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Assessment of Memory among Traumatic Brain Injury Patients during Follow-Up at a Tertiary Health Care Facility in Rural Setting

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Abstract

Background Head injury is an important public health problem nowadays. Traumatic brain injury (TBI) results from external force that leads to damage to brain tissue. Main causes of TBI are motor vehicle collisions and fall from height. One of the primary symptoms after TBI is impaired word retrieval. Therefore, this study was undertaken to assess memory impairment in TBI patients following treatment to asses a residual memory status to declare them apt for official works if improved enough.

Objectives The purpose of this study was to assess memory impairment in TBI patients to assess the residual memory status following treatment.

Materials and Methods The study was conducted in Outpatient Department (OPD) of Neurosurgery, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, Uttar Pradesh. The TBI patients were assessed by predesigned memory assessment questionnaire during their follow-up following discharge from hospital.

Results A total of 65 patients with TBI were assessed, of which 21 (32.3%) cases had frontal lobe injuries with 9 of 21 having memory loss (42.9% cases). The temporoparietal lobe was affected in 10 (15.4%) cases out of which 5 developed memory loss, that is, 50% cases. The multiple lobes were involved in 24 (36.9%) cases, out of which memory impairment occurred in 9 cases, that is, 37.5%. Four of total five cases (80%) of diffuse axonal injury had memory loss. Further, 16.9% (n = 11) TBI patients were unable to perform digit span test (immediate memory test), 44.6% (n = 29) cases could not perform three-word recall at 5 minutes (short-term memory test), and 15.4% (n = 10) cases could not perform (long-term memory test).

Conclusion The study showed that memory assessment is required in TBI patients for instituting proper rehabilitation measures and to allow them for sensitive memory-related work following discharge from hospital.

Keywords
- traumatic brain injury
- memory impairment

Introduction

Head injury is an important public health problem nowadays. In terms of number of cases and the number of deaths, head injury is the leading factor. Moreover, severe head injury remained a challenge to neurosurgeons and basic neuroscientists, as the mortality and morbidity is very high in these cases.[1-7]

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In traumatic brain injury (TBI), the external force results in varying degrees of damage to the brain tissue.[8-10] The common causes of TBI include road traffic accidents (RTA), violence, injuries at construction sites and sports, etc.[11,12] In India, RTA is the commonest cause of TBI on account of increasing vehicles and inefficient road safety norms. Every minute there is one accident and every 4 minutes there is a death in India. An epidemiological study of head injuries in the population attending an emergency in the United Kingdom revealed head injury accounting for 3.4% of all attendances per year. Among them, 10.9% injuries were of moderate to severe grade.[13] Considering the fact that motor vehicular accident is the leading cause of head injury worldwide, the World Health Organization dedicated the year 2004 to emphasize on this aspect by giving the theme "road safety" tips/teaching on the occasion of World Health Day.[14]

TBI results in damage to the brain due to external mechanical force such as rapid acceleration, impact, blast waves, or penetration by projectile objects.[15] Brain injuries can be classified into mild, moderate, and severe categories according to Glasgow Coma Scale (GCS). In mild head injury, GCS score is 13 to 15, moderate 9 to 12, and in severe head injuries GCS score is less than or equal to 8.[16] There are many features of head injury compromising higher mental functions among the survivors but one of the primary symptoms after TBI is impaired word retrieval.[17] Word retrieval is the process of finding the correct terminology for picture, an object, orthographic representation, or conversation, in which a person converts the initial conception to a lexical version.[18] TBIs result in death and disability, especially in children and young adults.[19]

There is no literature available related to memory assessment in TBI patients in rural areas of India as literacy has an impact on higher brain functions. Considering these aspects of trauma on brain functioning, this study was conducted among the TBI survivors attending the tertiary level health facility in rural setting to evaluate the various correlates (age, gender, and other socio-demographic profile) of TBI and its effect on memory functions of the victims following their treatment and discharge from hospital.

Aim and Objectives

1. To evaluate the memory status in mild and moderate brain injury study subjects following treatment and discharge.
2. To describe the socio-demographic profile of the TBI cases in rural settings of India.

Materials and Methods

This was a cross-sectional study conducted at Uttar Pradesh University of Medical Sciences, located at Saifai, in Etawah district of Uttar Pradesh, India. The study was conducted during the period of October 2018 to January 2019 after obtaining prior approval from the institutional ethical committee.

