

ISSN 1220-8841 (Print)  
ISSN 2344-4959 (Online)

ROMANIAN  
NEUROSURGERY

Vol. XXXVIII | No. 4

December 2024

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Shashank Nahar,  
Pavni Agrawal

DOI: 10.33962/roneuro-2024-178



# Comparison of the neurological outcomes and infection rate in surgical and conservative management of compound depressed skull fractures

Shashank Nahar<sup>1</sup>, Pavni Agrawal<sup>2</sup>

<sup>1</sup> Assistant Professor, Department of Neurosurgery, AIIMS Bhopal (M.P), INDIA

<sup>2</sup> Senior Resident, Department of Neurology, MGUMST, Jaipur (Rajasthan), INDIA

## ABSTRACT

**Background:** Depressed skull fractures (DSFs) constitute a significant chunk of head injuries. As per level 3 evidence of recent brain trauma foundation guidelines, depressed fracture segments greater than the thickness of the calvaria should undergo operative intervention to prevent infection and to improve neurological outcomes. This study was done to refute the Brain Trauma Foundation guidelines of level 3 evidence by non-surgical management of those depressed skull fractures in which surgical management is indicated, and we aimed to assess and compare the incidences of infection rate and neurological outcomes in patients of surgical and conservative management of depressed skull fractures.

**Material and methods:** This prospective interventional study included 102 patients with compound depressed fractures with a surgical indication as per "Brain Trauma Foundation Guidelines 2006 Level 3 Management" from August 2020 to December 2021. A minimum of 6 months of follow-up was done. Those who gave consent for surgery were included in the surgical group, and those who refused were included in the conservative group, and both groups were compared. In the surgical group, the method of choice recommended was the conventional method of elevation of the depressed fracture segment and debridement, and in the conservative group, simple debridement and suturing after saline and antibiotic wash followed by IV antibiotics were given. Statistical Analyses: Data were analyzed using the SPSS software (version 23.0) for Windows. Qualitative variables were analyzed using chi sq. test and quantitative data by Student's t-test.

**Results:** Out of 102 patients, 42 were managed surgically and 60 were managed conservatively. The majority, 44.1%, of depressed skull fractures were present over the frontal bone. The overall complication rate was 20.58% (21/102). 68.29% of patients contributed to neurological complications, and the rest (31.70% of complications) were infective. No significant difference was found in comparing the neurological outcomes and infection rate in non-surgically versus surgically managed groups.

**Conclusion:** Conservatively managed depressed fractures have equivalent neurological outcomes and infective complications when compared with surgical management. The results of our research will provide benefits towards more conservative management with adequate wound debridement and antibiotics so that these patients can also be managed in peripheral rural hospitals and avoid unnecessary referrals to higher tertiary centres.

## Keywords

traumatic brain injury,  
seizure,  
surgical elevation,  
hospital stay,  
surgical debridement



Corresponding author:  
**Shashank Nahar**

AIIMS Bhopal, India

naharshashank@gmail.com

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ISSN online 2344-4959  
© Romanian Society of  
Neurosurgery



First published  
December 2024 by  
London Academic Publishing  
[www.lapub.co.uk](http://www.lapub.co.uk)

## INTRODUCTION

Depressed skull fractures are one of the common findings among traumatic brain injuries and are most commonly dealt with by neurosurgeons in their day-to-day practice. Compound-depressed skull fractures, by definition, have a skin laceration resulting in communication between the external environment and the cranial cavity, leading to wound contamination and infections. (1) In literature, the reported overall infection rate in patients with depressed skull fractures varies from 9% to 14%. (2,3) There are specific surgical and non-surgical management indications in depressed fractures, defined as Level 3 recommendations by the Brain Trauma Foundation. (4) In patients with compound cranial fractures, depressed fracture segments greater than the thickness of the calvaria should undergo operative intervention to prevent infection. Non-surgical treatment is advocated in a compound depressed cranial fracture if there is no radiological or clinical evidence of dural penetration (CSF leak, intradural pneumocephalus on CT.), no significant intracranial hematoma, depression not more than 1 cm, no involvement of the frontal sinus, no gross cosmetic deformity, and no wound infection or gross wound contamination. (4) The surgical method of choice recommended is elevation of the depressed fracture segment and debridement. (4) It's always been a management dilemma for neurosurgeons whether the conventional method of surgery that is the elevation of the depressed fracture segment prevents the infection rate or not in all patients with compound depressed skull fractures. The primary objective of this study was to observe the effects of surgical and conservative management on the neurologic outcomes in patients with compound depressed skull fractures, and the secondary objective was to compare complications (neurologic and infections) between the treatment arms.

