



Factors affecting the outcome in surgically treated civilian penetrating head injury: Case series

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ABSTRACT

Penetrating brain injury (PBI) is any injury that causes penetration of the scalp, skull, meninges, and brain. It is a traumatic brain injury caused by either low-velocity sharp objects (e.g. a knife), high-velocity projectiles (shell fragment or bullets) or blast injury is the consequence of the detonation of complex explosives with or without PBI and closed head injury. Aim of the study: To evaluate the factors (pre-operative and operative) that affect the surgical outcome of civilian PBI. This study was done from February 2017 to October 2018 prospectively & retrospectively. The study involved only the civilian patients that got a penetrating head injury and surgically treated in Neurosurgical Teaching Hospital/Baghdad/Iraq. The data include thirty-nine (39) operated patients with PBI. Data information includes the Glasgow Coma Scale (GCS), radiological investigations (computerized tomography (CT-scan) and plain X-ray) the outcome determined by Glasgow Outcome Score (GOS). The patients were followed up during the time of hospitalization. The surgical outcome of the penetrating head injury in this study was assessed by GOS and was as follow, good recovery 10 patients (25.6%), moderately disabled 11 patients (28.2%), severely disabled 5 patients (12.8%), vegetative 6 patients (15.4%), Dead 7 patients (18.0%). Good outcome 21 patients 53.8% while poor outcome 18 patients 46.2%. GCS is significant factor (p-value = 0.002), time not affecting, CT-finding is significant factor (p-value = 0.000), blood pressure \geq 90 mm Hg is a good predictor factor (p-value = 0.001), speech difficulty is poor predictor factor (p-value = 0.004), outcome of inlet alone better than inlet and outlet. There are many factors affecting the surgical outcome in civilian penetrating head injury, and the significant factor is pre-operative GCS, CT-scan which is the best radiological investigation for pre-operative and post-operative assessment and show the details of the injury, blood pressure $>$ 90 mm Hg which is a good prognostic factor.

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INTRODUCTION

Penetrating brain injury (PBI) is any injury that causes penetration of the scalp, skull, meninges, and brain. It is a traumatic brain injury (TBI) caused

by low-velocity sharp objects (e.g. a knife) or high-velocity projectiles (shell fragments or bullets). A blast injury is also a (TBI) but is a consequence of the detonation of complex explosives with or without (PBI) and closed head injury (Aarabi *et al.*, 2011).

The majority of homicides and suicides involve the use of firearms and disproportionately affect persons <55 years, males and certain minority populations. The experience of civilian neurosurgeons with penetrating neurotrauma varies depending on their location. Blast injuries have been encountered frequently by military surgeons in Iraq and Afghanistan and are increasingly encountered by civilian neurosurgeons because of terrorist bombings in urban environments. Craniocerebral gunshot wounds (GSWs) and blast-injured patients are arguably among the most complex and surgically challenging trauma encountered by neurosurgeons (Rosenfeld *et al.*, 2015).

In Iraq, the metallic ceiling fan reported as a causative mechanism of penetrating head injury in the pediatric population (Hoz *et al.*, 2019).

The aim of this study is to determine and discuss the preoperative and operative factors that affect surgical outcomes of civilian penetrating head injury.

MATERIALS AND METHODS

This study started from February 2017 to October 2018 prospectively & retrospectively. The study involved only the civilian patients that got a penetrating head injury and surgically treated in Neurosurgical Teaching Hospital/Baghdad/Iraq.

The data include thirty-nine patients got a penetrating head injury; the ages of the patients' starts from 9 years to 55 years, both sexes.

Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 19). Chi-square test of association was used to compare between proportions. When the expected count of more than 20% of the cells of the table was less than 5, Fisher's exact test was used. A p-value of ≤ 0.05 was considered statistically significant.

