Seizure 19 (2010) 211–216

Contents lists available at ScienceDirect

Seizure

journal homepage: www.elsevier.com/locate/yseiz

Post-traumatic seizures—A prospective study from a tertiary level trauma center in a developing country

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ARTICLE INFO

Article history:
Received 13 December 2009
Received in revised form 23 January 2010
Accepted 5 February 2010

Keywords:
Post-traumatic seizure
Traumatic brain injury
Glasgow coma scale

ABSTRACT

Rationale: No large studies till date are available from India on post-traumatic seizures (PTS).
Methods: This is a prospective observational study of 520 patients with traumatic brain injury (TBI) (July 2007–2008). Patients admitted after 24 h of injury, with Glasgow coma scale (GCS) ≤ 4 were excluded.
Results: At a median follow-up of 386 days, 59 (11.4%) patients developed PTS. Incidence of immediate, early and late onset seizure were 6.5%, 2.1% and 2.7% respectively. In children, incidence of PTS was 18.3%. On univariate analysis, females, of age <10 years, with associated medical problems and with delayed loss of consciousness and poor GCS (<9), following fall from height, had significantly higher odds of PTS. On multivariate analysis, the risk of PTS was 3.7 times higher in patients who had fallen from height, 4.4 times higher in associated medical problems, and 3.7 times higher in severe head injury (GCS < 9) at presentation. PTS was associated with poor Glasgow outcome score and higher incidence of behavioral abnormality on follow up. 32% patient with PTS developed recurrent delayed seizures. Seizure recurrence was significantly higher in late onset PTS. PTS affected overall outcome of the patients in severe head injury.
Conclusion: The risk of PTS was higher in patients who sustained fall from height, in GCS < 9, and associated medical problems. About 1/3rd of the patients with early PTS developed recurrent delayed seizures.

1. Introduction

Traumatic brain Injury (TBI), apart from its major morbidity and mortality is a major cause of epilepsy, particularly in young adults.[1]

Post-traumatic seizures (PTS), identified as early as 460 BC by Hippocrates, have been defined as seizure occurring after head trauma which is causally related to the trauma itself. Diagnosis of epilepsy (of any kind) is reserved for patients who have had two or more unprovoked seizures.[1,2]

This important sequel of head injury has been widely studied in terms of epidemiology, prophylaxis and treatment. TBI accounts for 20% of the symptomatic epilepsies in general population.[3]

In general, the incidence of post-traumatic seizures varies with the time period after injury and population age range under study, as well as the spectrum of severity of the inciting injuries. It ranges from 4% to 53%.[1]

No large prospective studies are available from India. As societies and ethos vary, so does the risk of TBI.[1] Regional differences have been observed in patients' characteristics, case management and outcome.[3]

Understanding epidemiologic characteristics and natural course of the disease is one step toward controlling this medically and functionally costly complication of TBI.

We conducted this study to understand the epidemiology of post-traumatic seizures in Indian population, the risk factors involved, and its influence on mortality and morbidity including late clinical and functional outcome.

2. Materials and methods

A longitudinal prospective observational cohort study with a common risk factor (head injury) was carried out in Department of

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doi:10.1016/j.seizure.2010.02.004

Neurosurgery, All India Institute of Medical Science, New Delhi. We enrolled 520 patients with traumatic brain injury (TBI) coming to surgical casualty within 24 h of injury, from July 2007 through June 2008 and followed them at 3 monthly intervals (or earlier in case of any events). We excluded patients who came after 24 h of injury or were brain dead on arrival to casualty.

All these patients were evaluated on the basis of age, gender, mode of injury, level of consciousness [Glasgow coma scale (GCS)], type of injury, and radiological features (plain roentgenograms and non contrast enhanced CT scan (NCCT) head findings). As per our protocol, patients with normal CT scans of head were not given any prophylactic anticonvulsants. All patients with contusions or intracranial hematomas with or without GCS <13 were given anticonvulsant prophylaxis with diphenylhydantoin (phenytoin). If so given, phenytoin was continued for 3 months (non-operated patients), 6 months (operated patients) or 24 months (in case of PTS). The patients were followed up for 3 monthly intervals for a maximum period of 24 months. Patients who developed post-traumatic seizure were evaluated by Neurologist according to the pattern, latency of onset, frequency and family history of seizures and if required, CT head or MRI brain or EEG were performed.