## AIM OF OUR STUDY

This study was undertaken to assess and to compare the incidences of infection rate and neurological outcome in patients with surgically and conservatively managed depressed skull fractures, to find out whether surgery is really beneficial in all patients of compound depressed skull fractures to prevent the overall infection rate and to improve the neurological outcome.

## METHODOLOGY

This prospective comparative interventional study was approved by the scientific and ethical committee of Pt. JNM Medical College, Raipur (C.G.) & DKS Post Graduate Institute and Research Center, Raipur. A total of 102 patients with compound depressed fractures admitted in the department of neurosurgery at Pt JNM Medical College and DKS Postgraduate and Research Institute Hospital Raipur (CG) were included from August 2020 to December 2021. This sample size was calculated according to the primary objective, with study power at 80% and an  $\alpha$  error of 0.5. Out of 102 patients, 42 were managed surgically, and 60 patients were managed conservatively. Conservatively managed patients were considered those patients in whom surgery was indicated as per "Brain Trauma Foundation Guidelines 2006 Level 3 Management" (4), but as these patients have given negative consent for surgery, they were included under the non-surgical group or conservative group.

**Inclusion criteria** in our study were the following:

- Patients with compound depressed skull fractures who had indications for surgery according to Brain Trauma Foundation guidelines.
- Age group < 65 years.
- Follow-up duration: six months or more.

**Exclusion criteria** in our study were the following

- All depressed fractures in front of the hairline (operated for cosmetic reasons).
- Depressed fractures are operated for and associated with other intracranial injuries like sub-dural hemorrhage, extradural hemorrhage, contusion, and pneumocephalus.
- Patients who lost on the follow-up.
- Patients with skull base fractures.

In our study, there was no crossover from the conservative group to the surgical group. In all patients, a non-contrast CT scan was done to assess the exact size and depth of depressed fragments and the associated findings, such as subdural hemorrhage, extradural hemorrhage, contusions, and pneumocephalus. All patients of compound depressed fractures had accidental wounds (classified as class III/contaminated wounds as per U.S. Centers for disease control classification)<sup>26</sup> and

received intravenously cefuroxime 1.5 gm followed by 750 mg every 8th hourly along with intravenous metronidazole 500 mg every 8 hours.

Cleaning, suturing, debridement, and local wound dressing were done in all cases in an emergency room. All those patients who indicated surgery as per the criteria of the Brain Trauma Foundation guidelines level 3 evidence underwent surgery. Elevation of the depressed fracture segment was done, and repair of the underlying dural tear, if present, was performed as the conventional surgical procedure of choice. Patients who gave negative consent for surgery were considered in the non-surgical or conservative group, and they were managed conservatively by wound cleaning, suturing, debridement, and antibiotics.

During the hospital stay, infectious complications were noted in both groups of patients. The GCS and Glasgow outcome score were recorded at the time of discharge from the hospital. We have compared the infection rate and neurological outcomes with the variables such as age group, gender, mode of injury, GCS at the time of admission, site of fracture, type of management, and onset of seizures after injury as mentioned in Table 4, separately for non-surgically and surgically managed depressed fractures. Microsoft Excel was used in creating the database and producing graphs, while the data were analyzed using the SPSS software (version 23.0) for Windows. Numerical variables were reported as the mean  $\pm$  standard deviation, and qualitative variables were analyzed using chi square test. To analyze quantitative data, a Student's t-test was used. Differences between groups were assessed with the chi-square or Fisher's exact test for categorical variables. Two-tailed p-values less than 0.05 were considered significant ( $p < 0.05$ ).

## DISCUSSION

Depressed skull fractures occur in most head injuries, requiring immediate clinical assessment and management. In this study, we have included a total of 102 patients. We have discussed the presentation of depressed skull fractures in our tertiary care hospital concerning demography, mode of injury, site of injury, clinical presentation, the incidence of infectious and neurological complications, and duration of hospital stays in surgical and conservative management.

