Outcome of Depressed Cranial Fracture: A Single Centre Experience of 490 Cases with Short Literature Review

Mohan Karki[1], **Yam Bahadur Roka**[2]

[1,2]Department of Neurosurgery, Neuro Cardio and Multispeciality Hospital, Biratnagar, Nepal

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Abstract

Introduction: Depressed cranial fractures (DCFs) are one of the serious head injuries where road traffic accident (RTA) is the most common cause. So, we have assessed the outcome in surgically managed cases of depressed cranial fracture following head injury and study the factors which may affect the surgical outcome of patients.

Materials and methods: A retrospective assessment of 490 consecutive cases was undertaken who went surgery for depressed cranial fracture (DCF) in Department of Neurosurgery, Neuro-Cardio and Multispecialty Hospital, Biratnagar, Nepal, from January 2011 to December 2021. All age groups (except< 1 year) were included in this study and diagnosis confirmed by CT scan of brain with bone window. Outcome was assessed by Glasgow outcome scale.

Results: The incidence of depressed cranial fracture was highest in road traffic accident (RTA) and in the age group of 20-40 years. There was predominance of male over female with ratio 5.53:1. There was a significant correlation between age, mode of injury, fracture site, GCS at admission and intracranial bleed with outcome. Similarly, the complications such as CSF leakage, seizure were significant association with outcome. Of all 490 cases, most of them were operated within 5 hour with overall mortality rate of 0.40%.

Conclusions: Our study concluded that patient who underwent surgery for DCFs, with GCS >13 at the time of admission, age <40year and no hospital delay (<5hour) had better outcomes. Incidence of RTAs was noted comparatively higher rate in age 20-40 year, which can help us to find out best strategic management option.

Key words: Depressed cranial fractures, surgery, Glasgow Outcome Scale

Introduction

Depressed cranial fractures are one of serious head injury where mode of injuries commonly causing DCFs is RTA, fall injury and physical assault. It reports incidence of skull fractures per year is 44/100, 0001 and about half of death from trauma.[2] A cranial fracture is considered depressed when any portion of the outer table that lies below the normal anatomical portion of the inner table.[3] Depressed fracture can directly affect brain parenchyma or indirectly affect with compression underlying the brain tissue by EDH/ASDH and contusion.[4,5] The outcome of patients with depressed fracture varies and depends on multiple factors. Computed tomography (CT) scan imaging is sufficient and necessary to differentiate the bone fragments from underlying brain contusion or clots. There have been a limited number of previous studies analyzing overall outcomes of depressed cranial fracture and significant factors. So we have tried to look at the pattern of occurrence of depressed cranial fracture and examine the factors associated with patients of depressed fracture of cranium.

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Address for correspondence:
Mohan Karki, MBBS, MS (Neurosurgery)
Department of Neurosurgery
Neuro Cardio and Multispeciality Hospital
Biratnagar, Nepal
E-mail: jigyasu86@gmail.com

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Materials and Methods

We retrospectively reviewed all cases who were underwent surgery for depressed cranial fracture in the Department of Neurosurgery at Neuro Cardio and Multispeciality Hospital Biratnagar, Nepal during the period of January 2011 to December 2021.The admitted cases in the above mentioned period with one or more fragments bone depressed by at least thickness of cranium

were included and age less than 1 year as well as linear cranial fracture were excluded. We collected data of depressed cranial fractures with relation to age groups, sex, mode of injury, site of injury, type of depressed fracture, Glasgow Coma Scale (GCS) at admission, post operative infections and mortality (**Table 1**). The Outcome was measured by Glasgow Outcome Scale (GOS). Outcomes was studied in relation to the following variables: age, sex, mode of injury, site of injury, type of depressed fracture, GCS at admission, associated brain injuries such as Intracranial bleed(EDH/SDH)andcontusion. It was mentioned as good outcome if there was no eventful course postoperatively and poor outcome if patient developed some focal residual neurological deficit, post traumatic seizure disorder, vegetative state, or death in the hospital during treatment.[6] Descriptive statistics was calculated and statistical test of significance such as t-test and chi-square test were applied wherever required.

