Early Seizures after Severe Closed Head Injury

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ABSTRACT: ***Background:*** We studied the incidence and clinical significance of early post-traumatic seizures after severe closed head injury. ***Methods:*** This prospective study is based on clinical observation of 3340 adult patients with severe closed head injuries, each of them having a Glasgow Coma Scale (GCS) 3 to 8 after trauma. Anticonvulsant agents were not given to these patients unless there was evidence of seizure. ***Results:*** One hundred and twenty-one patients (3.6%) experienced seizures within 1 week after head injury; 42 of these (1.26% of the series) had seizures within 24 hours after trauma. The incidence of intracerebral parenchymal damage was found to be higher among those patients who developed seizures in the first week (66.1%) than in those who did not (62.7%). However this result did not reach statistical significance. The patients with early seizures had a lower mortality rate ($p < 0.01$). In patients who survived from the initial injury, the occurrence of early post-traumatic seizures did not appear to influence the neurological recovery at 6 months after injury. ***Conclusion:*** Presence of intracerebral parenchymal damage on CT scan after severe closed head injury does not increase the risk of early post-traumatic seizures. With proper treatment, patients presenting with early seizures may have a lower mortality rate. However, the occurrence of early seizures does not influence the neurological recovery in patients who survive the initial severe closed head injury.

RÉSUMÉ: Épilepsie survenant tôt après un traumatisme crânien fermé sévère. ***Introduction:*** Notre but était d'étudier l'incidence et la signification clinique de l'épilepsie post-traumatique précoce. ***Matériel et méthodes:*** Cette étude prospective est basée sur l'observation clinique de 3340 patients adultes ayant subi un traumatisme crânien fermé sévère. Après le traumatisme, chacun d'eux avait un score de 3 à 8 à l'echelle de coma de Glasgow. Des agents anticonvulsivants n'ont pas été administrés à ces patients, à moins qu'il n'y ait eu évidence d'épilepsie. ***Résultats:*** Cent vingt-et-un patients (3.6%) ont présenté de l'épilepsie dans la semaine qui a suivi le traumatisme; chez 42 de ces patients (1.26% du groupe total) l'épilepsie est survenue dans les 24 heures du traumatisme. L'incidence de dommage parenchymateux intracérébral était plus élevée chez les patients qui ont présenté de l'épilepsie dans la première semaine (66.1%) que chez ceux que n'en ont pas présenté. Cependant, ce résultat n'était pas statistiquement significatif. Les patients qui ont présenté de l'épilepsie précocement ont eu un taux de mortalité plus bas ($P<0.01$). Chez les patients qui ont survécu au traumatisme initial, l'apparition d'épilepsie post-traumatique précoce n'a pas semblé influencer la récupération neurologique mesurée 6 mois après le traumatisme. ***Conclusion:*** Après un traumatisme crânien fermé sévère la présence de dommage parenchymateux intracérébral au CT scan n'augmente pas le risque d'épilepsie post-traumatique précoce. Avec un traitement approprié, les patients presentant de l'épilepsie précoce peuvent avoir un taux de mortalité inférieur. Cependant, l'apparition d'épilepsie tôt après le traumatisme n'influence pas la récupération neurologique chez les patients qui survivent à un traumatisme crânien fermé sévère.

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The occurrence of an immediate or early post-traumatic seizure may complicate the management of severe head injury patients. During the immediate or early period after severe head injury, seizures may cause further depression of consciousness and hinder the evaluation of a patient's neurological condition and may mimic deterioration from intracranial causes. An immediate or early post-traumatic seizure can cause cerebral hypoxia, acidosis, and a further increase of intracranial pressure. Whether the immediate or early post-traumatic seizure will affect outcome of patients with severe closed head injury has not been well studied. Most of the previous studies analyzing the outcome of severely head injured patients have not included the factor of early post-traumatic seizures.[1-11]

In our department, anticonvulsants are not given to head injury patients unless there is evidence of seizures. This policy

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has offered us a unique opportunity to identify the incidence and several other important features of seizures developing within 24 hours or up to 1 week after severe closed head injury.

