

1 **Original research article**

2 **Outcome of surgically treated traumatic extradural hematoma**

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5 **ABSTRACT**

6 **Summary**

7 Extradural hematoma (EDH) has been seen as a neurosurgical emergency since eighteenth century.
8 Efforts have been on since then to reduce the mortality associated with this entity. The mortality has
9 dropped from around 80% in late nineteenth and early twentieth centuries to below 20% in many centers
10 now. Improving quality of care and, constant assessment of outcome and factors affecting outcome are
11 the driving forces leading to reduction in mortality.

12 **Objectives**

13 To determine the functional outcome and the effect of level of consciousness on traumatic extradural
14 hematoma patients who had surgery in our centers.

15 **Patients and methods**

16 It was a prospective observational study carried out on forty three patients with traumatic extradural
17 hematoma who had surgical evacuation of the hematomas in our centers over a five year period. Data
18 were collected using structured proforma in accident and emergency, theater, intensive care unit, wards
19 and in outpatient clinic. The data were analyzed using Environmental Performance Index (EPI) info 2007
20 software.

21 **Results**

22 Forty three patients had surgery for traumatic extradural hematoma during the five year period. There
23 were thirty eight males (88.37%) and five females (11.63%). Road traffic accident was the most common
24 aetiology. The functional outcome was 83.72% and mortality was 13.95%. Glasgow Coma Score prior to
25 surgery and age significantly affected the outcome, $P = .002$ and $P = .00$ respectively.

26 **Conclusion**

27 The favorable functional outcome from our study (83.72%) was within the current range in the world.
28 Level of consciousness prior to surgery and age significantly affected outcome.

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30 **KEYWORDS:** trauma, extradural hematoma, consciousness, surgery, outcome

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32 1 INTRODUCTION

33 Extradural hematoma occurs as a result of bleeding between the inner table of the skull and the outer
34 layer of the dura mater. It constitutes 1-3% ^[1, 2] of all head injured patients and 9% of those who are
35 comatose. ^[3] In eighty five per cent (85%) of patients, the source of bleeding is the middle meningeal
36 artery while in the rest, it is from middle meningeal sinus and dural sinuses. ^[4, 5]

37 Extradural hematoma is usually diagnosed with the aid of a Computerized Tomography (CT) scan. It
38 appears as a biconvex extra-axial lesion. It is usually hyperdense in acute stage, isodense in sub-acute
39 stage and hypodense in chronic stage.

40 Extradural hematoma is a neurosurgical emergency. Its immediate threat to life was reported as early as
41 eighteenth centuries. ^[6, 7] The outcome of treatment was so poor at that time that Callender ^[8] wrote that all
42 treatment of epidural hemorrhage were so hopeless that he advised against futile trephination of the skull.
43 However, from the experience of Gross ^[9] during the battle of Shiloh, he advised immediate evacuation of
44 extradural hematoma by trephination. With current application of emergency medical services and critical
45 care methodologies, the outcome of head injured patients requiring surgical intervention has improved. ^[10]
46 The introduction of Computerized Tomography Scan in 1972^[11] led to early diagnosis and reduction of
47 intervention time. Better neuroanaesthetic agents, early intubation and the use of ventilators and better
48 monitoring equipment, have all helped to improve care, reduce the intervention time and have
49 consequently translated into reduced morbidity and mortality in these patients. The trend globally has
50 been steady decline in mortality as care improves. ^[12] .With this trend in mind, we prospectively studied the
51 outcome of surgically treated traumatic extradural hematoma we managed in our centers.

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58 **2 PATIENTS AND METHODS**

59 It was a prospective cross-sectional study of the outcome of patients with computerized tomography scan
60 diagnosed traumatic extradural hematoma who had surgical evacuation of the hematoma from 1st
61 October 2008 to 30th September 2009 in the first center and from 1st August 2010 to 31st July 2014 in the
62 second center. (Gap due to time taken by first author to write fellowship examinations and to relocate to
63 center 2 that appointed him consultant on passing his fellowship examinations. He was actively involved
64 in surgical care of the patients and data collection. He continued the research in center 2.)

65 **2.1 Inclusion criteria:**

66 All patients with cranial CT scan diagnosed traumatic extradural hematoma who had surgical evacuation
67 of the hematoma were included in the study.