2.1. Main outcome measures

PTS were defined as immediate (<24 h), early (<1 week) and late (>1 week).[4] We analyzed the parameters shown in Table 4 as risk factors to develop PTS using binary logistic regression. Factors which appeared significant on univariate analysis ($p < 0.15$) were again analyzed using step wise logistic regression analysis to find independent risk factors for PTS. Long term clinical/functional/behavioral outcome were analyzed to know the effect of PTS over long term follow-ups using binomial logistic regression. Kaplan–Meier survival analysis was used to study the effect of PTS on survival rates. $p < 0.05$ was considered statistically significant. We used statistical software SPSS version 11.5.0 for analysis of data.

2.2. Ethical issues

The investigator obtained the informed consent of the prospective subject, or the consent of a legal guardian, in case of an individual who was not capable of giving informed consent. The research design followed the guidelines laid down by ICMR, New Delhi (published as "*Ethical Guidelines for Biomedical Research on Human Subjects, 2000*"). The investigators maintained the confidentiality of research data.

3. Results

3.1. Characteristics of the cohort

Of 520 patients, 420 (81%) were males and 100 (19%) females. Mean age was 28 years. 16.7% the patients were less than 10 year of age (youngest 14 days). Around 10% patients were more than 50 years age (oldest 89 years) (Table 1).

Most common mode of injury was road traffic accident (RTA) in 250 cases (48%), followed by fall from height (195 patients: 38%). Others included physical assault (46), miscellaneous (27). Only two patients in our series had gun shot injury.

81% of 250 patients (with RTA) were not wearing helmets. Of those wearing the helmets, only 24 (52%) were found to be suitable. All others were wearing cheap plastic and unsuitable helmets.

Transient (<5 min) loss of consciousness (LOC) was seen in 53 patients (10.2%). LOC ≥ 5 min was seen in 391 patients (75.2%) with delayed LOC in 6 patients (1.2%). Amnesia was seen in 24.7% patients.

Patients in our cohort had multiple injuries. 40.6% patients had ear/nose/oral bleeding. 11.5% had fractures involving long bones, scapula, nasal bones and facial bones. 20 (3.8%) had chest injuries, 10% had problems pertaining to spine including weakness of limbs, neck pain, hemiparesis, etc. 22 patients (4.2%) in our cohort had co-morbidities which included hypertension (4), diabetes mellitus (2), and pulmonary tuberculosis (2). Alcohol abuse was seen in 62 patients (11.9%).

129 patients (24.8%) were in poor GCS (≤8). 116 patients (22.3%) were in moderate grade GCS (9-13) and 275 (53%) were in good GCS (>13).

28 patients had skull base fracture; 25 patients (4.8%) had anterior skull base fractures and 2 with anterior skull base and clival fractures. 154 patients (30%) had calvarial fractures, commonest being frontal (38, 7.3%) followed by temporal (34, 6.5%). Most of these fractures were linear (76, 14.6%) and closed types (110, 21.2%).

Brain parenchymal injuries included epidural hematoma (62,11.9%; frontal [3.1%] followed by temporal [2.1%] were the commonest locations), subdural hematoma (102; 19.6%), lobar contusions (176, 32.8%; commonest location was frontal, 8.8%), multiple contusions (90, 17.3%), subarachnoid hemorrhage (85, 16.3%), intraventricular hemorrhage (19, 3.7%), pneumocephalus (22), diffuse axonal injuries (50), and infarcts (10). 162 (31%) patients had normal NCCT head.

160 patients (30.8%) required 214 surgical procedures. 48 required more than 2 procedures.

All the patients were followed for a median of 386 days. 280 patients (54%) were followed for more than 1 year (Table 2). Follow-up was on the basis of outpatient department (OPD) evaluation which included clinical examination, and if needed, radiological evaluation, or on telephonic conversation.

In our cohort, 60 patients (11.5%) expired. 412 (79.2%) patients improved, 26 (5%) had residual morbidity and 22 (4.2%) deteriorated.