Results

A total of 490 patients were underwent surgical intervention during study period. A total of 451 patients (91.48%) of study participants had a Glasgow outcome scale of 5 and 39 patients (8.52%) of study participants had Glasgow outcome scale of <5(**Table 2**).

Age and Sex

In our studies of 490 patients, maximum incidence was noted to be in the age group of 20-40 years (45.51%), 34.10 % in the age<20 years and 20.49% in the age > 40 years. The mean age of study participants was 34.70±10.52 years. The distribution of cases according to sex, 84.70% were male and 15.30% were female with male to female ratio of 5.53:1. No significant association was found between sex and Glasgow outcome scale. But, Significant association ($p<0.05$) was reported between age and Glasgow outcome scale for depressed cranial fractures.

Mode of injury and Site of injury

Road traffic accidents (RTA) was most common causes of depressed cranial fractures with occurrence rate of 62.04% (n=304) cases followed by fall injury, physical assault and others traumatic injury which were 20.81% (n=102), 13.27% (n=65) and 3.88% (n=19) cases respectively. The most common site of injury was frontal region found in 34.29% (n=168) cases followed by parietal in 27.14% (n=133); temporal in 16.94% (n=83); temporoparietal in 13.06 % (n=64); frontotemporal in 5.30% (n=26) and occipital region in 3.27% (n=16) cases. A significant correlation was found between mode of injury and site of injury with Glasgow outcome scale ($p<0.05$) for depressed cranial fractures.

GCS score at admission and Pre-hospitalization delay

GCS score at admission was 13-15 in 84.13% (n=413) patients, 9-12 in 14.28% (n=70) patients and <8 in1.42 % (n=7) patients. Out of 490 patients, 29.59% (n=145) patients was admitted < 2 hours of injury, similarly 49.60 %(n=243) in 2-5 hours and 20.81 % (n=102) patients >5 hours. Both GCS and Pre-hospitalization delay were significantly correlated with Glasgow outcome scale ($p<0.05$).

Type of fracture and Associated brain injuries

About 43.68% (n=214) cases had simple fractures and 56.32 %(n=276) cases had compound fractures.21.02 % (n=103) of cases had EDH (**Figure 1**), 20% (n=98) cases had EDH with SDH, 15.10% (n=74) cases had SDH only, 18.16 % (n=89) cases had underlying contusion, 9.19 % (n=45) cases had pneumocephalus and 16.53% (n=81) cases had no any associated brain injuries. We found significant association between intracranial bleed (EDH/SDH) and CSF leakage with Glasgow outcome scale (<0.05), but no significant correlation between contusion and dural tear with Glasgow outcome scale (>0.05) for depressed cranial fractures.

Complications

Out of 490 cases, about 3.06% (n=15) cases had infections, of which 86.67% (n=13) had superficial wound infection and 13.33% (n=2) had meningitis which was treated with appropriate antibiotics after culture and sensitivity testing. 9.18% (n=45) cases reported CSF leakage. Most cases of CSF leakage were treated conservatively and keeping lumber drain and some of persistent CSF leakage cases such as persistent rhinorrhea were treated by repairing dural tear. About 9.59 % (n= 47) had developed seizure which was managed with antiepileptic drugs. There was significant correlation between seizure and CSF leakage with Glasgow outcome scale ($p<0.05$), but no significant association between wound infection and Glasgow outcome scale ($p>0.05$). Overall mortality was 0.040% (n=2) in our series (Figure 2).

