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PROGNOSTIC FACTORS IN PATIENTS WITH DIFFUSE AXONAL INJURY A TERTIARY CARE EXPERIENCE

Neurosurgery

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ABSTRACT

Diffuse axonal injury(AI) s a severe form of traumatic brain injury and it is associated with immediate coma lasting from six hours to prolonged coma. Object of this study was to review various clinical parameters which might have been related to outcome of patients with DAI and, thus, to provide some valuable guidelines in management. A series of 82 patients of DAI treated in our institution between October 2020 to September 2023 are included in this study. Clinical factors such as age, sex, Glasgow Coma Scale(CS), duration of coma, presence of hypotension at admission, hypoxemia, signs of hypothalamic injury, abnormal eyeball movement, abnormal light reflex, abnormal electrocardiography, cerebral infarct, and seizure are reviewed and analyzed in conjunction with outcome. Among all clinical factors evaluated for the statistical significances only initial GCS, hypoxemia, abnormal light reflex, signs of hypothalamic injury, abnormal motor response(decortication or decerebration) at admission revealed to have significant correlation with outcome. Factors such as age, hypotension, abnormal ECG, cerebral infarct, seizure were not statistically significant in our study. Other findings, such as causes of deaths(old age associated with either expanding hemorrhage or hemorrhage in posterior fossa) in 4 of 18 patients with initial GCS greater than 13 and highest mortality rate for patients with combined hypoxemia and hypotension, should also be stressed. These findings suggest that when such clinical settings are evident physicians should be borne in mind that these will play unfavorable role to patients in terms of outcome and prognosis. Thus, careful and prompt attention should be given to these patients, especially treating elderly patients, even though they may have good initial GCSs.

KEYWORDS

Diffuse axonal injury; Head trauma; Prognosis.

INTRODUCTION

In recent years, the severe traumatic brain injury(TBI) has been increasing in accordance of increasing incidence of injuries from traffic accidents and constructions. Moreover, mortality rates from such injuries tend to be very high due to complexity and severity of their natures. Diffuse axonal injury(DAI) without focal hematomas are responsible for 40-50% of all severe head injuries and results in serious morbidity and high mortality rate1-3)5)10)17)21)30)35). It is caused from widespread tearing of axons and small vessel by shearing forces and is defined as prolonged traumatic coma over 6 hours following injury without demonstrable mass lesion2)8)31). This study was carried out, retrospectively, to investigate which clinical factors might have been related to clinical outcome, the prognostic factors, in patients diagnosed as DAI.

Clinical Material and Methods

A total of 82 patients diagnosed as DAI at our institution from october 2020 to september 2023 are included in this study. All of the medical records, radiographs were retrospectively reviewed and results from telephone surveys for those have incomplete records were added. The selected criteria of patients were loss of consciousness longer than 6 hours following traumatic brain injury with showing no demonstrable mass lesion or small hemorrhagic contusion (s) without mass effect on initial brain CT scan. Various clinical parameters such as age, sex, initial Glasgow Coma Scale(GCS), abnormal motor response to stimuli, signs of hypothalamic injury, initial pupil size(anisocoria or bilateral pupil dilatation), associated hypoxemia, hypo- or hypertension, duration of loss of consciousness(LOC) were analyzed to see whether these factors act on outcome as prognostic factors. Glasgow Outcome Score(GOS) after three months of injury was used for determination of patient outcome.

For the determination and comparison of significance for each factor in accordance with outcome, we divided the patients into two groups. A recovery group with either good recovery or at least moderate or severe disability, and other group(no recovery group) with patients who remain as persistently vegetated or are dead. Statistical significance was assessed by Chi-square test and Fisher exact test. P value less than 0.05 was considered to be statistical significance.

