venous sinuses.

There is no evidence that elevating a depressed skull fracture will reduce subsequent development of post traumatic seizures which are probably related to initial brain injury.

#### **Indications for surgery**

No treatment is necessary when these occur in temporo perital area in absence of underlying brain injury as the deformity will usually contract as the skull grows.

- Radiological evidence of intra parenchymal bone fragment.
- Associated neurological deficit.
- Signs of increased intra cranial pressure.
- Signs of CSF leak deep to galea.
- Difficulty in long term follow up.

#### **METHODS**

This is observational study done in Department of General Surgery, Hamidia Hospital Bhopal on 36 patients over period of 18 months from November, 2015 to May, 2017. This study was carried out after obtaining necessary ethical clearance from the institutional ethical committee.

#### **Inclusion criteria**

*Criteria for surgical intervention*

- The fracture lying over the motor area or displaced fracture segment
- Migration of bone segments into brain parenchyma

- CSF leak
- Underlying hematoma
- Exclusively for cosmetic purpose in some cases.

*Criteria for titanium miniplates*

- Fracture overlying frontal region producing cosmetic deformity
- Fracture involving basic frontal region producing instability and
- Grossly comminuted fracture with significant bone loss.

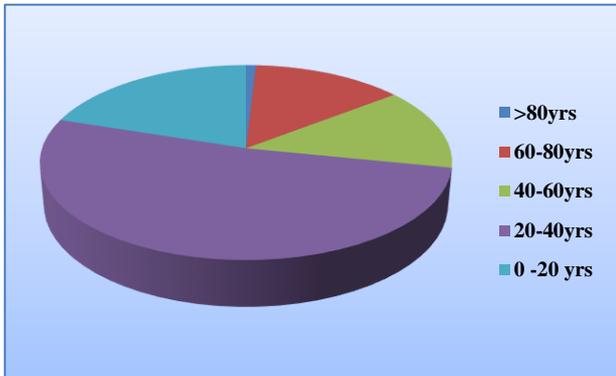
*Exclusion criteria*

- Patient less than 13 years of age
- Patient with minimal or undisplaced skull fracture

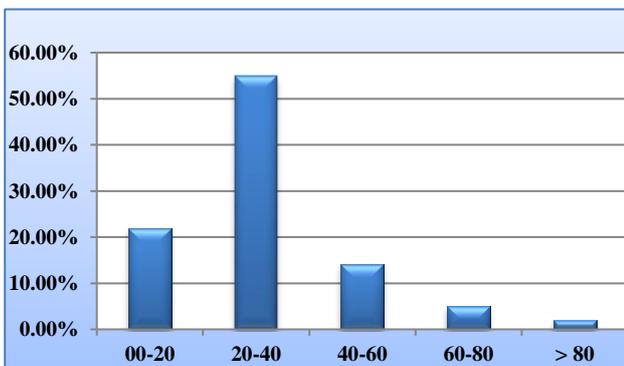
Patients data were collected from all patients attending Hamidia hospital, general surgery outpatient department, casualty in patient department and were evaluated and followed according to protocol. All cases were subjected to surgery within 24 hours of injury.

**RESULTS**

Among 36 patients, 30 patients were males and 6 patients were females. Distribution of patients in various age groups is as per Figure 1 and Figure 2.



**Figure 1: Age wise distribution of patients.**



**Figure 2: Percentage wise distribution.**

Most of the patients were in age group of 20-40 years (55%) of age group followed by 22% in 0-20 years, 15% in 40-60 years, 5% in 60-80 years and 1% in > 80 years of age.

**Table 1: Total number of cases.**

Cases	Number
Male	30
Female	03

Most of the Patients presented with open fracture skull (72%) and majority of them had underlying brain injury (89%) (Table 1 and Table 2).

**Table 2: Open / closed fracture.**

Fracture	Number	Percentage
Closed	10	27
Open	20	72

All the 36 cases were subjected to surgery out of which 18 cases(56%) underwent fixation with titanium mini-plates, 13 cases (36.1%) were treated with primary elevation of depressed skull fracture while 4 (11.1%) and 1 (2.8%) went fixation with titanium wire and absorbable sutures (Table 3).

**Table 3: Underlying brain injury/ percentage distribution of brain injury.**

Underlying brain injury	Number	Percentage
Present	32	89
Absent	04	11

Incidence of post operative infection rate was nil with titanium mini-plates (Table 5) and neurological recovery was complete with titanium mini-plates.