Table 1: Distribution of the study population of depressed cranial fracture

Variables	Number of cases N (%)	Mean ± SD
Age group, year		
<20	167 (34.10)	34.70±10.52
20-40	223(45.51)	
>40	100(20.49)	
Sex		
Male	415(84.70)	
Female	75(15.30)	
Mode of injury		
Road traffic accident	304 (62.04)	
Fall injury	102(20.81)	
Physical assault	65(13.27)	
Others	19(3.88)	
Site of fracture		
Frontal	168(34.29)	
Temporal	83(16.94)	
Parietal	133(27.14)	
Occipital	16 (3.27)	
Fronto-temporal	26(5.30)	
Temporo-parietal	64(13.06)	
GCS at admission		
13-15	413(84.30)	
9-12	70(14.28)	
<8	7(1.42)	
Pre-hospitalization delay(h)		
<2	145(29.59)	
2-5	243(49.60)	
>5	102(20.81)	
Associated brain injuries		
EDH	103(21.02)	
EDH with SDH	98(20)	
SDH	74(15.10)	
Contusion	89(18.16)	
Pneumocephalus	45(9.19)	
Normal	81 (16.53)	
Type of fracture		
Simple	214(43.68)	
Compound	276(56.32)	
Mode of presentation		
Headache	112(22.86)	
Headache with vomiting	99(20.20)	
LOC	135(27.56)	
Seizure	47(9.59)	
Nasal Bleed	58(11.84)	
Ear Bleed	29(5.91)	
Nasal bleed with Ear Bleed	10(2.04)	

Table 2: Factors associated with Glasgow Outcome Scale scores of patient with depressed cranial fracture

Factors		Good Outcome (%)	Poor Outcome (%)	P-Value
Sex:	Male	383 (92.29)	32 (7.71)	0.63
	Female	68 (90.67)	7 (9.33)	
Age ,year:	<40	366 (93.85)	24 (6.15)	0.003
	>40	85 (85.00)	15 (15.00)	
Mode of injury:	RTA	273 (89.80)	31(10.20)	0.03
	Non-RTA	177 (95.16)	9 (4.84)	
Fracture type:	Simple	201 (93.93)	13 (6.07)	0.17
	Compound	250 (90.58)	26 (9.42)	
GCS at admission):	>13	392 (94.92)	21 (5.08)	<0.0001
	: <13	59 (76.62)	18 (23.38)	
Site Of fracture:				
	Frontal	140 (83.33)	28 (16.67)	0.01*
	Temporal	82 (98.80)	1(1.20)	
	Parietal	121 (90.98)	12 (9.02)	
	Occipital	15 (93.75)	1 (6.25)	
	Fronto-temporal	26 (100)	0	
	Temporo-parietal	61 (95.31)	3 (4.69)	
Associated Brain Injuries:				
Intracranial Bleed Present		247 (89.82)	28 (10.18)	0.03
Intracranial Bleed Absent		204 (94.88)	11 (5.12)	
	Contusion	83 (93.26)	6 (6.74)	0.63
	No Contusion	368 (91.77)	33 (8.23)	
	Dural Tear	252 (91.64)	23 (8.36)	0.70
	Dural Intact	199 (92.56)	16 (7.44)	
	Pneumocephalus	43(95.55)	2(4.45)	0.55
	No-Pneumocephalus	415(93.26)	30(6.74)	
Pre-hospitalization delay (hr):				
	<5hr	374 (96.39)	14 (3.61)	<0.0001
	>5hr	77 (75.49)	25 (24.51)	
Complications				
Wound Infection		15(100)	0	0.68
No wound infection		470(98.95)	5(1.05)	
CSF leakage		36 (80.00)	9(20.00)	0.001
No CSF leakage		415 (93.26)	30 (6.74)	
Seizure		40(85.11)	7(14.89)	<0.0001
No seizure		431(97.29)	12(2.71)	

**t-test*

Table 3: Literature review of depressed fracture of skull.

Study(year)	Major mode of injury	Commonest site of injury	Common age distribution (year)	complications				
				Seizure %	Contusion %	Infection rate %	Dural tear %	Death %
Braakman R et al (1972)	RTA	Parietal bone	0-15	-	-	3.5	51	12.9
Al-Haddad SA et al.(2002)	Assault	Parietal bone	0-15	-	-	8.2	49.3	1.4
Ritesh S.Saterdey et al (2018)	RWA	Parietal bone	20-40	26	34	14	28	10
Ananda Praksh et al(2019)	Assault	Parietal bone	16-45	-	59	15	57	16.77
Present study (2020)	RTA	Frontal bone	20-40	9.59	18.16	3.06	56.12	0.4