RESULTS

There were 66 males and 16 females cases . Male was predominant with male to female ratio being 4.1. Traffic accident by automobile(63%) was most common cause of trauma(63%) with pedestrian accidents being about twice more prevalent than in-car passenger accidents(41% vs. 22%, Table 1). Comparison between genders for the difference of outcome revealed no correlation between sex and outcome although female had a tendency to have less favorable prognosis(p=0.26, Table 2). Mean age of patients was 32 years old with a range from 1 to 79 years. Patients below 30 years of age accounted for 56%. Although there was no statistical significant difference between age groups, those patients over 40 had high non recovery rates(Table 3). The duration of loss of consciousness(LOC) was ranged from 1 day to 96 days with mean of 13 days. Recovery of consciousness was observed in 46 of the 82 patients(56%) and remaining 36 (44%) patients never regained consciousness. There were 30 deaths from our series. Among these, 16 of 20 patients (80%) who had initial GCSs 5 or less died and 10 out of 26 patients(38%) with initial GCSs between 6 and 8. There were no deaths from patients who had initial GCSs between 9 and 12, but 4 patients among 18 patients(22%) with their GCSs greater 26 died. Overall, mortality rate for the patients who fit into category of severe head injury(GCS ≤ 8) in our series was 56.6% and there was statistically significant correlation between GCS and outcome($p<0.001$,Table 4).

For the comparison of outcomes from patients with pupillary abnormalities, there were 12 patients who showed inequal size(anisocoria) of one pupil secondary to brain herniations and ten of these(83%) failed to recover consciousness. Patients having bilateral fixed pupillary dilatations were 12 in number and they all were not recovered. Also, 14 out of 58 patients who had normalsized symmetric(isocoric) pupil failed to recover(24%). When compared for correlation with outcome, abnormal pupils(anisocoria and bilateral fixed pupils) showed significant correlation with poor prognosis ($p<0.001$, Table 5).

Table 1. Modes of injury(n=82)

TYPE	NUMBER
PEDESTRIAN TA	34 (41%)
PASSENGER TA	18(22%)
MOTOR CYCLE	12(15%)
FALL	10(12%)
HIT BY OBJECT	8 (10%)

*TA:traffic accident

Table 2. Comparison of outcome according to gender of patients(n=82)

SEX	RECOVERY	NON-RECOVERY	TOTAL
MALE	40	26	66
FEMALE	6	10	16

(p=0.26)

Table 3. Comparison of outcome according to age groups

AGE	RECOVERY	NON RECOVERY	TOTAL
1-10	14	6	20
11-20	8	6	14
21-30	12	0	12
31-40	6	4	10
41-50	0	4	4
51-60	4	8	12
61-70	0	2	2
>71	2	6	8

(p=0.09)

14 of 16 patients with associated hypoxemia(87%) were not recovered whereas 11 patients of 33 patients who did not have hypoxemia did not recover(33%), thus showed a correlation with poor prognosis (p<0.001, Table 6).

Presence of hypotension was not associated with statistical significant correlation with outcome;being 16 of 32 patients(66%) having associated hypotension not recovered whereas 28 of 70 patients(40%) without associated hypotension were also not recovered(p=0.37, Table 6). Abnormal motor response to stimuli on the other hand, decorticated or decerebrated posture, showed a significant correla-tion with outcome;22 out of 28 patients having abnormal response never gained consciousness(79%) whereas only 14 out of 54 patients(26%) with normal response were not recovered(p=0.003, Table 7). Patients with signs of associated hypothalamic injury at admission did poorly;no

recovery from patients with central fever, only 4 patients(20%) with hyponatremia due to SIADH recovered(p<0.05)(Table 8). Other factors, such as seizure, abnormal ECG,age, sex, duration of loss of consciousness and presence of cerebral infarct did not correlate with outcome(data not shown).

Table 4. Correlation between initial GCSs and outcome

RECOVERY GROUP	NON RECOVERY GROUP				
INTIAL GCS	GOOD RECOVERY	MODERATE DISABILITY	SEVERE DISABILITY	PERSISTENT VEGETATION	DEAD
<5	0	0	2	2	16
6-8	0	6	8	2	10
9-12	4	8	4	2	0
>13	14	0	0	0	4

(p<0.001)

Table 5. Correlation between pupillary abnormalities and outcome

	RECOVERY	NON RECOVERY
ANISOCORIA	2	10
BILATERAL PUPILLARY DILATION	0	12

(p<0.05)