Clinical Material and Methods

This prospective study is based on adult patients with severe closed head injuries managed by the authors between July 1984 and July 1995. The patients were all admitted to either Chang Gung Memorial Hospital, the Linko Medical Center or the Keelung Medical Center. The Glasgow Coma Scale (GCS) score[12] determined when the patient arrived at the emergency room was used to assess the level of consciousness and the severity of head injury. Patients with documented severe closed head injury (GCS score 3 to 8 for at least 6 hours) were included in this study. Patients with penetrating injuries, compound depressed skull fractures or a history of seizure before injury were excluded. An emergency CT scan was obtained immediately after the patients' vital signs were stabilized at the emergency service.

Anticonvulsant agents were not given to these patients unless there was evidence of seizure. Intravenous phenytoin was administered to patients who developed post-traumatic seizures. The oral anticonvulsant (phenytoin) were continued at least 2 years in patients who developed seizures during the study period. Regular follow up was performed monthly at the outpatient clinic after the patients' discharge from the hospital. For patients who were unable to visit the outpatient clinic, information about their neurological status, including the occurrence of seizures, was obtained from the personnel who directly take care of the patients through monthly telephone interviews. The outcome was measured at 6 months after injury and was classified by using the Glasgow Outcome Scale (GOS).[13] The outcome was classified as: grade I, good recovery; II, moderate disability; III, severe disability; IV, vegetative state; V, death.

The data studied included a demographic profile, an account of the traumatic incident, a description of injuries, the treatment history, and the outcome. A computer-stored data base software program (dBASE IV, Ashton-Tate) was used in this study. Comparison of group means based on the continuous data was made by using independent sample t tests. Comparisons between the subgroups of patients for categorical variables were performed with the chi-squared test or, when the expected cell frequencies were low, Fisher's exact test. A p value of 0.05 was considered statistically significant. The dBASE STATS system (Ashton-Tate) was used for the analyses.

Results

Demographic Features

This study included 3340 consecutively treated adult patients who had sustained a severe closed head injury. The age of the patients ranged from 18 to 83 years (mean 33.6 years), the male to female ratio was 4.0:1. The most common causes of the injuries were motorcycle accidents (58.4%) and traffic injuries to pedestrians (29.6%). Table 1 summarizes the presentation of 121 patients with severe head injury who developed early post-traumatic seizures.

Table 1: Incidence of Early Seizures in Patients with Severe Head Injury.

	Total	Early seizures		Statistical significance
		No.	% of total	
No. of cases	3340	121	3.6	
Sex (M:F)	4.0:1	4.6:1		*NS
Mean age	33.6	27.5		*NS
Cause of injury				
Motorcycle	1951	49	2.5**	
Automobile	156	3	1.9	
Pedestrian	990	54	5.5**	p<0.05
Fall	204	14	6.8**	
Other	39	1	2.6	
Glasgow Coma Scale Score				
8	764	33	4.3	***NS
7	850	39	4.6	
6	474	15	3.2	
5	369	14	3.8	
4	495	13	2.6	
3	388	7	1.8	

*student t test ** Fisher's exact test and Yate's correction
*** chi-square test
NS = Not significant

Incidence of Early Post-traumatic Seizure

There were 121 patients (3.6%) who developed seizures within the first week after head injury. The male:female ratio was 4.6:1 and the mean age was 27.5 years. Forty-two of these patients developed seizures within 24 hours after head injury, accounting for 1.26% of the total study population. Most of the seizures (86.8%) that occurred during the first week after the injury were of the generalized tonic-clonic type. No statistically significant difference was found between the early seizure and seizure free group of patients in gender, age and GCS score; except for cause of injury ($p<0.05$). (Table 1)