3.2. Post-traumatic seizures

59 patients (11.4%) developed seizures during the study period. Mean age of patients with PTS was 26.3 years (1–89 years). 34 patients (6.5%) had immediate onset seizures, 11 (2.1%) had early onset (<1 week) seizures, and 14(2.7%) had late onset (>1 week of head trauma) seizure (Table 3). Commonest type of seizure was generalized tonic clonic convulsions in 55 and complex partial in 4. None had status epilepticus. Post-ictal hemiparesis was seen in 3, confusion in 25 patients and amnesia in 1 patient.

Table 1
Age distribution of the patients.

Age groups	Number of patients ($n = 520$)	%
<10 years	93	17.9
10–20 years	74	14.2
20–50 years	303	58.3
>50 years	50	9.6

Table 2
Duration of follow up of the cohort.

Duration of follow up	Number of patients ($n = 502$)	%
<6 months	107	20.6
6–12 months	133	25.6
12–24 months	280	53.9

Table 3
Type of seizure according to onset after trauma.

Onset of seizure	Number (n = 520)	Adults (>20 years) (n = 303)	Pediatrics (<10 years) (n = 93)
Immediate	34 (6.5%)	19 (13%)	10 (10.8%)
Early			
1–6 h	8 (1.5%)	6 (3.7%)	4 (4.3%)
>6 h but <7 days	3 (0.6%)		
Late	14 (2.7%)	10 (6.6%)	3 (3.2%)

3.3. Risk factors for PTS

3.3.1. Univariate analysis

From a total of 48 risk factors analyzed as such for PTS, on binomial logistic regression analysis, factors like pediatric age group (age less than 10 years), female sex, fall from height, delayed loss of consciousness, amnesia of more than 30 min, associated medical problems, past and family history of epilepsy, GCS at presentation, lobar contusions, brain edema, infarction and surgical intervention like contusion evacuation and lobectomy, appeared to be significant risk factors for PTS (Table 4). Pediatric age group (age less than 10 years) was found to have 1.4 times more risk of PTS than older age groups. Females were 1.8 times more at risk than males to have PTS. Delayed loss of consciousness had 8 times higher risk of PTS. Patients with brain edema were 1.7 times more at risk to suffer PTS.

PTS was associated with a lower GCS score (mean of 10.5). Patients who did not develop PTS had mean GCS of 12.9. The initial GCS (p = 0.010) also correlated with development of PTS with each individual component of GCS ably predicting seizure occurrence (p = 0.005, 0.031, 0.041, 0.01 for eye, verbal, motor and total score respectively). A GCS of less than 9 correlated significantly with a higher risk of developing PTS (2.3 times higher risk as compared to GCS more than 13).

One of the two patients who had both personal and family history of epilepsy had PTS. Extradural hematoma (EDH), subdural hematoma (SDH) and lobar contusions were seen in 7 (11.7%), 12 (29.3%) and 25 (42.4%) patients with seizures. These including other parameters like midline shift, subarachnoid hemorrhage (SAH), Intraventricular hemorrhage (IVH), pneumocephalus and calvarial fractures did not significantly correlate with the incidence of PTS. There was no correlation with other factors like type of surgery (lobectomy/decompression of contusion). We did not give phenytoin prophylaxis to patients with normal CT scans and such patients did not show statistically significant risk of developing PTS.

Table 4
Significant risk factors for post-traumatic seizure (PTS) on univariate analysis.