Table 6. Correlation between hypoxemia and hypotension with outcome

	RECOVERY	NON RECOVERY	P VALUE
HYPOXIA	2	14	P-(0.01)
NO HYPOXIA	44	22	
HYPOTENSION	4	8	P – (0.37)
NO HYPOTENSION	42	28	

Table 7. Correlation between abnormal motor response and outcome

	RECOVERY	NON RECOVERY
NORMAL MOTOR RESPONSE	40	14
ABNORMAL MOTOR RESPONSE	6	22

(p=0.003)

Table 8. Correlation between hypothalamic injury and outcome

	RECOVERY	NON RECOVERY
CENTRAL FEVER WITH EXCESSIVE SWEATING	0	6
HYPONATREMIA DUE TO SIADH	2	8
HYPONATREMIA DUE TO CSW	2	2

DISCUSSION

Classically, traumatic brain injuries can be classified into Focal and diffuse injuries3)6)8)36). Focal brain injuries include cortical contusions, subdural hematoma, epidural hematoma, and intracerabral hematoma. These lesions cause neurological dysfunction by local damage and by mass lesions within the skull, leading to brain shifting, herniation, and brainstem compression. Diffuse axonal injuries are associated with more global disruption of neurological function and are not usually associated with definite mass lesions.

The mechanism of DAI is shaking effect of the brain within the skull and is caused by acceleration-deceleration effects of the mechanical input to the head2)5)10-12)17)26). Determination of its severity is based on the direction, magnitude and speed of head motion, either from rest or to rest,during the injury sequence. These result in shearing or stretching of nerve fibers with consequent axonal damage that is the substrate of the diffuse brain injuries. On the analysis of human autopsy and experimental material as well as imaging modalities1)5) 7)12)13)19)21)23)27), frequently involved anatomical loci of DAI are revealed to be tegmentum of brainstem, corpus callosum, third ventricle choroid plexus, parasagittal cortex.

The prognostic factors involved in patients with DAI have been variable1)10)15)22)23)26)29)34)35), including initial GCS, abnormal motor response, hypothalamic injury sign, duration of loss of consciousness, initial pupil size, associated hypotension or hypoxia. seizure, age, and sex. Pediatric group tends to be involved more frequently with diffuse brain injury than adults3)5)16)17), but mortality rate is generally known to be lower2)21)23). Moreover, Miller et al.27) have found that there is a steady increase in mortality rate with age and Pazzaglia et al. 30 have suggested that age clearly influences the clinical course with regard to both mortality rate and quality of survival. In the present study, most common age group was those with age 1 to 10 years and patients less than 30 years old accounted for 56% of all cases. Although there was no statistical significant correlation between age groups and outcome, there was strong tendency for poor prognosis after age 40, recovery rate being only 23%. Previous reports indicate male has been more frequently involved in DAI 8)15)16)22)23)28), as in our case(80%). Thirty nine percent of these patients showed no recovery whereas 61% of female patients had no recovery. But, difference of outcome was not statistically significant(p=0.267).

Hypoxia and hypotension have been known to be one of the most important associated medical conditions with regards to outcome in severly injured patients head injury patients2)14) 18)22) 23)26) 28)34)35). Eisenberg et al.7)8) emphasized that head injured patients with associated hypoxia or hypotension are expected to have the worst outcome and since damaged brain is more vulnerable to hypoxia or hypotension, combined with either or both conditions would be associated with poorer outcome8)11)19)20). In our series, the non-recovery rate of patients with hypoxia was 87% and that of patients without hypoxia was only 33%. This showed statistically significant difference(p=0.01). On the other hand, non recovery rate of patients with hypotension(66%) did not have a significant difference compared to patients without hypotension(40%, p=0.37). But, it should be pointed out that when these patients had both hypoxia and hypotension(2 cases) none of them survived indicating the importance of such detrimentally combined medical conditions.

It is becoming general consensus that initial GCS in head injured patients strongly correlates with outcome, especially when patients with GCS score below 5 will have poorer outcome10)11) 12) 16)22)29). Also, in this study, 80% mortality rate was observed patients with GCS score 5 or less. There was 38% mortality rate from patients with GCS score from 6 to 8 and 22% from those over 13, thus showing a significant correlation between GCS and outcome ($p<0.001$).