RWA-railway accident, RTA-road traffic accident

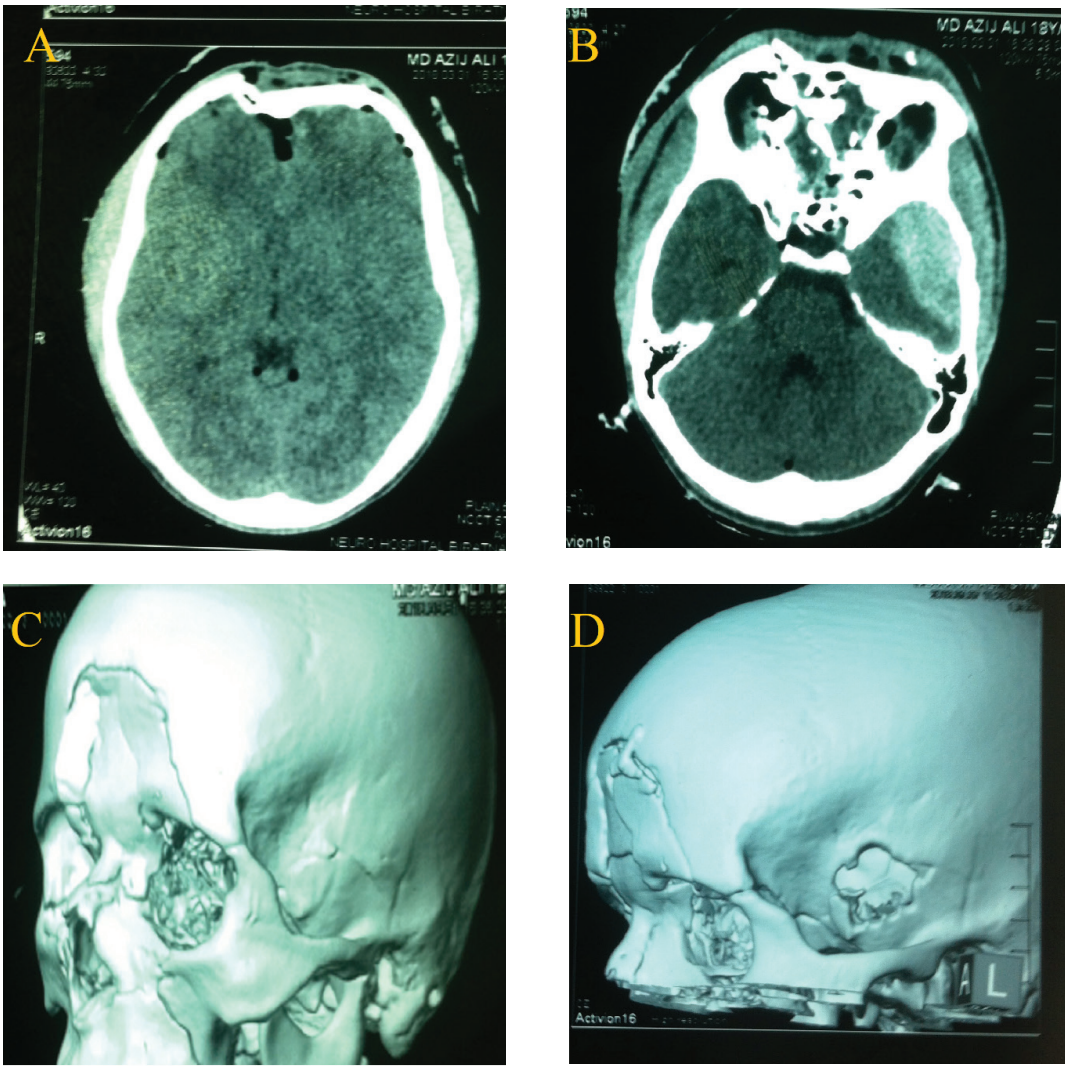

Figure 1: Preoperative Three dimensional (3D) CT image (Bone window C) showing comminuted depressed fracture of mid frontal and nasal bone (C) and Axial CT scan (Brain window) showing depressed mid frontal bone fracture with pneumocephalus and left temporal EDH (A,B), Postoperative axial 3D CT scan showing elevated fracture frontal bone and left temporal craniectomy for EDH removal(D).