	No PTS (n = 461)	PTS (n = 59)	Odds ratio (95% CI)	p
Age groups				
<10 years	76 (16.5%)	17 (28.8%)	1	
10–20 years	67 (14.5%)	7 (11.9%)	0.467 (0.183–1.195)	0.112
20–50 years	275 (59.7%)	28 (47.5%)	0.455 (0.237–0.875)	0.018
>50 years	43 (9.3%)	7 (11.9%)	0.728 (0.280–1.894)	0.515
Sex				
Male	378 (82%)	42 (71.2%)	1	
Female	83 (18%))	17 (28.8%)	1.843 (1.000–3.398)	0.050
Fall from height				
No	302 (65.5%)	23 (39%)	1	
Yes	159 (34.5%)	36 (61%)	2.973 (1.703–5.191)	0.000
Delayed LOC				
No	454 (99.3%)	56 (94.9%)	1	
Yes	3 (0.7%)	3 (5.1%)	8.107 (1.598–41.139)	0.012
Amnesia >30 min				
No	247 (80.5%)	27 (69.2%)	1	
Yes	60 (19.5%)	12 (30.8%)	1.830 (0.876–3.820)	0.108
Medical problems				
No	447 (97%)	51 (86.4%)	1	
Yes	14 (3%)	8 (13.6%)	5.008 (2.005–12.513)	0.001
P/H epilepsy				
No	460 (99.8%)	58 (98.3%)	1	
Yes	1 (0.2%)	1 (1.7%)	7.931 (0.489–128.511)	0.145
F/H epilepsy				
No	460 (99.8%)	58 (98.3%)	1	
Yes	1 (0.2%)	1 (1.7%)	7.931 (0.489–128.511)	0.145
Initial GCS				
14–15	252 (54.7%)	23 (39%)	1	
9–13	102 (22.1%)	14 (23.7%)	1.504 (0.744–3.038)	0.255
≤8	107 (23.2%)	22 (37.3%)	2.253 (1.204–4.216)	0.011
Lobar contusions				
No	310 (67.2%)	34 (57.6%)	1	
Yes	151 (32.8%)	25 (42.2%)	1.510 (0.869–2.621)	0.144
Brain edema				
No	299 (64.9%)	31 (52.2%)	1	
Yes	162 (35.1%)	28 (47.5%)	1.667 (0.966–2.877)	0.066
Brain infarct				
No	460 (99.8%)	58 (98.3%)	1	
Yes	1 (0.2%)	1 (1.7%)	7.931 (0.489–128.511)	0.145

3.3.2. Multivariable analysis

Factors with $p < 0.10$ on univariate analysis were analyzed using stepwise logistic regression analysis (keeping $p < 0.05$) for independent association to PTS (Table 5). We found that TBI due to fall from height were at 3.7 times more at risk to develop PTS as compared to other mode of injury (p = 0.001). Associated medical problems like hypertension, diabetes mellitus, chronic airway disorders, liver diseases, cerebro-vascular disease and renal failure at the time of injury, raise the risk of developing PTS by 4.4 times (p = 0.009). Severity of injury, measured in Glasgow coma scale, seems to predict occurrence of PTS. As compared to mild head injury (GCS 14–15); moderate (GCS 9–13) and severe (GCS ≤ 8) head injury were found to be 2.8 (p = 0.026) and 3.7 (p = 0.007) times more at risk of PTS during follow-up.

3.4. Effect of seizures

Among the various clinical outcomes analyzed on follow-up using binomial logistic regression, patients with PTS had 1.9 odds of not showing improvement in behavior (p = 0.030) as compared to those who did not have seizure. Even though not significant, patients with PTS had 1.016 times more risk of persistence of headache (p = 0.96), and 1.53 times failure of improvement in Glasgow coma scale (GCS) on follow up (0 = 0.225).

Table 5
Significant risk factors for PTS on multivariable analysis.

	Odd ratio (95% CI)	p
Fall from height		
No	1	
Yes	3.737 (1.773–7.875)	0.001
Associated medical problems		
Absent	1	
Present	4.394 (1.444–13.370)	0.009
Initial GCS		
Mild (14–15)	1	
Moderate (9–13)	2.758 (1.130–6.734)	0.026
Severe (≤8)	3.726 (1.442–9.630)	0.007

Statistically significance: $p < 0.05$.

Table 6
Association of post-traumatic seizure (PTS) with different outcome variables.