Pupillary abnormalities such as anisocoric pupil or bilateral pupil dilatation due to herniation have been also reported to correlate with poor prognosis8)20)24)27)28). In this study, the non-recovery rate of patients having anisocoric pupils (83%) or bilateral pupil dilatations(100%) was higher than that of normal pupil patients(24%) with a statistically significant difference($p<0.001$). Levy et al.23-25)reported that, based on one of the largest and earliest well designed series of clinical cases of patients with DAI, the motor response to stimuli has significant influence on outcome and abnormal motor response to stimuli is related to worse prognosis. In our study, patients who had normal motor responses had 74% of recovery rate, whereas those with abnormal motor response showed only 21% of recovery rate which was statistically significant($p=0.003$). The duration of loss of consciousness(LOC) has been shown to be strongly related with outcome in some reports29)34)35) indicating that longer the duration worse the outcome. In this study, patients who had LOC less than 10 days had good recovery(80%) or mild disability(20%) but when it is beyond 40 days, mild disability was seen only in 20% of cases and severe disability 80% .But, determination of statistically significant difference was not possible. Signs of post-traumatic hypothalamic injuries include abnormal excretion of ADH due to damage of pituitary stalk 6)9)28)31)32) or central fever with excessive sweating due to damage of thermoregulatory center9)30)31) and these are also known to correlate with worse outcome. In our study, 80% of patients for SIADH did not recover and patients with diabetes insipidus(DI) had 67% of nonrecovery rate. Moreover, all three patients with central fever and excessive sweating did not recover with was not recovered. These showed statistically significant correlation($p<0.05$). We did not compare the outcome of patients from various modes of injury due to insufficient matched numbers of each category. But interestingly, motorcycle accidents accounted for 15% of our cases which might reflect the fact that these accidents are becoming increasingly popular and when they are involved with other parties such as automobiles, they have high tendency to be associated with severe injuries to other parts of body which may complicate the situation. In our series, their initial GCSs were ranged from 3 to 13 with a mean being 9 and there were 4 deaths(33.3%) and 4(33.3%) with severe disability.

CONCLUSION

A total of 82 patients with DAI were retrospectively studied to determine the prognostic factors which might have played in terms of outcome. Among all clinical factors evaluated for the statistical significances initial GCS, hypoxemia, abnormal light reflex, signs of hypothalamic(injury, abnormal motor response(decortication or decerebration) at admission revealed to have significant correlation with outcome. Other findings, such as causes of deaths(old age associated with either expanding hemorrhage or hemorrhage in posterior fossa) in 4 of 18 patients with initial GCS greater than 13 and highest mortality rate for patient with combined hypoxemia and hypotension, should also be stressed. These findings suggest that when such clinical settings are evident physicians should be borne in mind that these will play unfavorable role to patients in terms of outcome and prognosis. Thus, careful and prompt attention should be given to these patients, especially treating elderly patients, event though they may have good initial GCSs.