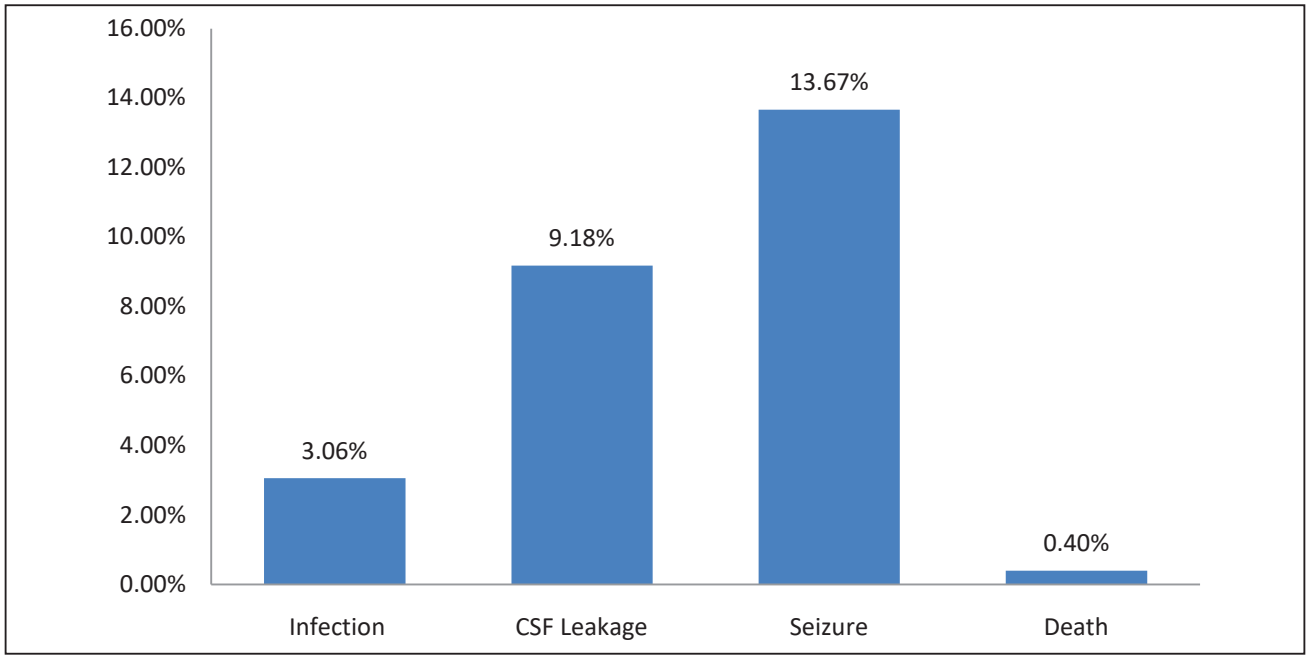

Figure 2: Graph showing complications (%) following surgery for case of DCFs

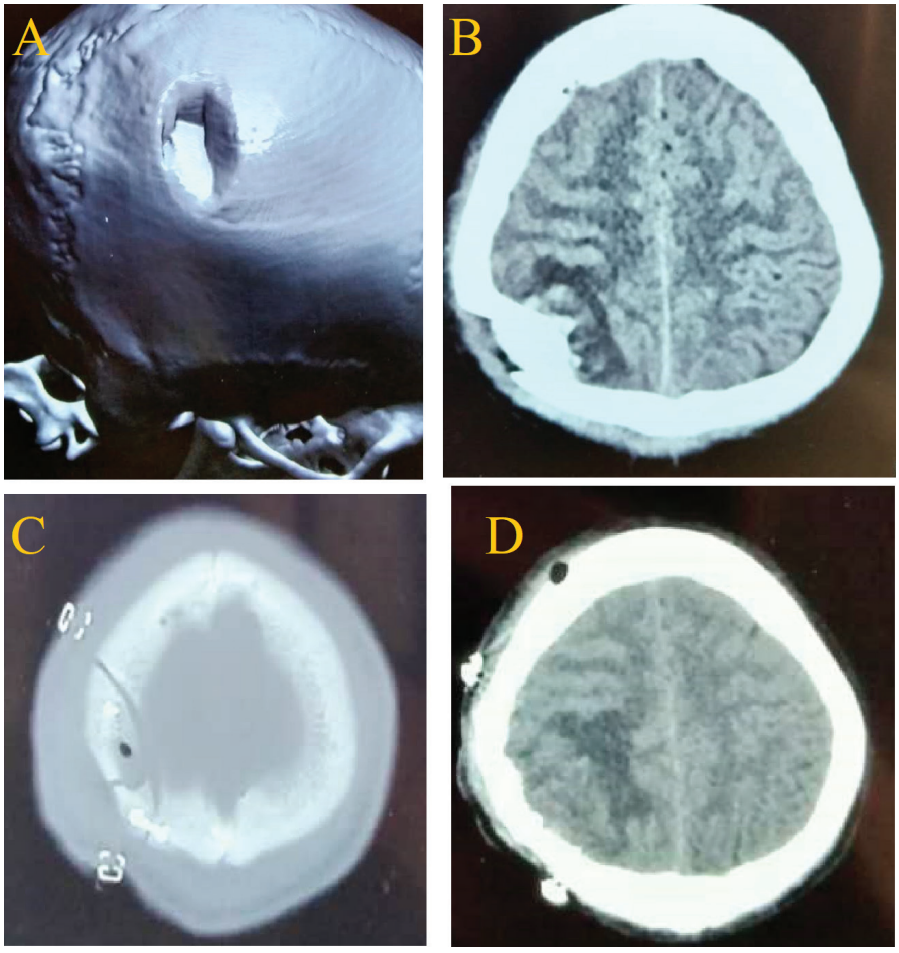

Figure 3: Preoperative 3D CT image showing right parietal depressed fracture (A) and Axial CT image showing right parietal depressed fracture with contusion; Postoperative 3D CT image showing elevated fracture(C) and Axial CT image showing resolving contusion (D).