PTS	Survived ($n=460$)	Death ($n=60$)	Odds ratio (95% CI)	p
No (461)	411 (89.2%)	50 (10.8%)	1	
Yes (59)	49 (83.1%)	10 (16.9%)	1.678 (0.800–3.519)	0.171
PTS	Improvement in headache ($n=272$)	No Improvement in headache ($n=152$)	Odds ratio (95% CI)	p
No (377)	242 (64.2%)	135 (35.8%)	1	
Yes (47)	30 (63.8%)	17 (36.2%)	1.016 (0.540–1.909)	0.961
PTS	Improvement in dizziness ($n=165$)	No Improvement in dizziness ($n=293$)	Odds ratio (95% CI)	p
No (408)	144 (35.3%)	264 (64.7%)	1	
Yes (50)	21 (42%)	29 (58%)	0.753 (0.415–1.369)	0.352
PTS	Improvement in behavior ($n=381$)	No improvement in behavior($n=131$)	Odds ratio (95% CI)	p
No (453)	344 (75.9%)	109 (24.1%)	1	
Yes (59)	37 (62.7%)	22 (37.3%)	1.877 (1.061–3.318)	0.030*
PTS	Improvement in GCS ($n=442$)	No Improvement in GCS ($n=78$)	Odds ratio (95% CI)	p
No (461)	395 (85.7%)	66 (14.3%)	1	
Yes (59)	47 (79.7%)	12 (20.3%)	1.528 (0.770–3.033)	0.225
PTS	Good Glasgow outcome scale ($n=412$)	Poor Glasgow outcome scale ($n=108$)	Odds ratio (95% CI)	p
No (461)	372 80.7%)	89 (19.3%)	1	
Yes (59)	40 (67.8%)	19 (32.2%)	1.985 (1.097–3.593)	0.023*

* Statistically significant $p < 0.05$.

Of the 60 patients who expired in this study, 10 had PTS (Odds ratio 1.678, $p = 0.171$). On categorizing patients with Glasgow outcome scale (GOS), taking GOS 1 and 2 as poor and GOS 3–5 as good, patients with PTS were 2 times more at risk to have poor GOS ($p = 0.023$) as compared to other TBI patients without PTS (Table 6).

The Glasgow outcome score (GOS) also correlated significantly when compared with GCS matched cohorts (Table 7).

3.5. Kaplan–Meier survival analysis

Log rank analysis showed that patients with post-traumatic seizure (PTS) had 1.85 times more hazards of death as compared to those without PTS, however it was not statistically significant ($p = 0.174$) (Fig. 1).

3.6. Recurrence of PTS

Of 59 patients with PTS, 19(32.2%) had recurrences. 5 had second episode within 24 h, 3 within 7 days, and 11 after 7 days of trauma. 6/34 patients (17.6%) with immediate seizure had recurrence as compared to 2/11 (18.2%) with early and 11/14 (78.6%) with late seizures. Hence late seizures seems to be associated with recurrences more often than immediate and early seizure ($p = 0.000$).

Table 7
Outcome of patient according to severity of head injury and seizure.

Severity of head* injury	Seizure*	Glasgow outcome scale (GOS)				
		1	2	3	4	5
Severe (GCS ≤ 8)*	No	36	4	21	7	39
	Yes	6	3	5	0	8
Moderate (GCS 9–13)	No	6	4	6	9	77
	Yes	0	0	0	0	14
Mild (GCS 14–15)	No	8	1	3	16	224
	Yes	4	0	1	3	15

* GOS of patients according to severity of head injury highly significant in either presence of seizure ($p = 0.002$) and without seizure ($p = 0.000$).

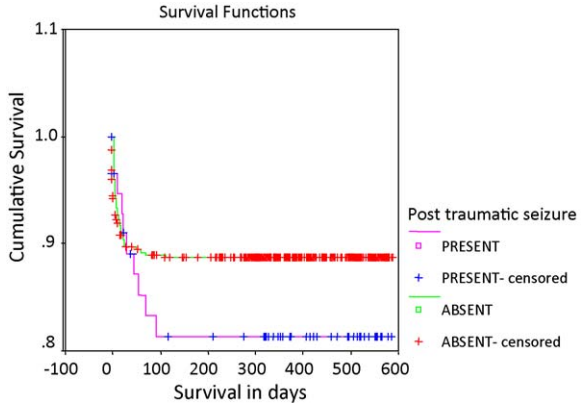

Fig. 1. Kaplan–Meier survival analysis in TBI patients with or without PTS ($p = 0.17$).