## A. Demographic characteristics

In our study, the mean age group in the surgically managed group of patients,  $24.73 \pm 14.96$  years, was close to the mean age group of  $26.95 \pm 14.87$  years reported by Sidram V et al. and  $27.9 \pm 12.9$  years reported by Manne S et al. in surgically managed depressed fractures.(5,6) In the non-surgically managed group, the mean age in our study was  $31.23 \pm 14.02$  years, close to  $34 \pm 3$  years reported by Robert F. Heary et al. in non-surgically managed depressed fractures. (7)

**Table 1.** Shows the mode of injury.

Sr. No.	Mode of injury	No of patients (N = 102)
1	Road traffic accidents	76 (74.5%)
2	Assaults	15 (14.7%)
3	Fall from height	9 (8.8%)
4	Others	2 (2.0%)

**Table 2.** Shows the site of the depressed fracture

Sr. No.	Site of depressed fracture	No of patients (N = 102)
1	Frontal	45 (44.1%)
2	Parietal	35 (34.3%)
3	Temporal	17 (16.7%)
4	Occipital	2 (2.0%)
5	Fronto-temporal	2 (2.0%)
6	Parieto-occipital	1 (1.0%)

**Table 3.** Shows the clinical presentation of depressed fracture patient.

Sr. No.	Clinical presentation	No of patients(N = 102)
1.	Loss of consciousness	78 (76.5%)
2.	Vomiting	38 (37.3%)
3.	ENT bleed	26 (25.5%)
4.	Seizures	15 (14.7%)

## B. Mode of injury

Road traffic accidents were the principal mode of injury in most patients 76 (74.5%).{as shown in Table no 1}. Similar to our study, other studies by Manne S et al. (5), Jamieson et al. (8), Rotterdam and Glasgow series(9,10) have also reported RTA being the primary cause of depressed skull fractures. Manne S et al. (5) reported a maximum incidence of 66.7% of RTA in his series, and other non-RTA reasons like

assaults, falls from height, and railway accidents combined accounted for only 33.3% of cases. The increased incidence of RTA in our region was due to the increasing incidence of riding bikes under the influence of alcohol and non-wearing helmets.

### C. Site of depressed fracture

Our study found that most depressed skull fractures were present over the frontal region in 45 (44.1%) patients at the back of the hairline, followed by the parietal region in 35 (34.3%) patients. Other sites involved were temporal region in 17 (16.7%) patients, occipital in 2 (2%) patients, frontotemporal in 2 (2%) patients, and Parieto-occipital in 1 (1%) patient. {as shown in Table no 2} Our results are similar to the study of Vala H et al., who also reported the maximum incidence of depressed fracture in the frontal region at 35%, followed by the parietal region in 26% of patients. (11) Other sites were the temporoparietal region in 12%, the frontoparietal region in 14%, the temporal region in 7%, and the occipital region in 6% of patients reported in his study. (11) Our results were in contrast to the study of Satardey RS et al., who reported parietal bone as the commonest site in 48% of patients, followed by frontal bone in 34%, temporal in 10%, frontoparietal in 4%, and occipitotemporal in 4% of patients. (2)

### D. Clinical presentation

In the clinical presentation, loss of consciousness was the common symptom and found in the majority of our patients, 78 (76.5%) patients. {as shown in Table no 3} Our results were similar to the study of Satardey RS et al. (2) and E. Shingiro et al. (12), who also reported the loss of consciousness as the most common clinical presentation in the majority of patients, 76% and 59.2%, respectively, in patients of depressed skull fractures after head injury.

### E. Distribution of focal neurological deficits

In our study, focal neurological deficit occurred in 20/102 (19.60%) patients, and the incidence was close to 16% reported by Asif M et al. (13). Hemiparesis was observed to be the most common focal neurological deficit in 12 (60.0%), followed by aphasia in 5 (25%), and mono paresis in 3 (15.0%) patients. Asif M et al. also reported hemiparesis as the most common focal neurological deficit in their study in 12% of patients. (13) Like our study, C. M. van den Heever et al. and Rolekar NG et al. also reported

similar types of focal neurological deficits in patients with depressed skull fractures. (14,15)