Cases who had been treated for TBI, attending the Neurosurgery Outpatient Department (OPD) during follow-up and who met the inclusion criteria, were included in this study. Most of these were admitted to the Indoor Patient Department in the Neurosurgery Department following TBI and were discharged after their appropriate case management. Those patients who had history of any neurodegenerative illness, alcohol or substance abuse, cognitive dysfunctions, and mental deterioration due to fulminant infection or neurological disorders, including patients with repeated trauma or any chronic illness, were excluded from the study. Patients who were unable to follow verbal as well as written commands and could not be assessed by neurocognitive battery of tests were also excluded from the study.

The subjects were enquired, and information was collected in the predesigned questionnaire that comprised of various socio-demographic variables. All the subjects were first examined by a faculty of Neurosurgery in the OPD and subsequently were referred for memory evaluation that was done by single Physiology faculty trained in testing neurological functions. The details of case history, mode of trauma, GCS score at admission, radiological findings, investigations performed, and treatment details like surgery or conservative management of cases were recorded from case files and discharge summaries. Memory status of each case was evaluated using tests for immediate, short-, and long-term memories. The memory functioning questionnaire was followed to assess this component adequately. Patients from 3 weeks to 6 months following treatment of TBI were evaluated for memory impairment.

We studied 65 patients of TBI. Patients were divided into two groups, namely mild and moderate TBI, based on GCS scores at the time of admission. Patients with severe GCS scores were not the part of our study.

Data thus collected were entered on Microsoft Excel worksheet and statistically analyzed using Statistical Package for the Social Sciences software version 21.

Observations and Result

►**Table 1** depicts that majority of these cases of TBI were in the age group of 20 to 39 years (38.5%) and 40 to 59 years (36.9%). Among them, male patients were more (64.6%) as compared with females. Majority of them were married (70.5%), residing in joint families (61.5%), and educated below intermediate (72.3%). It also depicts that majority of the subjects were either unemployed or having some private job.

►**Table 2** reveals that the proportion of memory loss was higher (80%) among diffuse axonal injury (DAI), 50% in temporoparietal lobe injury, while it was 37.5% and 32.3% in multiple lobe injury and frontal lobe injury, respectively. RTAs (75.4%) were the commonest mode of injury. According to the GCS score at admission, it was observed that 75.4% cases had mild brain injury while 16.9% had moderate TBI and 7.7% had severe TBI. It was also observed that among all cases, 26.2% were operated for the brain injury while the remaining 73.8% were managed conservatively. Immediate, short-, and long-term memory status were assessed using various tests, which revealed that the TBI had more effect on the short-term memory with

Table 1 Sociodemographic profile of the study subjects (n = 65)

Variable name	Frequency (n)	Percentage
Age groups (in years)		
≤19	10	15.4
20–39	25	38.5
40–59	24	36.9
60–79	6	9.2
Gender		
Male	42	64.6
Female	23	35.4
Type of family		
Nuclear	25	38.5
Joint	40	61.5
Educational status		
Illiterate	2	3.1
Below intermediate	47	72.3
Intermediate	2	3.1
Graduate and above	14	21.5
Marital status		
Unmarried	18	27.7
Married	46	70.8
Divorcee	1	1.5
Occupation		
Not working/housewife	19	29.2
Student	11	16.9
Private job	19	29.2
Government job	4	6.2
Businessman	9	13.8
Others (farming, etc)	3	4.6

44.6% cases being depicted in ►**Table 3** unable to recall three words at an interval of 5 minutes.Tests for analyzing memory status in patients using Frequency of Forgetting Scale revealed that there was more difficulty in recall of phone numbers (35.4%) and personal dates (32.3%). Approximately half of the cases (47.7%) had (►**Table 4**) no difficulty in recognizing faces and name recalling.

►**Table 5** shows that approximately half of the cases (44.6%) were unable to recall past events occurred during the last 1 month following injury. Memory of remembering past events was very good for events that occurred years back.

Discussion

Motor vehicle collisions and fall from height disproportionately affects the young population (teenagers and young adults) and is more common in men than in women.[20] The present study has also revealed that more than half of the TBI subjects were either teenagers or young adults and 64.6% of them were males.