4. Discussion

Post-traumatic seizures have been widely studied[1,5–8] but the majority of epidemiological data come from wartime series[1,9,10] as they present with severe grade injuries. In our study cohort, the incidence of PTS was 11.4%. In children, PTS was 18.3% and in adults, 23.3%. We found a higher incidence of PTS in children compared to literature (0.2–9.8%).[1,5,7,8,11,12–26] Being an institution-based study, we do agree that this could be an underestimate of population risk of PTS. We could also miss cases having subtle seizure in view of lack of facility of video EEG. Moreover, it has been shown that risk of first seizure continues to be elevated for more than 10 years after severe head injury[5]; hence following these patients further would unmask more seizure frequency.

The incidence of immediate seizures (6.5%), early seizures (2.1%) and late onset seizures (2.7%) were comparable with earlier studies (early PTS: 2.1–16.9% and late PTS: 1.9–30%).[1,4,5,7] In general, seizures that happen at or minutes after impact—'immediate', 'contact' or 'concussive' seizures are not included in studies of early PTS, hence exact incidence of immediate seizures and their exact clinical significance remains unclear.[1]

Table 8
Risk factors for PTS quoted in literature.

Risk factors		Studies
Severity of TBI	30% in severe	Frey et al.[1]
Note: There is considerable lack	1% in mild and moderate.	
of consistency in the use of different	Relative risk of seizure	Annegers et al.[11] (n = 4541, 1935–1984)
markers to define subgroups of injury severity	After mild injury – 1.5	
	Moderate injury – 2.9	
	Severe injury – 17.2	
Age of patient	2.6% in <15 years age	Annegers et al.[5]
Intracerebral blood collection	≤30% increase in early PTS	Hahn et al.,[8] Desai et al.[6]
Chronic alcoholism	5–15%	Marchal et al.,[13] Temkin et al.,[14] Wiedemayer et al.[15]
Family history of PTS	Increased risk	
Depressed skull fracture	27% incidence of early PTS	Temkin et al.[12]
Penetrating head injury	20% incidence of early PTS	Temkin et al.[12]

In pediatric population, similar to other studies citing higher incidence of early onset PTS as compared to late PTS,[5,7,8,27] we found the same pattern in our series.

4.1. Risk factors for post-traumatic seizures in Indian population

We found that the independent risk factors associated with occurrence of post-traumatic seizure were fall from a height, associated medical problems and severity of head injury measured in Glasgow coma scale (GCS) at presentation. Patients who had fall from a height were 3.7 times higher at risk to have PTS as compared to other mode of injuries. There were only two cases of gun shot injury, and majority of road traffic injury involved pedestrian in our study (low velocity injury). These factors may have influenced the analysis.

Associated medical problems increase the risk of PTS by 4.4 times. This may be related to drug interaction or due to predisposition to seizure either due to disease or due to medications being taken.

We found that each component of GCS predicted occurrence of seizure with poorer score related to higher risk of PTS. Patients with severe head injury (GCS < 9) were found to have almost 4 times higher risk of developing seizure as compared to minor head injury (GCS 14–15).

On multivariable analysis, we did not find any significant correlation to other described risk factors (Table 8) like intracerebral hematoma, younger age, prolonged amnesia, duration of loss of consciousness, extent of brain volume loss, chronic alcoholism and depressed skull fracture.[1,5,6,7,12,27,28] It is possible because, the incidence of penetrating injuries like shot gun injuries or high velocity injuries in this series was very low. Annegers et al.[5] have found that incidence is higher in penetrating injury (50% over 15 years follow up) as compared to closed head injury, but no patient is found to have seizure after 3 years of penetrating head injury. Yablon[23] found 11% incidence of PTS in severe non-penetrating TBI as compared to penetrating TBI. Arabi et al.[24] in their study of 489 soldiers, who sustained penetrating head injury during Iran Iraq war, found that the projectile type, site of injury on the skull, patient-age, number of affected lobes, related hemorrhagic complications, and retained metallic or bone fragments statistically related to post-traumatic epilepsy. In our cohort all the patients with moderate or severe head injury or having abnormal CT head study, were given phenytoin prophylaxis; it is possible that phenytoin could have a prophylactic role in these patients. However, a large study by Lee et al.[16] of severe closed head injury (GCS < 9) in 3340 adults, concluded that patients with intracerebral parenchymal damage did not increase incidence of PTS.