68 **2.2 Exclusion criteria**

69 All patients with cranial CT scan diagnosed traumatic extradural hematoma that were managed non-
70 operatively were excluded from study. Patients who had traumatic extradural hematoma discovered and
71 evacuated during surgery for open depressed skull fractures in patients who did not do cranial CT scan
72 were also excluded from the study.

73 **2.3 Methods:**

74 Patients who had traumatic brain injury were resuscitated in accident and emergency using Advanced
75 Trauma Life Support protocols. We used Normal saline for adult and 4.3%Dextrose in1/5Saline for
76 children to ensure euolemia and normotension. We gave Paracetamol 15mg/kg 8 hourly to ensure good
77 analgesia. Ceftriaxone 1gm once daily for adult and 100mg/kg once daily for children, was given to those
78 with open wounds. We gave Oxygen via face mask or nasal catheter at 4-7litres/minute aiming at ≥95%
79 saturation. Cranial computerised tomography scan was done for those who could afford it (most of the
80 CTs were done in private centers as center 2 did not have functional CT and the CT in center 1 was

81 functionally epileptic. No universal insurance coverage in our country). Other investigations such as full
82 blood count, urinalysis, chest x-ray, serum electrolyte/urea/creatinine were done. On CT scan acute
83 extradural hematoma appears as hyperdense biconvex extra-axial collection bounded by dural
84 attachment to suture lines. Fracture across suture line may alter the shape into somehow crescentic,
85 mimicking acute subdural hematoma. Traumatic extradural hematoma in children $\geq 5\text{mm}$ or $\geq 10\text{mm}$ in
86 adult were operated. Those associated with depressed skull fractures qualified for surgery. We used
87 craniotomy to evacuate the hematoma. However, minicraniectomy (extended burr hole) was used in
88 patients that could not withstand craniotomy and for faster decompression in deteriorating patients. After
89 surgery, the patients were admitted in the wards. They were given fluids, antibiotics and analgesics for
90 12-48 hours depending on the state of the patients. For conscious patients, we discontinued fluids after
91 12 hours and commenced oral feeding. The antibiotics and analgesics were changed to orals. For
92 unconscious patients we continued infusions, intravenous antibiotics and intramuscular analgesic for 48
93 hours. We commenced nasogastric feeding using our high energy/high protein diet on the third day. The
94 diet is constituted thus: 500ml pap, two tablespoonful powdered milk, two tablespoonful soya bean
95 powder, one tablespoonful red oil, and one tablespoonful cray fish powder. The daily fluid requirements of
96 the patients were factored in the diet. They were given five to six times a day. Antibiotics and analgesic
97 were then given via the nasogastric tubes. On discharge, the patients were followed up in outpatient
98 clinic.

99 Data were collected using structured profroma which was component of compound research that was
100 approved by research and ethics committee in center 1. It was a component of prospective data bank that
101 was approved by research and ethic committee in center 2. The biodata, etiology, Glasgow Coma Score
102 after resuscitation, symptoms and signs, CT findings and other investigations were documented in
103 accident and emergency (A&E), Glasgow Coma Score prior to induction, interval between injury and
104 surgery, the procedure used, and findings at operation were documented in theater. The progress of the
105 patients till discharged were documented in the wards.

106 The Glasgow Outcome Scale (GOS) was the principal tool used in determining the outcome of patients.
107 It assesses the functional state of the patient after treatment. It classifies them into five categories: 1
108 dead, 2 vegetative state, 3 severe disability, 4 moderate disability, and 5 good recovery.^[13] The functional

109 outcome was assessed at three months post-injury as it had been found that the outcome at three
110 months was the best predictor in long term. ^[14] The Scores at three months were obtained in the
111 outpatient clinic for patients that survived.

112 Patients were regarded as having good functional outcome if they had moderate disability or good
113 recovery.

114 The data were analysed with EPI **info 7 software**. We used the 'add analysis gadget, of the Visual
115 Dashboard to analyse the data. We used frequency component to find frequency of some variables such
116 as gender. We used the mean component to find mean of continuous variables such as age. We recoded
117 age into groups using 'defined variable' component. Univariate variables were analysed using MXN/2X2
118 components. Its advanced components were used for multivariate variables. At 95% confidence interval,
119 $P < .05$ was considered significant.