REFERENCES

1) Adams JH, Graham DI, Murray LS, et al:Diffuse axonal injury due to non-missile head injury in humans. Analysis of 45 cases. Ann Neurol 12:557-563, 1982
2) Alberrico AM, Ward JD, Choi SC, et al:Outcome after severe head injury:Relationship to mass lesion, diffuse injury,and ICP course in pediatric and adult patients. J Neurosurg 67:648-656, 1987
3) Becker DP, Miller JD, Ward JD, et al:The outcome from severe head injury with early diagnosis and intensive management. J Neurosurg 47:491-502, 1977
4) Bell TS, Ellenberg L, McComb JG:Neurophysiological outcome after severe pediatric near-drowning. Neurosurgery 17:604-608, 1985
5) Bruce DA, Alavi A, Bilaniuk L:Diffuse cerebral swelling following head injuries in children:The syndrome of "maliignant brain edema". J Neurosurg 54:170-178, 1981
6) Crompton MR:Hypothalamic lesions following closed head injury. Brain 94:165-172, 1971
7) Eisenberg HM, Gary HE, Aldrich EF, et al:Initial CT findings in 753 patients with severe head injury. A report from the NIH Traumatic Coma Data Bank. J Neurosurg 73:688-698, 1990
8) Eisenberg HM, Weiner RL, Tabaddor K:Emergency care: Initial evaluation, in Cooper. PR(ed):Head injury. 2nd ed. Baltmore:Williams & Wilkins, 1987, pp20-33
9) Fleische AS, Kutner MH:Suprahypophyseal hypogonadism and hypothyroidism during prolonged coma after head trauma. J Coin Endocrinol Metab 45:747-754, 1977
10) Gennarelli TA, Spielman GM, Langfitt TW, et al:Influence of the type of intracranial lesion on outcome from the severe head injury. J Neurosurg 56:26-36, 1982
11) Gennarelli TA, Thibault LE, Adams JH, et al:Biomechanics of acute subdural hematoma. J Trauma 22:680-686, 1982
12) Gennarelli TA, Thibault LE, Adams JH, et al:Diffuse axonal injury and traumatic coma in the primate. ANN Neurol 12: 564-574, 1982
13) Gentry LR, Godersky JC, Thompson B:MR Imaging of head trauma:Review of the distribution and radiopathologic features of traumatic lesions. AJNR 9:101-110, 1988
14) Graham DI, Adams JH, Dolye D:Ischemic brain damage in fatal non-missile head injuries. J Neurol Sci 39:213-234, 1978
15) Jennett B, Teasdale G, Galbraith S, et al:Severe head injuries in three countries. J Neurosurg Psychiatry 40:291-298, 1977
16) Kalff R, Kocks W, Pospiech J, et al:Clinical outcome after head injury in children. Child's Nerv Syst 5:156-159, 1989
17) Kim HJ:Pathophysiology of craniocerebral trauma. J Kor Neurosurg Soc 16(4):1183-1199, 1987
18) Langfitt TW, Gennarelli TA:Can the outcome from head injury be improved? J Neurosurg 56:19-25, 1982
19) Lee HS, Bae WK, Lee KS, et al:Initial CT findings of the early death after head injury. J Kor Neurosurg Soc 20(4): 154-160, 1991
20) Lee HS, Lee KS, Bae HK, et al:Systemic insults in the early death after head injury. J Kor Neurosurg Soc 19(8):1101-1106, 1990
21) Lee HJ, Cho MK, Kim Y, et al:A clinical observation in craniocerebral injuries in adult. J Kor Neurosurg Soc 1(1):67-78, 1972
22) Levati A, Farina ML, Vecchi G, et al:Prognosis of severe head injuries. J Neurosurg 57:779-783, 1982
23) Levi L, Guilburd JN, Lemberger A, et al:Diffuse axonal injury:Analysis of 100 patients with radiological signs. Neurosurgery 27:429-432, 1990
24) Levy DE, Bates D, Caronna JJ, et al:Prognosis in nontraumatic coma. Ann Intern Med 94:293-301, 1981
25) Levy DE, Caronna JJ, Singer BH, et al:Predicting outcome from hypoxic-ischemic coma. JAMA 253:1420-1426, 1985
26) Min BY, Park YK, Jung YK, et al:Post-traumatic cerebral infarct. J Kor Neurosurg Soc 19(10-12):1349-1377, 1990
27) Miller JD, Butterworth JF, Gudeman SK:Further experience in the management of severe head injury. J Neurosurg 54: 289-299, 1981
28) Overgaard J, Christensen S, Hvid-Hansen O, et al:Prognosis after head injury based on early clinical examination. Lancet 2:631-635, 1973
29) Park SW, Park K, Kim YB, et al:Prognostic factors in diffuse axonal injuries of brain. J Kor Neurosurg Soc 20(12):983- 990, 1991
30) Pazzaglia P, Frank G, Frank F, et al:Clinical course and prognosis of acute post-traumatic coma. J Neurol Neurosurg Psychiatry 38:149-154, 1975
31) Petersdorf RG:Disturbances of heat regulation,in thorn GW(ed):Harrison's Principles of Internal Medicine