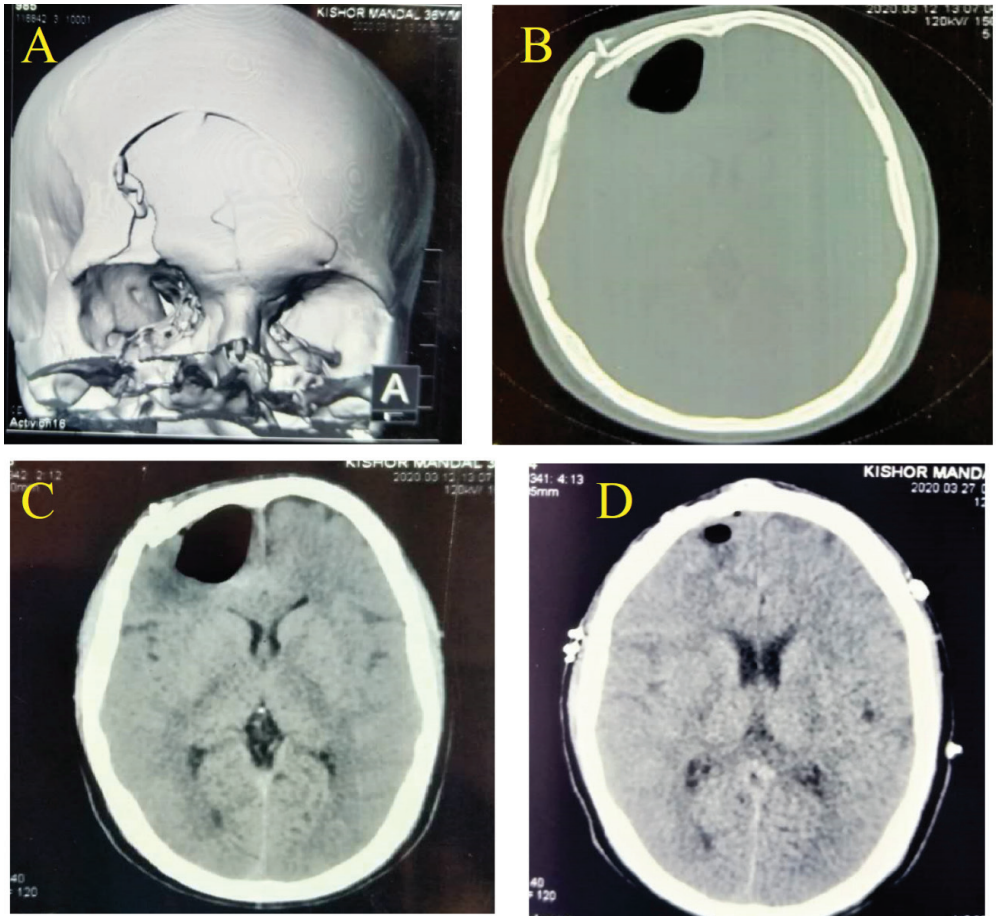

Figure 4: Preoperative 3D CT image showing frontal bone depressed fracture(R>L) (A), axial Ct image showing pneumocephalus (B, C) and Postoperative axial CT image showing elevated fracture with resolving pneumocephalus.

Discussion

Head injury has led to major concern not only for developed countries but also for developing country because which is leading causes of morbidity and mortality of trauma patients. In DCFs, the outer table of one or more fractures edge lies below the normal anatomical level of the inner table as determined by surrounding intact cranium.[3] Either conservative or surgical approaches can be employed to manage depressed fractures depending upon segments of depressed fractures. In our institute, we have studied 490 cases of depressed cranial fractures who underwent surgeries.

In our studies, 84.70% (n=415) cases were male and 15.30% (n=75) were female with ratio of male to female was 5.53:1. There was no significant association between sex and outcome which is similar to previous studies.[7, 8] The mean age of presentation was 34.70±10.52 years in our series. We noted maximum patients (45.51%) were in the age group 20-40 years. RTAs were found to be the most common mode of injuries (62.04%). There were studies [9, 10, 11] that reported almost 50% of the patients were <16 year of age. Most of these age group cases were working populations who were at risk of RTAs, assault and other injuries while commuting.[7] The outcome became worse with increase in age from 6.15% in age <40 years to 15% in >40 years. So there was significant correlation between age and outcome as reported by Ritesh et al and Jagger J.[12,13]