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127 **3 RESULTS**

128 Forty three patients with traumatic extradural hematoma were operated within the period. Twenty four
129 patients (55.81%) were referred to our centers from other health facilities, while nineteen patients
130 (44.19%) came direct to us from the trauma scenes. There were thirty eight males (88.37%) and five
131 females (11.63%). The age ranged from two years to seventy two years with a mean of 30.28 years. The
132 majority of patients were 20 – 40years (55.82%), table1.

133 **Table 1: Age group frequency**

Age group	Number	Percent (%)
0 - >10	3	6.98

10 - >20	6	13.95
20 - >30	14	32.56
30 - >40	10	23.26
40 - >50	6	13.95
50 - >60	1	2.33
60 - >70	2	4.65
70 - >80	1	2.33
Total	43	100

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135 The most common etiology was road traffic accident (RTA), table 2.

136 **Table 2: Etiology frequency**

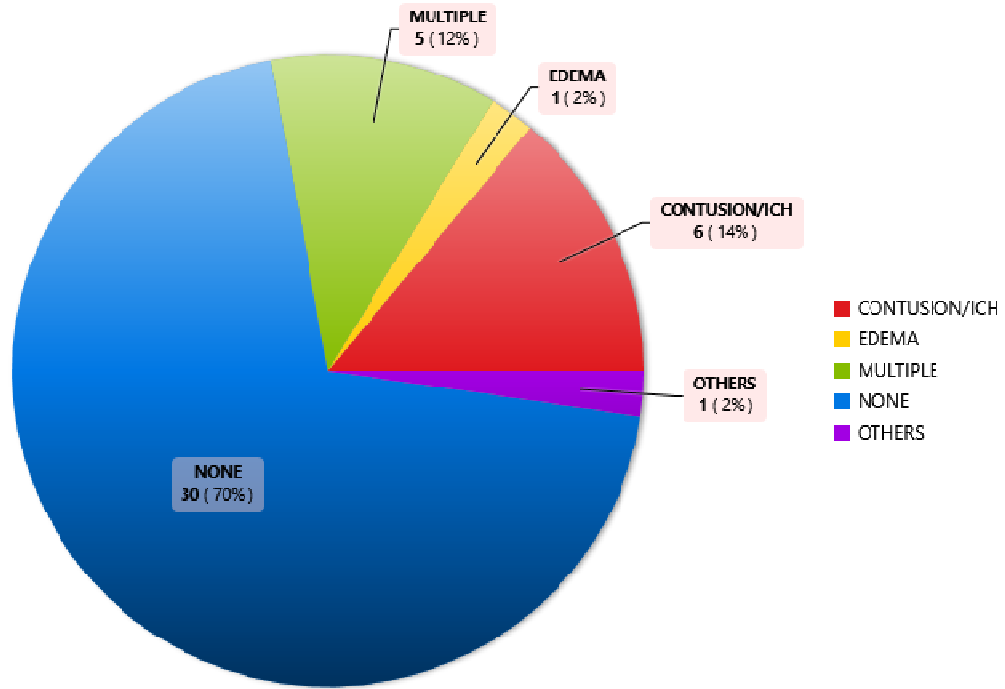
Etiology	Number	Percent (%)
Assault	7	16.28
Fall	4	9.30
Others	2	4.65
RTA	29	67.44
Sports	1	2.33
Total	43	100

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138 The most common associated intradural lesion was contusion/intracerebral haemorrhage (ICH), 14% fig

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140 **Fig 1: Intradural lesions**



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142 Etiology had no significant relationship with intradural lesions, $P = .997$. Nineteen patients (44.19%) had
 143 associated skull fractures while 24 patients (55.81%) did not have associated fractures. Among those with
 144 fractures, only one patient died, while five patients died in those without fractures.