**Table 4: Different types of brain injury and its percentage wise distribution.**

	No.	%
EDH	15	22
Dural tear	17	25
Brain contusion	21	3.1
Bone fragments	9	1.3

**Table 5: Surgeries for depressed fracture skull.**

	No.	%
Titanium miniplate fixation	18	50
Nylon suture/titanium wire	4	11.1
Elevation of fracture segments	13	36.1
Absorbable (poly-l-lactide)	1	2.8

**Table 6: Post-operative complications.**

Post-operative complications	
Infections	Major wound infections -1%
	Minor wound infections -7%
	Meningitis -1%
	Osteomyelitis -1%
	Cerebral abscess -0%
Post op seizures	0%
Pseudomeningocele	1%

**Table 7: Incidence of post-op infections.**

Incidence of post-op infections	%
Total infection rate	8.2
• Titanium plate	0
• Elevation of depressed	7.2
• Others	2

## DISCUSSION

In depressed skull fracture outer table of one or more of the fracture edges lies below the normal anatomical level of the inner table as determined by the surrounding intact skull. At the site of impact mostly the inner table fracture first and get depressed inside. The fracture segment produces dural tear and underlying bone damage.

Thirty patients were male and six were female. Road traffic accident was the major mode of injury, encountered in 22 patients, followed by fall from height, assaults and in one case it was due to blast of pressure cooker.

The most common age ranged between 20 to 40 years. All patients were conscious with Glasgow coma scale of 13- 15, at the time of admission.

Plain CT scanning of brain was performed, which revealed fracture involving basifrontal region in 13 (36.1%) patients, fronto-parietal region 20 (55.6%), temporal bone and other location were involved in 3 patients each (8.3%).

Simple depressed fractures with no underlying pathology were noticed in two patients. Compound depressed fracture with underlying pathology like haematoma in 8 patients, dural tear in 22, CSF rhinorrhoea and pneumocephalus were observed in 3 and 6 patients respectively.

Eighteen (50%) cases underwent titanium miniplate fixation. In four (11.1%) patients, apposition of bone was done by using nylon suture /titanium wire. In thirteen (36.1%) cases only elevation of fracture segments were carried out. Only in one (2.8%) case it was possible to put absorbable (Poly-L- lactide) miniplate.

Elevation of bone fragments occasionally improves a focal neurological deficit originating in the cortex directly under a depressed bone fracture. The brain dysfunction generally undergoes a neurological recovery over a period of several weeks to months, similar to that after a stroke or a head injury without a depressed fracture.

To repair depressed fractures of the skull, wire ligatures are usually sufficient. However, complex depressed fractures of the skull in which the bone is smashed into several fragments are difficult to reconstruct by wiring. Therefore, bone flaps tend to be mobile and may result in deformed appearance. In such cases bone fragments combined with titanium miniplates to repair depressed skull fracture are used.

These miniplates were originally developed for maxillofacial surgery, and are biologically quite stable. The rigid fixations of bone fragments in the repair of depressed skull fractures can be a problem, especially if not all fragments are replaceable. Usually, in these cases mini or microplates are used.

Similarly, the titanium mini-plates were used for the following indications:

- immediate reconstruction in the primary treatment of comminuted fractures with bone loss in non load-bearing areas.
- treatment of contour irregularities .

Setsuku et al had described that bone flaps that were broken into fragments could achieve sufficient stability, to resume the original cranial shape by using titanium miniplates.<sup>9</sup> An extra advantage is that titanium miniplates rarely interfere with postoperative imaging.

Frontal bone contour defects causes marked facial deformity, which is instantly obvious. Reconstruction of large defects of the frontal bone and bony orbit may be required following trauma.

The correction of deformity was up to an acceptable level, which is more than 90% correction as compared to contra lateral site. A better cosmetic result was noticed whenever miniplate was used. Infection and plate rejection was not observed in this study. In one case persistent CSF rhinorrhoea occurred.

Nadell et al did primarily elevation of depressed fracture segment of skull and found that 5.46% had scalp wound infection.<sup>10</sup>

The conventional methods of stabilizing fragments in cranial depression fracture include the use of threads, wires and plates. Titanium is an useful tool in the fixation of bone fragments in the repair of depressed skull fractures. Implant rejection was not observed and no delayed healing or infection occurred. Similarly no

wound infections, exposures or loss of the implants have been observed. Long-term stability of the reconstructions was excellent.

Similarly, Stendel et al also conducted a similar study with the use of titanium miniplates and found the similar results.<sup>11</sup> Complete neurological recovery was seen in patients where fixation was done with titanium miniplates. Even the post-operative epilepsy rate was nil in patients where primary reconstruction was done with titanium miniplates.

## CONCLUSION

Hence use of titanium mini-plates is feasible, safe and cosmetically preferable than other conventional methods of stabilizing fragments in depressed skull fracture.

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*Ethical approval: The study was approved by the Institutional Ethics Committee*

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