In the present study, RTAs was most common mode of injury (62.04%). A similar study was done by [7,12,13] where RTAs was most common mechanism in depressed fractures. But, Theses findings differed with a study, Al-Derazi et al.[14] in which accidental heavy object fall was major the causes of injury;and Swann et al and Ananda et al,[15,16] in which assault was principal causes of injury. RTAs had higher rate of morbidity and mortality compared to Non-RTAs patients. There was significantly correlation between outcome and mode of injury ($p<0.05$). Similar findings were observed in the study conducted by Jagger et al .[13] Compound DCFs was noted in 56.32 % (276) and 43.68% (214) had simple or closed DCF, which were similar study to by Al-Deraji et al,[14] compound DCF was present in 72% (86) patients and simple in 28%(34)

patients. Patients with compound DCF had 90.58% good outcome and 93.93 % good outcome in simple DCF patients. Ritesh et al reported that patients with simple DCF had 100% good outcome as compared those compound DCF of 68.8%.[12] No significant association was found between fracture type with final outcome (>0.05).

The patients with GCS score >13 (84.13%) at the time of admission fared well with better long term outcome as against those with GCS score below it. There were 413 patients between 13 and 15 GCS score of which 392 had good outcome. Patients with preoperative GCS in the range of `13-15 were 84.13% (413), in the range of 9-12 were 14.28% (70) and those below 8 were 1.42% (7). A similar study done by Ritesh et al.[12] patients with preoperative GCS in the range of 13-15 were 37 %, in the range of 9-12 were 145 and those below 8 were 12%. There were significant association GCS at admission with final outcome (<0.05). Therefore it can be emphasized that GCS both at admission and at discharge had significant role in predicting outcome. [7]