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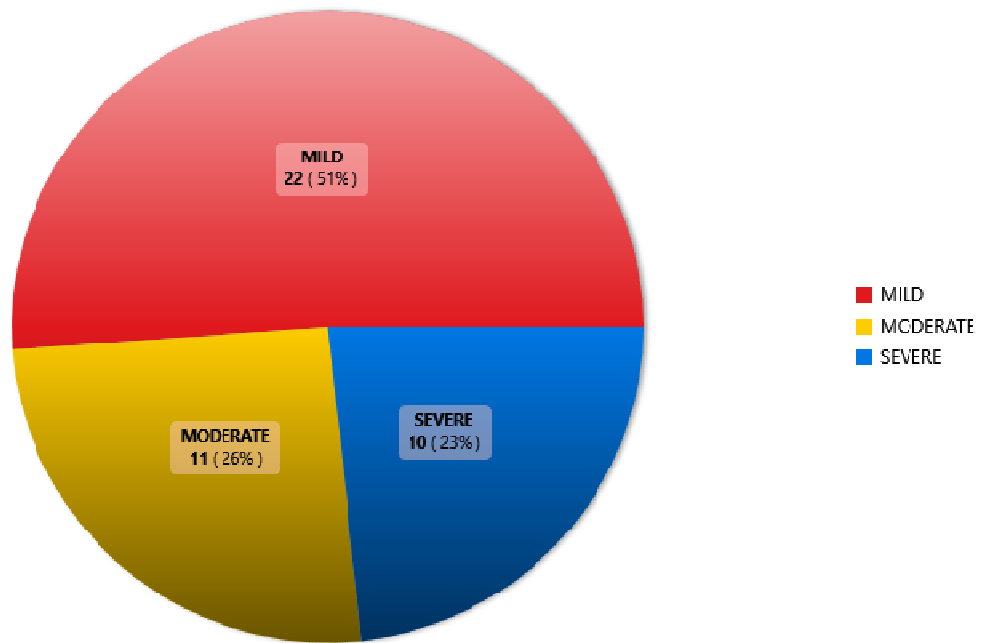
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154 Based on GCS prior to surgery, mild traumatic brain injury (GCS 13-15) had highest frequency 22 (51%),
 155 fig 2.

156 **FIG 2 GCS prior to surgery**



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158 Thirty seven patients (86.05%) had craniotomy, while six (13.95%) had minicraniectomy. Nine patients
 159 had surgery the first day, thirteen the second day, nine the third day, and the rest (12) after three days.
 160 Two patients died on the first day, two on the second day, one on the fifth day, and the last after one
 161 week.

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170 The favourable functional outcome (≥ 4) was 83.72% with mortality rate of 13.95%. The GCS prior to
 171 surgery significantly affected the outcome, $P = .002$ table 3.

172 **Table 3: GCS VS GOS**

GCS	GOS					
	1 (%)	3 (%)	4 (%)	5 (%)	≥4 (%)	Total (%)
Mild	0 (0.00)	0 (0.00)	1 (4.55)	21 (95.45)	22 (100)	22 (100)
Moderate	1 (9.09)	1 (9.09)	2 (18.18)	7 (63.64)	9 (81.82)	11 (100)
Severe	5 (50)	0 (0.00)	0 (0.00)	5 (50)	5 (50)	10 (100)
Total	6 (13.95)	1 (2.333)	3 (6.98)	33 (76.74)	36 (83.72)	43 (100)
<i>P</i> = .002						

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174 The age group significantly affected the outcome, *P* = .00 table 4.

175 **Table 4: Age vs GOS**

AGE	GOS					
	1 (%)	3 (%)	4 (%)	5 (%)	≥4 (%)	Total (%)
1 - <10	1 (33.33)	0 (0.00)	0 (0.00)	2 (66.67)	2(66.67)	3 (100)
10 - <20	0 (0.00)	0 (0.00)	0 (0.00)	6 (100)	6 (100)	6 (100)
20 - >30	1 (7.14)	0 (0.00)	3 (21.43)	10 (71.43)	13 (92.86)	14 (100)
30 - >40	1 (10)	0 (0.00)	0 (0.00)	9 (90)	9 (90)	10 (100)
40 - >50	1 (16.67)	0 (0.00)	0 (0.00)	5 (83.33)	5 (83.33)	6 (100)
50 - >60	0 (0.00)	1 (100)	0 (0.00)	0 (0.00)	0 (0.00)	1 (100)
60 - >70	1 (50)	0 (0.00)	0 (0.00)	1 (50)	1 (50)	2 (100)
70 - >80	1 (100)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (100)
Total	6 (13.95)	1 (2.33)	3 (6.98)	33 (76.74)	36 (83.72)	43 (100)
<i>P</i> = 0.00						