Data information includes age, sex, Glasgow Coma Scale (GCS) on admission, vital signs, neurological examination, the time between injury and surgery, radiological investigations (CT-scan and plain X-ray), operative procedures, follow up for complications and assessment and the outcome determined by Glasgow Outcome Score. CT-scan was the main radiological investigation that we depend on it in both pre-operative and post-operative evaluation.

Management started with the patients by initial

assessment and resuscitation accompanied by laboratory investigations and then radiological investigation (CT-scan). According to patient condition if need an endotracheal tube or not for airway security and respiratory assisting according to GCS and CT-scan finding making decision done.

The operative procedures were either craniotomy or craniectomy and debridement then hemostasis by bipolar coagulation, surgical and gel foam, with the watertight dural repair which was either by fascia lata or pericranium patch then skin closure. The patients were followed up during the time of hospitalization.

RESULTS AND DISCUSSION

Total data are 39 patients, 89.7% males, and 10.3% of females were operated on. The age prevalence was nearly the same of 3rd decade (30.8%) and 4th decade (33.3%). The gender & age were not affecting surgical outcome, p-value = (0.6), (0.9) respectively.

Most of the penetrating injuries were by rifle bullet (61.5%), and best outcome were with other tools (nail, wood, screwdriver, cast iron, metallic ceiling fan and open-ended metal tube) and shrapnel's outcome better than bullet, and this factor not affecting the surgical outcome (p-value = 0.9).

The patients were presented with GCS range (9-12), 44.7% & (13-15), 42.1% while (5-8), 13.2% of them (3 cases with unavailable data), the outcome of (13-15) group was the best 87.5%. The patients had systolic blood pressure ≥ 90 mmHg are 55.6% and associated with a good outcome, and 44.4% of the patients had systolic blood pressure < 90 mmHg and associated with poor outcome, these factors had a positive correlation with the outcome, p value=(0.002), (0.001) respectively. The patients they had the only inlet wound 53% associated with good outcome and not affected the surgical outcome (p value= 0.61), but who had both inlet & outlet wound 100% associated with poor outcome. The patients had speech difficulty (28.1%) and affected the surgical outcome (p-value =0.004) (7 cases with unavailable data). The patients had a seizure (31.4%), and 68.6% of them were free of seizure and 44.1% of patient with a motor deficit (5cases with unavailable data), these factors were not affecting the surgical outcome, p-value = (0.5), (0.8) respectively.

Table 1: distribution of studied variables according to the outcome

P value	Good outcome		Poor outcome		No	Variables
	%	No	%	No		
0.60	51	18	48.6	17	35	Gender
	75	3	25	1	4	Male Female
0.9	50	3	50	3	6	Age
	50	6	50	6	12	< 20 years
	61	8	38	5	13	20-29 years
	60	3	40	2	5	30-39 years
	33	1	66	2	3	40-49 years ≥ 50 years
0.9	57	4	42	3	7	Penetrating tools
	50	12	50	12	24	Shrapnel
	62	5	37	3	8	Bullets Others
0.002	20	1	80	4	5	Clinical parameters at presentation
	35	6	64	11	17	Glass coma scale
	87	14	12	2	16	5 – 8 9 – 12 13 – 15
0.001	80	16	20	4	20	Blood pressure
	25	4	75	12	16	Systolic ≥ 90 Systolic < 90
0.6	53	21	46	18	39	Wound
NA*	0	0	100	7	7	Having only inlet wound Having inlet & outlet wound
0.004	73	17	26	6	23	Speech difficulty
	11	1	88	8	9	No Yes
0.5	58	14	41	10	24	Seizure
	45	5	54	6	11	No Yes
0.8	57	11	42	8	19	Motor deficit
	53	8	46	7	15	No Yes
0.001	92	12	7	1	13	CT scan findings
	75	3	25	1	4	Depressed fracture with bone chips inside single lobe Depressed fracture with bone chips with extra axial hematoma