### F. Severity of head injury

In our study, at the time of admission, the majority of patients had a minor type (GCS 13–15) of head injury in 75 (73.5%) patients, followed by 22 (21.6%) patients with a moderate type (GCS 9–12) of head injury, and in 5 (4.9%) patients the severe type of head injury (GCS < 8) was present. {As shown in Table no 4} Our result was similar to Venkati GS et al., who also found the majority of patients, 74%, having a minor type of head injury (GCS 13–15), followed by 14% having a moderate type of head injury (GCS 9–12), and 12% having a severe type of head injury (GCS < 8) at the admission. (16)

**Table 4.** Shows severity of head injury.

Sr. No.	Severity of Head injury	No of patients (N = 102)	Percentage (%)
1	Minor head injury (GCS 13-15)	75	73.5%
2	Moderate head injury (GCS 9-12)	22	21.6%
3	Severe head injury (GCS < 8)	5	4.9%

**Table 5.** Type of management and neurological outcome in overall depressed fractures.

Sr. No.	Type of management	Total (N=102)	Good outcome (GOS =5)	Poor outcome (GOS < 5)
1.	Surgically managed (n = 42)	42	38 (90.5%)	4 (9.5%)
2.	Non surgically managed (n= 60)	60	56 (93.35%)	4 (6.7%)
P value			0.597	
Chi-Square value			0.279	
Degrees of freedom			1.00	

### G. Type of management and neurological outcomes

In, our study, in the non-surgically managed group, 93.35% of patients had good surgical outcomes (GOS > 5) as compared to the surgical group having 90.5% of patients with good surgical outcomes (GOS > 5), but results were not found to be statistically

significant ( $P > 0.05$ ) as shown in (Table 5). Our results were similar to the study C. M. van den Heever et al. (15). They have also reported good neurological outcome of 96% of patients in non-surgically managed fractures as compared to 93% of patients in surgically managed compound depressed fractures. Damage to the underlying brain occurs on impact and, on the whole, cannot be improved by surgery. Even the simple debridement of the wound, saline, and antibiotic wash followed by suturing of the wound and keeping the patients on IV antibiotics without a conventional surgical method of elevation of a depressed fracture gives similar types of neurological outcomes. There are plausible reasons that bleeding from the injured cortex usually ceases before the conventional surgery and gets reactivated when the depressed fragments are elevated, especially in patients whose dura is torn. There seems to be a real hazard in damaging more cortex and underlying brain. Thus, we suggest the first-line management of a depressed fracture should be non-surgical.

## H. Complications

The overall complication rate in our study was found to be 20.58% (21 out of 102 patients). This was close to the study of Ahmad S et al., who reported a 17.77% complication rate (16 out of 90 patients), but in contrast to Kurmi DJ et al., who reported 53.84% incidence (35 out of 65 patients). (17, 18) In our study, in surgically managed patients, the presence of complications rate was 28.57% (12 out of 42), and in non-surgically managed patients, the complication rate was 15% (9 out of 60). The total neurological complications contributed 68.29%, and the rest (31.70%) of complications were infective. Our study's results contrast to the study of Kurmi DJ et al., who reported wound infection (15.8%) as the most common overall complication, followed by seizures (13.8%). (18) In our study, in both surgically managed and non-surgically managed patients, the presence of seizures was the most common neurological complication in 28.57% and 13.33% of patients, respectively. The overall incidence of seizures was 19.60%. This was similar to the study of Kurmi DJ et al. and Ahmed J et al. (17, 18), who also reported seizures (20%) as the most common complication in the surgically managed group of patients, while it was in contrast to Sidram V et al. (2), who reported wound infection as the commonest complication in

11.3% of patients with surgically managed depressed fractures. However, in the non-surgical group of patients, seizures (13.33%), as reported in our study as the most common complication, were found to be in contrast to the study of Kurmi DJ et al. (17), who reported wound infections (17.5%) as the most common complication in the non-surgical group.