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178 Time to surgery did not have significant effect on the outcome, *P* = .760. Mode of presentation (direct or
 179 referred) did not affect the outcome, *P* = .675. The favourable outcome among patients with associated
 180 fractures was 94.74% with mortality rate of 5.26%. The favourable outcome in those without associated
 181 fractures was 75% with mortality rate of 20.83%. Although the presence of fracture did not significantly

182 affect the outcome, $P = .092$, the trend was there. Three patients (6.98%) had post-traumatic seizure.
183 Two had early, while one had late post-traumatic seizures.

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203 **4 DISCUSSIONS**

204 Majority of our patients, 24 (55.81%) were referred from other health facilities. The high percentage of
205 referred patients in our neurosurgical centers was due to high population coverage by our centers. The

206 first center covers one state with about 15 million people, while the second center covers two states and
207 parts of three adjoining states totalling about 7 million people ^[15] Emejulu et al. ^[16] In Newi, South East,
208 Nigeria, found that referred patients constituted 42.4% in their study. Adeleye and Okonkwo ^[17] in South
209 West, Nigeria, found that 75% of their patients were referred from other health facilities. The high volume
210 of referred patients to neurosurgical centers in our country depicts not only the dearth of neurosurgical
211 centers but also lack of trauma system and universal insurance coverage unlike what is obtained in
212 developed countries. ^[18, 19]

213 Our study showed more males than females. The relatively higher ratio of males in our **study** was due to
214 occupation. More males are involved in technical works in our environment and they form the largest
215 occupation group involved. Males in our environment are involved in commercial vehicle and motorcycle
216 driving which many youths have resorted to due to high unemployment rate in our country. Our result was
217 within the range of many studies showing higher proportion of male to female ratios, 2:1 to 8:1. ^[20,21,22] The
218 most common cause of extradural hematoma was road traffic accident with motorcycle accident being the
219 highest subgroup. The emergence of motorcycles as the commonest cause of road traffic accident in
220 Nigeria had been documented in the literature. ^[23] Younger age group was mostly affected in our study.
221 These are people who are in their prime working actively to make ends meet. The affectation of this
222 younger age group which form the work force of the society had been documented by other authors. ^[24]
223 The most common intradural lesion was contusion/ICH. The presence of intradural lesion depicts the
224 extent of force impacted on the cranium. As noted by many authors, focal brain **injury is produced** by
225 collision forces acting on the **skull, resulting** in local tissue compression beneath the site of impact. ^[25]
226 Such **injuries are** commonly characterized by laceration, contusion, and hematoma occurring in either the
227 presence or absence of a skull fracture. ^[26] Nineteen (44.19%) of our patients had skull fractures. In
228 Chowdhury et al. ^[22] study, 74.09% had associated fractures. Khan et al. ^[27] in their study found that
229 79.2% of their patients had associated skull fractures. Local impact on skull causes deformation of skull
230 that results on fracture and stripping dura off the inner surface of the skull. Yavuz et al. ^[28] found that the
231 degree of deformation of skull and type of fracture produced depended on the striking force. Ford et al. ^[29]
232 found that localized impact strips off the dura from the inner table of the skull with resultant extradural
233 hematoma formation, and the higher the force of the impact, the higher the stripping off, and the larger

234 the volume of the hematoma formed. It had been found that oozing from fractured ends of the skull leads
235 to extradural hematoma formation in about one third of cases.^[30] On the other hand, skull fracture in
236 relation to EDH serves as decompression outlet thereby reducing intracranial pressure.^[31] That might
237 have accounted for low mortality among those with fractures in our study. The fracture may also **serve**
238 **another** purpose. Because EDH strips the dura off the inner table of skull, the hematoma becomes
239 covered in inside by dura and on outside by bare skull bone. Because no soft tissue grows on bare bone,
240 chronicity of EDH becomes rare. However in those with fracture, the cartilage cells from pericranium
241 migrate through the fracture opening during repairing of the fracture. The external part of the hematoma
242 abutting the fracture site may get involved in the calcifying process and the outer part gets calcified, or the
243 entire hematoma gets calcified. This unique chronicity was first recognized and removed 6 years following
244 injury; it was invested by a calcified membrane.^[32] Cases of calcified EDH causing seizures months or
245 years after the original trauma had been reported.^[33, 34]