CT Scan Findings

CT scan showed intracerebral parenchymal damage (intracerebral hemorrhage, subdural hemorrhage, cerebral contusion) in 2098 (62.8%) of 3340 patients. Intracerebral parenchymal damage was found in 66.1% patients with early post-traumatic seizures. Although the incidence of intracerebral parenchyma damage was found to be higher in those patients who developed seizures between day 2 and day 7 (72.2%) than in those who developed seizures within 24 hours (54.8%), no statistical significance was found. The incidence of intracerebral parenchymal damage was also found to be higher in patients who developed seizures in the first week (66.1%) than those who did not (62.7%). This result is also without statistical significance. (Table 2)

Table 2: Computerized Tomography (CT) Findings in Patients with Severe Closed Head Injury.

	CT evidence of cerebral parenchymal damage			
	Without (%)	With (%)	Total case	Statistic significance
Without seizure	1201 (37.3)	2018 (62.7)	3219	NS
With Seizure	41 (33.9)	80 (66.1)	121	
Day 1	*19 (45.2)*	*23 (54.8)*	*42*	
Day 2-7	*22 (27.8)*	*7 (72.2)*	*79*	NS
Total	**1242 (37.2)**	**2098 (62.8)**	**3340**	

*chi-square test
NS: not significant

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Treatment and Outcome

There were 1501 patients who underwent craniotomy to remove intracranial hematoma including fifty-four patients with early post-traumatic seizures. The occurrence of early post-traumatic seizures did not affect the decision to operate in this study. The mortality rate for all severe head injured patients was 43.2%. The mortality rate was significantly lower for early post-traumatic seizure patients (29.8%) than for patients without early post-traumatic seizures (43.7%), ($p<0.01$) (Table 3). The mortality rate was higher in the day 1 seizure group (38.1%) than day 2 to day 7 group (25.3%), but this result did not reach the statistical significance ($p>0.05$). No death was related to poorly controlled seizures.

Table 3: Influence of Early Post-traumatic Seizures on Outcome of Severe Closed Head Injury Patients.

GOS	Early seizure		Total	Statistical significance
	Yes (%)	No (%)		
I + II	45 (37.19)	1129 (35.07)	1174 (35.15)	
III	36 (29.75)	607 (18.86)	643 (19.25)	*p>0.05
(IV+V)/V	40/36 (33.06/29.75)	1483/1408 (46.07/43.74)	1523/1444 (45.60/43.23)	**(p<0.01)
Total	**121**	**3219**	**3340**	

GOS :Glasgow outcome scale;
I: good recovery; II: moderate disability; III: severe disability
IV: vegetative state; V: death
*: comparison of the surviving patients between two groups
**: comparison of the mortality between two groups
p: chi-square test

At 6 months post-injury, follow-up of all surviving patients showed that 35.1% had GOS grade I or II, 19.3% became grade III and 45.6% became grade IV or V. The neurological recovery of surviving patients at 6 months after injury showed no significant difference between patients with or without early post-traumatic seizures ($p > 0.05$) (Table 3). Seven patients in the early post-traumatic seizure group had seizures during the 6 months follow up period due to inadequate serum levels of phenytoin. There were 45 patients who had no early post-traumatic seizures, but developed late seizures during the 6 month follow up period.

Discussion

Severe head injury has been defined as having a total GCS score ranging from 3 to 8 after head trauma.[2,5,7,10-15] In reviewing the literature, the mortality and morbidity of severe head injury remains high despite aggressive surgical and non-surgical treatment.[1-11] During the first week after trauma, the occurrence of seizures may complicate the management of severe head injured.