In this present study**,** frontal region (34.29%) was the most common site of fractures followed by parietal region (27.14%) and temporal region (16.94%). Our study findings were similar with study by Manne et al.[7]and differed with study done by Ritesh et al,[12] where most common site of fractures were parietal 40% followed by frontal 34% and temporal 10%. There were significant association between fracture site and outcome score (<0.05). Patients involvement with even single bone fractures associated with intracranial bleed (10.18%) had poor outcome as compared without intracranial bleed (5.12%). DCFs associated brain injuries are another factor for predicting the outcome. In our study, 21.02% of cases had EDH, 20%-SDH, 18.16%-contusion and dural tear -56.12%. These findings were differed from study by Hossain et al, [17] findings where EDH-22%, contusions-31%.There were statistical correlation between intracranial bleed with outcome score (<0.05).Our study findings differed with a study by Manne et al in which site of fracture was not statistically association with outcome score (>0.05).[7] Our study reported patients with contusion had 93.26% good outcome and 6.74% poor outcome (**Figure 3).** No significant association was noted between contusion and outcome score (>0.05). Other findings such as dural tear and pneumocephalus were no statistically significant with outcomes which are similar to findings reported by Manne et al. [7]

In the present study, patients with low GCS at admission presented in the hospital was significant correlation between prehospital delay and outcome (<0.05). Within five hours hospitalization, there was 96.39% patient had good outcome and 3.61% had poor outcome. Similarly, 75.45% patients had good outcome and 24.52% patients had poor outcome in case of hospitalization more than five hours of trauma. Our report differed from a study done by Ritesh et al, where no statistical significant association between pre-hospital delay and outcome was noted. [12] The increased time taken to reach hospital increased risk of morbidity and mortality**.**

In our study, other findings such as dural tear and pneumocephalus (**Figure 4)** were not related to final outcome, which are similar findings studied by Manne et al.[7] One of complications associated with DCFs, seizure was found 47(9.59 %) patients of all case, where poor outcome had 14.89% as against those without seizure -2.71%. There were statistically significant between seizure and poor outcome (<0.05).This is similar finding reported by Ritesh et al, where 26% patients had complication of seizure (**Table 3**).[12] Patients with wound infections were 3.06% in the present study.There were no significant correlation with wound infection to outcome score (<0.05). Ritesh et al reported 14% patients had wound infection and had greater chance of morbidity and mortality, which differed from our study.[12]Patients with DCFs had 9.89% CSF leakage, whereit showed poor outcome (20%)as compared to without CSF leakage (6.74%).So our study presented significant association between CSF leakage with outcome score(<0.05). There were 2 cases of death in our study (0.4%). Lumber drain insertion was done for treatment of one of the patients with CSF otorrhea. Later it developed meningitis and then hydrocephalus; and extra-ventricular drainage insertion was done. He died after 3 month after discharge, but reason of death was unknown. Other patient developed hydrocephalus which had Right frontal DCFs with EDH/contusion and Mild intra-ventricular hemorrhage. Right frontal extra- ventricular drainage was inserted for IVH and hydrocephalus. It also developed meningitis with persistent hydrocephalus. Two times EVD insertion were done. Both of death cases had low GCS (<8) and underlying hematoma. A study done by Haines, where requirement of antibiotic treatment for all patients with compound DCFs was unclear.[18] Use of antibiotics for fracture elevation and craniotomies cases had better role in prevention of infection as similar result reported by Van EkB et al.[19]

Conclusions

Our study reported few significant factors which influence the outcome of depressed cranial fractures. This study concluded that patients with DCFs having age <40 years, good GCS>13 at admission, without underlying brain injury, no hospitalization delay (<5hour) had better outcomes. Underlying intracranial hemorrhage (EDH/SDH) and CSF leakage had poor outcome as compared to contusion and significant association was also noted. Delaying in the hospitalization (>5hour) with low GCS (<13) along with complaints of seizure had poor outcome

and strong statistically significant correlation was found. This did not find any significant relation of following factors such as sex, fracture type, contusion, dural tear and pneumocephalus with outcome.

Contributorship Statement

Dr. Mohan Karki conceived and designed study, Data collection and manuscript writing and drafting of manuscript. Dr. Yam Bahadur Roka was responsible for editing and providing technical feedback with design and analyses.

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Availability of Data Statement: Data sharing is not applicable to this article as no datasets were generated analyzed during current study.

Ethical Statement and Patient consent for publication: We declare that all patients gave informed consent prior to inclusion in this study

Ethical approval:"for this type of retrospective study formal ethical approval no required"

Conflict of interest: All authors certify that they have no affiliations with or involvement in any organizations or entity with any financial interest, or non-financial interest.

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