Continued on next page

<i>Table 1 continued</i>						
	38	5	61	8	13	Depressed fracture with bone chips with intra axial hematoma
	0	0	100	6	6	Depressed fracture with bone chips with intraventricular hemorrhage
	33	1	66	2	3	Depressed fracture with bone chips with contusion
						Time interval for doing surgery
0.2	50	5	50	5	10	< 5 hours
	63	14	36	8	22	5-8 hours
	20	1	80	4	5	≥ 9 hours
						Table (1) continued Surgical parameters
						Type of surgery
0.2	50	18	50	18	36	Craniectomy
	100	3	0	0	3	Craniotomy
						Venous sinus injury
0.4	58	18	41	13	31	No
	37	3	62	5	8	Yes
						Air sinus injury
0.3	57	20	42	15	35	No
	25	1	75	3	4	Yes
						Patch used for duraplasty
0.7	57	8	42	6	14	Fascia lata
	52	13	48	12	25	Per cranium
						Post-operative complication
						Cerebrospinal fluid leakage
1.0	52	18	47	16	34	No
	60	3	40	2	5	Yes
						Infection
0.6	51	17	48	16	33	No
	66	4	33	2	6	Yes

* p value ≤ 0.05

* Not applicable

Common CT-scan findings are depressed fracture with bone chips inside single lobe (33.3%) associated with good outcome and depressed fracture with bone chips with intra-axial hematoma (33.3%) associated with poor outcome, and the worst outcome was depressed fracture with bone chips with intraventricular hemorrhage (IVH). It was affecting the surgical outcome (p-value = 0.001).

The time interval analysis shows most of the patients operated within 5-8 hours (2 cases with unavailable data), 7.7% of the patients had craniotomy, and all of them had good surgical outcome, the others 92.3% had craniectomy, 50% poor and 50% good outcome, but not affecting surgical outcome, p-value = (0.2) for both.

The patients had venous sinus injury (20.5%) which were managed by gel foam and patch sutured on it, and all of them were partially tear at anterior third of superior sagittal venous sinus, and 62.5% of them were poor outcome, and 10.3% of the patients had frontal air sinus injury, and 75.0% of them were poor outcome, were not affected the surgical outcome p-value = (0.4), (0.3) respectively.

Most of the patches were per cranium which includes 64.1% of the patients, and fascia lata include 35.9% of the patients, the outcome near to be the same and there was no difference in association with postoperative complications, was not affecting factor p-value = 0.7. The patients had cerebrospinal fluid leakage (12.8%) and 40.0% of them were poor outcome and 60.0% had good outcome & 15.4% of the patients had wound infection and 33.3% of them were poor outcome and 66.7% had a good outcome, these were not affected factors, p-value = (1.00), (0.6) respectively as shown in Tables 1 and 2.

There is an obvious male predominance in penetrating injuries to the head with 35 males and 4 females, and it is not a significant factor p-value = 0.609 even in other studies (Ambrosi et al., 2012). In comparison to other studies done in which they have a nearly equal proportion between male and female (Roth et al., 2005) and this difference because of most our patients were male workers who are prevalent in our community.

The age prevalence was nearly same of 3rd decade (30.8%) and 4th decade (33.3%) which in comparison with other studies the commonest age group is the 2nd decade of life (Roth et al., 2005) or 2nd and 3rd (Roberto et al. 2003). And this difference because of our country conditions and most of the male workers are in 3rd and 4th decade of life. In our study, it is not significant p-value = 0.946 while there is a study showing it as a significant factor and this

difference because of limited numbers of old ages in our study (Ambrosi et al., 2012).

Most of the penetrating injuries were by rifles' bullets (61.5%), and the best outcome were with other tools (nail, wood, screwdriver, cast iron, metallic ceiling fan and open-ended metal tube) and shrapnel outcome better than bullet and these results because of its mechanism and velocity and kinetic energy and depended on site of trauma and the damage.