**Table 6.** Shows the distribution of various complications in patients with depressed skull fractures.

Sr. no	Types of complications	Surgically managed patients (n=24)	Conservatively managed patients (n=17)	Total (n=41)
1	Superficial wound infection	3	4	7
2	CSF leak	3	0	3
3	Osteomyelitis	1	0	1
4	Bacterial Meningitis	1	1	2
5	Focal neurological deficit	4	4	8
6	Seizures	12	8	20

**Table 7.** Overall complications in patients with surgically and non-surgically managed depressed skull fractures.

Infections	Surgically managed	Non-surgically managed	P-value	Chi-square
Present	8	5	0.11	2.55
Absent	34	55	(Not Significant)	

**Table 8.** Infectious complications in patients with surgically and non-surgically managed- depressed skull fractures.

Neurological complications	Surgically managed	Non-surgically managed	P-value	Chi-square
Present	16	12	0.04	4.06
Absent	26	48	(Not Significant)	

## I. Infectious complications

We found that the overall infectious morbidity in our study was 13/102 (12.74%), which is higher than in reported studies by Brisbane (7%), Glasgow (3.5%), and Rotterdam (5%). (19, 9, 10) .The most common infectious morbidity in our study was superficial wound infection in 7/13 (53.84%), followed by infected CSF leak in 3/13 (23.77%), followed by

meningitis in 2/13 (15.38%), and osteomyelitis in 1 (7.69%) patient. {as shown in Table no 6} Prakash A et al also reported that superficial wound infection was the most common infectious morbidity in 38% of patients. (19) There was no significant difference (P >

0.05) in terms of infection rate in surgically managed patients (19.04%) and non-surgically managed patients (8.33%). {as shown in Table no 7} A similar difference in the infection rates has been observed by C. M. van den Heever et al. (8% vs. 2.8%) (15) and

**Table 9.** Assessment of neurological outcomes with different variables.

Sr. No.	Variable	Variable	No of cases	Good outcome (GOS 5)	Poor outcome GOS (<5)	Chi-Square value	Degrees of freedom	P-value
1	Age group	< 20 years	34	33 (97.1%)	1 (2.9%)	5.034	3.00	0.169
		21-40 years	45	42 (93.3%)	3 (6.7%)			
		41-60 years	21	17 (81.0%)	4 (19.0%)			
		>61years	2	2 (100.0%)	0 (0.0%)			
2	Sex	Male	89	82 (92.1%)	7 (7.9%)	0.000	1.00	1.000
		Female	13	12 (92.3%)	1 (7.7%)			
3	Mode of injury	RTA	76	71 (93.4%)	5 (6.6%)	0.659	1.00	0.417
		Non -RTA	26	23 (88.5%)	3 (11.5%)			
4	GCS at admission	Minor(13-15)	75	73 (97.3%)	2 (2.6%)	38.845	2.00	<0.001 (S)
		Moderate(8-12)	22	20 (90.9%)	2 (9.1%)			
		Severe(<8)	5	1 (20.0%)	4 (80.0%)			

Hossain MZ et al. (20) reported 12% infection rates in their research of surgically managed depressed fractures. The higher incidence of infections in both groups might be due to the different sets of patients due to loco-regional factors. Our study was also in contrast to the conclusion reported by M. Z. Hossain MZ et al. that surgical treatment of contaminated depressed skull fractures decreases complications like meningitis, cerebral abscess, and osteomyelitis. (20) We found that despite surgical treatment of compound-contaminated fractures by conventional approach, infections like meningitis and osteomyelitis were still present in the surgical group of our patients. So, we conclude that even the non-surgical management of compound depressed fractures without undergoing the conventional surgical method of elevation of the depressed fracture, bedside debridement of the wound, antibiotic-saline wash, and primary closure done in an emergency room followed by IV antibiotics can prevent the infection rate. Jennet et al. also found that only debridement done bedside reduces the incidence of infection to 4.6% in their series. (21) Early surgical management also cannot prevent the time onset of postoperative infectious complications as compared to non-surgical management. The Brain Trauma Foundation guidelines (Level III recommendation) for managing depressed skull

fractures advocate surgical management of contaminated compound fractures by conventional surgical methods to reduce the rate of infection. Our study is also a level III study, but our results disagree with the above-said guidelines. There is a need for randomized control trials to clear this issue.

The average duration of treatment of complications in the conservative group for infectious complications was 26 days, while in the surgical group it was 44 days. In both groups, the bacterial meningitis and osteomyelitis had long-term treatment of 6 to 8 weeks of IV antibiotics followed by oral antibiotics for 4 to 6 weeks. Factors responsible for infected complications in both groups for compound depressed fractures were delayed onset of presentation after trauma, mostly after 72 hours, wounds soaked with dirty mud and foreign particles, and delayed treatment with prophylactic I.V. and local antibiotics for contaminated wounds.