246 Patients with GCS 13-15 formed the majority. That might have been due to localized impact with less
247 effect on reticular formation and other areas involved in maintaining consciousness. Most of the patients
248 from assault had localized impact from plank, stick, iron road, motorcycle exhaust pipe, besides stone.
249 Rehman et al.^[1] found that patients with GCS 13-15 formed 56.67% in their study. Mezue et al.^[21] found
250 highest rate among patients with GCS 13-15 in their own study. Conversely, Khan et al.^[27] had highest
251 incidence (50%) among patients with GCS 3-8. The **most common** etiology in their study was fall,
252 followed by RTA unlike ours where RTA was most common followed by assault, thus making fall more
253 likely to have caused more severe injuries. Thirty seven patients had craniotomy which is the standard
254 surgery for EDH. Six patients had minicraniectomy (extended burr hole). It was used when patient was
255 deteriorating for faster decompression or when they could not withstand craniotomy. It was placed where
256 craniotomy line would pass in case there was need for craniotomy. In most cases the bleeding vessels
257 were seen and coagulated. Mezue et al.^[21] in Enugu, Nigeria used minicraniectomy in eight of their
258 patients. In deteriorating patient, minicraniectomy is faster way for decompression of extradural
259 hematoma, especially in developing countries where Gigli saw is still used to raise bone flap.

260 Favourable functional outcome was 83.72% and the mortality was 13.95%. In Khan et al.^[27] study the
261 favourable outcome was 79.2% with a mortality of 12.5%. Rehman et al.^[1] in their study found favourable

262 outcome in 83.33% and mortality of 10%. These are almost similar to our results. Many authors reported
263 mortality between 10% and 20%;^[35-38] others reported less than 10% mortality.^[20, 39] The outcome was
264 significantly related to GCS prior to surgery. Khan et al.^[27] also found significant relationship between
265 GCS at presentation and outcome. Other authors found that admission GCS was the most significant
266 factor affecting outcome.^[22] Our result showed that those operated in coma had higher mortality. The
267 poor outcome in comatose patients had been reported by many authors with varying functional
268 outcome.^[40, 41] The high mortality may be due to the severity of associated injury to brain parenchyma or
269 severe compressive effect of the haematoma overwhelming the compensatory mechanisms of intracranial
270 contents. The age of patients significantly affected the outcome. There was high mortality in patients
271 above 60 years. That was likely due to aging affecting the protein turn over, and aging of their systems
272 affecting their ability to withstand stress. Many authors reported the significant relationship of age with
273 outcome.^{[27, 30, 42, 43].}

274 . The seizure rate in our study was 6.98%. Seizure is a marker of parenchymal injury. Mezue et al.^[21]
275 found seizure rate of 23.7% in their study. Their patients with GCS 3-8 (34%) were more than our patients
276 with GCS 3-8 (22%), showing that their study had patients with severe injuries more than ours. Many
277 authors reported that patients with lower GCS at presentation had higher incidence of intradural damage
278 with EDH.^[44, 45]

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281 5 CONCLUSION

282 Traumatic extradural haematoma remains a major indication for neurosurgical intervention in our centre.
283 The favourable outcome in our study was 83.72% with mortality of 13.95%. The GCS and age
284 significantly affected the outcome. The challenge is how to improve the care of these patients as many
285 other centres are currently achieving below 10% mortality rate. The need to review our care systems with
286 provision of trauma system and universal health insurance coverage to keep pace with the trend in the
287 world cannot be overemphasized.

288 5.1 Caution!

289 We have to be cautious in hyping intervention time in extradural hematoma especially in those with
290 associated skull fractures decompressing the pressure effect. These patients when conscious can be
291 monitored clinically and radiologically as days go by. Many may not require surgery. In the course of this
292 study we saw two patients with subacute extradural hematomas with associated overlying skull fractures.
293 Patients were conscious. We monitored them for two weeks. We did repeat CT. Both hematomas had
294 resolved.

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