Most of the patients presented with GCS range (9-12) 17 (44.7%) & (13-15) 16 (42.1%) while (5-8) 5 (13.2%), outcome of (13-15) group was the best (87.5%) and it is significant factor and has strong positive correlation with the outcome, which is comparable to the studies that showed a post-resuscitation GCS score greater than 8 was highly predictive of favorable outcome (Sights, 1969; Aarabi et al., 2014; Mark et al., 2010).

Blood pressure is a significant factor affecting the outcome, in our study 20 (55.6%) of the patients had systolic blood pressure ≥ 90 mmHg and associated with good outcome, and 16 (44.4%) of the patients had systolic blood pressure < 90 mmHg and associated with poor outcome (Kazim et al., 2011).

The outcome of patients had inlet alone better than that with inlet and outlet (100% poor outcome) which is comparable with other studies (Setti et al., 2005; Robert et al., 1996; Henry et al., 2006).

Eleven (31.4%) of the patients had a seizure, and 24 (68.6%) of them were free of seizure. Most of the studies showed a range of 25% - 55% of seizure in post-PBI, and as a factor affecting the surgical outcome, it is not significant (Sights, 1969; Kim, 2001).

Motor deficit account 15 (44.1%) of the patients in comparison with other studies in which Motor deficit (19%) and this is due to the site of injury where the commonest sites include motor strip (frontoparietal injury) (Ambrosi et al., 2012; Martins et al., 2003).

Nine (28.1%) of the patients had speech difficulty depending on the site of injury and considered as bad predictor it has a significant relationship with surgical outcome.

There is a strong relationship between CT-scan finding, and GOS, depressed fracture with bone chips inside with single lobe involvement is the best outcome while with IVH is the worse which is comparable to other studies (Ambrosi et al., 2012; Martins et al., 2003).

As operative procedure just 3 (7.7%) of the patients had craniotomy because of epidural hematoma, and

Table 2: Association of patch type with Cerebrospinal fluid leak and infection

	Cerebrospinal fluid leakage				Infection				Outcome			
	Yes		No		Yes		No		Poor		Good	
Patch type	N	%	N	%	N	%	N	%	N	%	N	%
Fascia lata	14	12	86	86	2	14	12	86	6	43	8	57
Pericranium	3	12	22	88	4	16	21	84	12	48	13	52

all of them had good surgical outcome, the others 36 (92.3%) had craniectomy and had 50% poor and 50% good outcome and as a factor affecting surgical outcome it is not significant, while study done by Patricia B. and coworkers showed a larger craniotomy can diminish mortality (Ambrosi *et al.*, 2012) and this difference because of limited numbers of craniotomy in our study.

Most of the patches used pericranium 25 (64.1%) of the patients and fascia lata 14 (35.9%) of the patients, the outcome near to be the same and there was no difference in association with postoperative complications and outcomes, it is not a significant factor for surgical outcome.

In this study, the outcome of patients measured using the Glasgow Outcome Scale was 53.8% of the patients with good outcome and 46.2% with poor outcome. Good recovery was 25.6%, mortality was 18.0% most of the patients were moderately disabled, and it is comparable to other studies (Martins *et al.*, 2003; Henry *et al.*, 2006).

The time interval analysis shows most of the patients were operated on within 5-8 hours in comparison with other studies which is lesser than this range because of most of the referral cases from areas which are far away from the hospital, and it is not a significant factor as in other studies (Cavaliere *et al.*, 1988).

CONCLUSIONS

We conclude that there are many factors affecting the surgical outcome in civilian penetrating head injury, and the important factor are:

1. Pre-operative GCS.
2. Brain CT-scan finding.
3. Blood pressure ≥ 90 mm Hg is a good prognostic factor.
4. Speech difficulty.
5. Presentation of the patient.

Recommendation

1. CT scan must be available in every general hospital.
2. Principles of management of penetrating brain injury is the same as for other injuries started with a primary assessment and secondary survey, with good resuscitation in both stages of the management, dural repair should be done watertight which will prevent CSF leak and wound infection. Tension-free skin suturing should be applied. Good postoperative care, with prevention and early treatment of complications, usually optimizes the outcome.

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