#### **J. Incidence of seizures and outcome in surgical and non-surgically managed patients**

In our study, the overall incidence of late-onset seizures (>7 days) was 19.6%, which is near the incidence of 15% reported by Jennet B et al. in his research of depressed skull fractures. (21) The average time of onset of these seizures was 11.44

days after trauma. They concluded that the occurrence of seizures in the depressed skull is the combined effect of focal and diffuse brain damage, which predisposes to epilepsy. In our study, the incidence of late-onset seizures (>7 days) in the non-surgical group was (8/60) 13.33%, while in the surgical group, it was 28.57% (12/42). Our results are, in contrast, to the studies of Hossain MZ et al. (20) and Sidram V et al. (2), who concluded that conventional surgical treatment of elevation of depressed fracture segment decreases the seizures' incidence.

#### **K. Assessment of neurological outcomes with different variables**

On assessing neurological outcomes with different variables, we found no statistically significant ( $P > 0.05$ ) association with age and sex, mode of injury, type of depressed fracture, site of fracture, and type of management, whether surgical or non-surgical, with neurological outcome, as shown in (Table no 9).

On the other hand, a better GCS at the time of admission and the absence of seizures have a significantly positive influence ( $P < 0.05$ ) on the neurological outcome of a depressed skull fracture. Satardey RS et al. reported that age, sex, site of fracture, and type of depressed fracture have a significant correlation with the neurological outcome. (2) Manne S et al. reported that there is no significant correlation between age and gender, site of the fracture, or type of fracture with the neurological outcome, while GCS at the time of admission has a strong correlation with neurological outcome. (5) Bidur KC et al. and Al-Haddad SA et al. reported that better GCS at admission correlated with favorable neurological outcomes. (22, 23) The poor outcomes with seizures have also been suggested by Satardey RS (2). Manne S et al. (5) suggested RTAs causing depressed skull fractures had poor outcomes compared to other injuries. We and Satardey RS et al. did not find this relevant. (18)

#### **L. Hospital stay**

Our study found a statistically significant difference ( $P < 0.05$ ) in terms of the mean duration of hospital stay. Our results were similar to the study of Katikar DB et al., who also found a shorter duration of hospital stay in non-surgically managed patients compared to surgically managed patients with depressed skull fractures. (24) Our practice of

managing patients of compound depressed fractures conservatively without conventional surgery will provide an additional socioeconomic advantage, especially for poor countries, in significantly saving funds and available resources and potentially reducing transfer costs. Additionally, non-surgical management is less time-consuming and reduces the duration of hospital stay.

#### **Strength of our study**

Our study is the fourth prospective study in the history of 200 years for the treatment of compound depressed fractures. We believe that our study may open up new discussions and a quest for more powerful studies in the future.

#### **Limitations**

Randomization of patient selection was not possible because of the medicolegal nature of traumatic brain injury cases, and our sample size was also too small.

#### **Future recommendations**

Simple debridement and suturing of compound depressed fractures without conventional surgery is also equally effective management of compound depressed skull fractures, and these patients can be managed in rural peripheral hospitals.

#### **CONCLUSION**

The number of patients with head injuries in tertiary neurosurgical centres with limited beds is rapidly increasing as there is an increasing incidence of road traffic accidents. The results of our research will provide benefits towards more conservative management with adequate wound debridement and antibiotics so that these patients can also be managed in peripheral rural hospitals and avoid unnecessary referrals.

#### **ABBREVIATIONS**

TBI: traumatic brain injury,  
DSFs: depressed skull fractures,  
CN: cranial nerve,  
GCS: Glasgow Coma Scale,  
GOS: Glasgow outcome scale,  
LOC: loss of consciousness,  
RTA: road traffic accidents.