4.2. Risk of recurrent seizure

We found 32.2% recurrence rate in 59 patients with PTS in our follow-up for a median of 386 days. Frey, 2003, reported that PTS may have as much as 86% risk of developing a second episode in 2 years. Recurrence rates after a single seizure vary between 26 and 71% in world literature. However about one third of our patients did not receive phenytoin as the CT Scans were normal. As longer remission rates (25–40%) have been reported,[1] it is possible that follow-up of these patients for longer period may increase the incidence of recurrences.

Initial multiple episodes of seizure did not predict long term recurrences in our study.

We found that 79% of the patients with late onset PTS had repeated seizure episode, which was seen to predict seizure recurrence significantly. Immediate and early onset PTS were associated with lesser number of recurrences. However, conventional risk factors like elderly age, alcohol abuse, severity of head injury or initial GCS, radiological abnormality and intracranial surgery did not significantly increase the risk of recurrence in our series.

4.3. Effect of PTS

Early PTS can have grave consequences due to the resulting rise of ICP, alterations in Blood Pressure, changes in oxygenation, increase in metabolic demands and excess neurotransmitter release. It has recently been shown to worsen functional outcome significantly after TBI.[29] Vespa et al.[30] performed a prospective assessment of the consequences of epileptic activity by assessing the change in extracellular glycerol levels in 13 patients. Glycerol is a marker of cellular membrane breakdown. Two patients had seizures on EEG with associated delayed elevations of glycerol associated with the seizure activity. Preliminary evidence suggests that post-traumatic seizures lead to additional membrane injury as reflected by elevated extracellular glycerol levels.

Mazzini et al.[31] studied 143 patients for 11.9 ± 8.6 months. They did not find any influence of PTS on cognitive functions but patients with PTS had significantly higher incidence of personality disorders, and had significantly worse functional outcome 1 year after the trauma. Our series revealed that patients with PTS continue to complain of headache. Besides, occurrence of PTS seems to affect the overall outcome of patients of traumatic brain injury. Similar findings were seen by Wang et al.[25] in their study of 170 patients with PTS over 10 years period.

4.4. Prevention

Temkin et al.[32] have shown in prospective double blind study 73% reduction of risk of early PTS after phenytoin loading dose

20 mg/kg within 24 h of non-penetrating head injury; but there was no benefit in continuing the drug after 1 week. Schierhout and Roberts[33] in their review of 10 RCT involving 2036 participants, drew similar conclusions. In our centre, we routinely give phenytoin for 3 months in non-operated patients with intracerebral contusions, for 12 months in operated patients and for 24 months after last PTS episode. Hence we cannot comment on efficacy of phenytoin in our series.

The ripening of the epileptic focus in post-traumatic epilepsy, as in iron induced epilepsy, seems to be due to a cascade of events beginning with hemorrhage, haemolysis, iron or heme compound liberation, free radical formation, peroxidation and cell death. Experimentally free radical scavengers and antiperoxidants have marked prophylactic effect. Some of them (phosphate diester of vitamin E and C, melatonin, vanillyl alcohol) may be employed in clinical practice, but till date, there is no controlled study in human beings.[34,35]

5. Conclusion

The incidence of post-traumatic seizure in Indian civilian population is 11.4%, with higher frequency in severe head injury. Incidence of immediate, early and late onset seizure is 6.5%, 2.1% and 2.7% with recurrence rate of 32.2% (higher in late onset seizure) on follow up of median 386 days. In presence of PTS, severe head injury has higher risk of poorer overall outcome. Our study describes regional differences in epidemiology of post-traumatic seizure. Patients who fell from a height or had associated medical problems or presented with lower GCS (<9), had higher risk of PTS. Pediatric population has higher incidence of PTS with higher ratio of early onset PTS. Patients with traumatic brain injury who had PTS had poorer outcome (GOS) and had higher incidence of behavioral abnormality. We need to follow patients of traumatic brain injury with more scrutiny especially patients with poorer grade of Glasgow coma scale, and if possible, undertake EEG based evaluation. Efficacy of using phenytoin in mild or moderate head injury needs to be reevaluated in view of lower risk of PTS. Being a single institutional based study with follow up limited to 24 months, we may be still underestimating population risk of PTS. A larger multicentric study will be of benefit to show more answers.

Disclosure

None of the authors has any conflict of interest to disclose.

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