Annegers et al. found that 10.3% of 136 severe head injured adult patients in their series had early post-traumatic seizures.[1] Desai et al. reported that 18.3% of 60 severely head injured patients had early post-traumatic seizures.[16] Both of the studies defined severe head injury as patients with loss of consciousness or posttraumatic amnesia or both for longer than 24 hours, or including a cerebral contusion or intracranial hematoma. Jennet indicated that 11.7% of 154 head injured patients with post-traumatic amnesia greater than 24 hours had seizures within the first week after injury.[17] Da Silva et al. reported that 7% of 142 head injured patients with coma scales less than 9 had early post-traumatic seizures.[4] Guidice and Berchou found that 1.9% of 164 head injured patients who had experienced a loss of consciousness and post-traumatic amnesia for at least one hour experienced seizures within one week after injury.[18] In Sazbon and Groswasser's series of 134 patients in prolonged posttraumatic coma lasting over 30 days, 6.7% had early post-traumatic seizures.[19] Kalisky et al. reported 1% early post-traumatic seizures in 180 patients, who had coma duration lasting 6 hours or had evidence of cerebral trauma on a CT scan.[20] A higher incidence of early post-traumatic seizures has been reported among pediatric patients, and following penetrating injury.[16, 21-30] In our study, the incidence of post-traumatic seizures after severe head injury was 3.6%. It is difficult to compare this series with other studies because of the different definitions of severe head injury. As compared with our previous reports, the incidence of early post-traumatic seizures was significantly higher ($p<0.01$) in the severe (3.6%) than mild (2.36%) but lower than in moderate (4.1%) closed head injuries.[31,32] The high percentage of head injuries caused by motorcycle accidents and pedestrian injury in this study is due to the features of head injury in Taiwan.[33] There are no previous reports regarding the incidence and significance of early post-traumatic seizure related to various causes of severe closed head injuries.[16,21-30] In our series and previous reports, a significantly higher incidence ($p<0.05$) of early post-traumatic seizures among patients with injuries from motorcycle accidents, pedestrian injury and accidental fall was shown.[31,32] Whether these results indicate that the cause of closed head injury affects the incidence of early post-traumatic seizure or is due to the different demographic features as indicated by Desai, needs further observation.[16]

The presence of intracranial hemorrhage increasing the probability of early post-traumatic seizures has been documented in previous studies.[16, 24-27,34] However, Guidice and Berchou reported no difference in the occurrence of seizures in patients with a hematoma as compared to those who did not have a hematoma.[18] We also found no statistical difference between patients with or without early post-traumatic seizures in terms of the presence of an intracerebral parenchyma hemorrhage on CT scan. This result may be due to the better resolution of CT scans in recent years. Jenkins et al. compared CT and magnetic resonance (MR) imaging in head injury patients and found that cortical and subcortical contusions were more common on MR images than on CT scans.[35] Although the MR images are more sensitive than CT scans in detecting the intracerebral parenchyma damage, it is still impractical to obtain a MR image for severe head injury in the acute phase after trauma.

Rose et al. reported that poorly controlled seizures are the second most common avoidable factors contributing to death after head injury.[36] In Desai et al.'s series, early post-traumatic seizures significantly increased the risk for sequelae, but not the risk of death.[16] Lee et al. found that early post-traumatic seizures did not increase the risk of either mortality or morbidity

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in moderate head injury patients.[32] In our present study, the mortality of severe head injury were significantly lower with occurrence of early post-traumatic seizures. However, the neurological recovery of surviving patients at 6 months after injury showed no significant difference between patients with or without early post-traumatic seizures. This result suggests early post-traumatic seizures following severe closed head injury is an indication of less brain damage during the early period after injury. The development of early post-traumatic seizure may reflect that cortical spinal tracts are relatively intact in severe closed head injuries. With proper treatment and seizure control, a lower mortality rate can be expected in patients with early post-traumatic seizure than without after severe closed head injury as shown in our study. For patients surviving from the initial severe closed head injury, the occurrence of early post-traumatic seizure does not influence the neurological recovery.

Our study suggests that the incidence of early post-traumatic seizures might vary according to the cause of injury. The presence of intracerebral parenchymal damage on CT scan after severe closed head injury did not increase the risk of early post-traumatic seizures. With proper treatment, patients presenting with early seizures may have a lower mortality rate but similar neurological recovery to those who have no early post-traumatic seizures after severe closed head injury.

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