## REFERENCES

1. Shukla D, Jain M. Depressed skull fractures—case series of 100 patients. *JEBMH*.2018;5(48):3324-26.
2. Ritesh S, Satardey, Srikant Balasubramaniam, Jayashree S, Pandya, Rajesh C, Mahey. *Asian J Neurosurgery*. 2018 Apr-Jun; 13(2): 341-347.
3. Retnam KR, Jawahar G, Natarajan M. Midline depressed fractures of the skull. *J Indian Med Assoc*. 1986;84(9):271-2.
4. Guidelines for the Management of Severe Traumatic Brain Injury, 3rd edition. Brain Trauma Foundation: Introduction. *J Neurotrauma*.2007;24(1):1-2.
5. Manne S et al. Surgical outcomes in depressed skull fractures: an institutional experience. *Asian J Neurosurg*.2019;14:815-20.
6. Sidram V et al. A prospective study of the spectrum of a depressed fracture of the skull and its surgical outcomes. *Int J Head and Neck Surgery*.2015;6(4):134-138.
7. Heary RF, Hunt CD, Krieger AJ, Schulder M, Vaid C. Nonsurgical treatment of compound depressed skull fractures. *J Trauma* 1993;35(3):441-447.
8. Jamieson KG, Yelland JD. Depressed skull fractures in Australia. *J Neurosurg*.1972 Aug;37(2):150-5.
9. Miller JD, Jennett WB. Complications of depressed skull fracture. *Lancet*.1968;2:991-5.
10. Braakman R. Depressed skull fracture: Data, treatment, and follow-up in 225 consecutive cases. *J Neurol Neurosurg Psychiatry*. 1972; 35:395-402.
11. Vala H, Vaja MA. Depressed skull fracture: Prognosis of patients after conservative or surgical management. *IP Indian J Anat Surg Head Neck Brain*. 2020;6(1):8-13.
12. E. Shingiro et al. Clinical profile of skull fractures in Rwanda. *RMJ*.2017;74(3). Muhammad Asif, et al. Depressed Skull Fracture Management of 100 Cases at DHQ Teaching Hospital/Sahiwal Medical College Sahiwa Pak. *J. of Neurol. Surg*.2017;21(3).
13. Rolekar NG. Prospective study of the outcome of depressed skull fracture and its management. *Int J Med Sci Public Health* 2014; 3:1540-1544.
14. CM. van den Heever and D. J. van der Merwe. Management of depressed skull fractures. *J Neurosurg* 71:186-190, 1989.
15. Venkati G S, Yadav V, Shankar K B, Sikka A, Retrospective study of depressed skull fractures at a tertiary care center. *IP Indian J Neuroscience*.2020;6(1):55-58.
16. Kurmi DJ, Deka K, Ahmed J. A prospective clinical study of depressed skull fractures with special reference to their management. *J Evid Based Med Healthc* 2021;8(18):1195-1200.
17. Ahmad S, Afzal A, Rehman L, and Javed F. Impact of depressed skull fracture surgery on outcome of head injury patients. *Pak J Med Sci*. 2018 Jan-Feb;34(1):130-134.
18. Prakash A, Harsh V, Gupta U, Kumar J, Kumar A. Depressed Fractures of Skull: An Institutional Series of 453 Patients and Brief Review of Literature. *Asian J Neurosurg*. 2018 Apr-Jun;13(2):222- 226.
19. M Zahed Hossain, M S Mondle, M Monzurul Hoque. Depressed Skull Fracture: Outcome of Surgical Treatment. *The Journal of Teachers Association RMC*. 2008; 21(2):140-146.
20. Jennett B, Miller JD. Infection after depressed fracture of skull. Implications for management of nonmissile injuries. *J Neurosurg*. 1972 Mar;36(3):333-9.
21. KC Bidur, Shakya B, Thapa A. Study of Outcome of Patients Sustaining Depressed Skull Fracture Following Blunt Head Trauma. 2018;14(2):81-4.
22. Al-Haddad SA, Kirolos R. A 5-year study of the outcome of surgically treated depressed skull fractures. *Annals of the Royal College of Surgeons of England*. 2002;84(3):196-200.
23. Katikar D B, Jaykar R D, Rahul Ghule, Shivprasad Lakhapatre, Vikas Kumar. A prospective randomized study of operative and conservative management for compound depressed fractures of the skull. *MedPulse—International Medical Journal*. 2014 Oct; 1(10) 689-693.
24. K. K. Mukherjee et al. Prospective comparison of simple suturing and elevation debridement in compound depressed fractures with no significant mass effect. *Acta Neurochirurgica*.2015; 157:305-309.
25. Kumar S et al. A prospective comparative evaluation of surgery and conservative management treatment for compound depressed skull fractures. *World Neurosurgery*.2022; E1-E9.