It was observed that 75.4% of cases suffered from TBIs due to RTA, followed by fall from height (15.4%). Various researchers in developed nations have reported fall from height (28%), motor vehicular traffic accidents (20%), and assault (11%) as the leading causes of TBI.[21-24] The highest incidence of motor vehicular traffic accidents has been reported in the 15 to 19 years age group, while fall was the leading etiology in the 0 to 4 and >75 years age groups.[25-29] Young age predilection can be explained on the basis that this being the productive period of life, most of these are bread earners of family at this age group. Aged drivers are most common victims for RTA as suggested by Owsley et al[30] and Bilban.[31] In puberty age group (32.3%), there are more chances of accidents because of increase in testosterone level and catecholamine (epinephrine and norepinephrine), speeding and drink driving, and less use of seat belt while driving or sitting in the car.[32,33] It was also observed that 70.8% of the TBI victims were married, which may be explained on the basis of increased responsibilities or problematic relationship leading to increase road risk behavior. Papez circuit, which is limbic associated structure, functions primarily in the cortical control of emotion and memory storage and contains centers that regulate aversion and gratification. Additional structures associated

Table 2 Pattern of traumatic brain injury in the cases (*n* = 65)

Variable name	Frequency (*n*)	Percentage
Site of injury		
Frontal lobe	21	32.3
Tempo-parietal lobe	10	15.4
Occipital lobe	5	7.7
Multiple lobes involvement	24	36.9
Diffuse axonal injury (DAI)	5	7.7
Mode of injury		
Road traffic accidents	49	75.4
Fall from height	10	15.4
Violence	3	4.6
Others (animal attack, etc.)	3	4.6
Glasgow outcome score at admission		
Mild brain injury (13–15)	49	75.4
Moderate brain injury (9–12)	16	24.6
Glasgow outcome score at discharge		
Mild brain injury (13–15)	58	89.3
Moderate brain injury (9–12)	7	10.7
Operation status		
Done	17	26.2
Not done (conservatively managed)	48	73.8

Table 3 Memory status of study subjects (*n* = 65) determined using various memory tests

Memory test used	Bad *n* (%)	Fair *n* (%)	Good *n* (%)
Immediate memory tests			
Digit span test	11 (16.9)	40 (61.6)	14 (21.5)
Repeating three words	24 (36.9)	21 (32.3)	20 (30.8)
Naming months backward	16 (24.6)	25 (38.5)	24 (36.9)
Interrupted counting	9 (13.9)	21 (32.3)	35 (53.8)
Short-term memory tests			
Thee-word recall at 5 min	29 (44.6)	16 (24.6)	20 (30.8)
How did you reach hospital	4 (6.2)	6 (9.2)	55 (84.6)
Long-term memory tests			
Past event recall in past 25 y	10 (15.4)	21 (32.3)	34 (52.3)

with the Papez circuit include the prefrontal cortex, septum, and amygdala.[34] Damage to the mammillothalamic tract, ventral anterior nucleus, and ventral lateral nucleus at the floor of third ventricle during TBI can result in memory and language impairment.[35] Amnesia can be a result of disconnection of mamillary bodies from the Papez circuit.[36]

Memory loss may affect a person in many ways. Forgetfulness can happen because of a busy lifestyle, depression, or as side effect of old age. However, memory impairment can also be a result of traumatic event such as a brain injury or as a side effect of Alzheimer's or dementia. An article by the National Institute of Neurological Disorders mentions that the most common side effect of TBI is memory loss.[37] In the present study, out of total 65 patients with TBI, 21 patients had frontal lobe injury with 9 of them developing memory loss, that is, 42.9% cases. The temporoparietal lobe was affected in 10 cases out of which 5 developed memory loss, that is, 50% cases. The occipital lobe was affected in 5 cases but none developed memory loss. The multiple lobes were involved in 24 cases with memory loss observed

Table 4 Memory status of study subjects (n = 65) determined using Frequency of Forgetting Scale for various tests

S. no.	Test used	Always n (%)	Sometimes n (%)	Never n (%)
1	Forgetting names	8 (12.3)	27 (41.5)	30 (46.2)
2	Forgetting faces	6 (9.2)	28 (43.1)	31 (47.7)
3	Forgetting appointments	10 (15.4)	31 (47.7)	24 (36.9)
4	Forgetting things	15 (23.1)	28 (43.1)	22 (33.8)
5	Forgetting direction to places	15 (23.1)	26 (40.0)	24 (36.9)
6	Forgetting phone numbers	23 (35.4)	19 (29.2)	23 (35.4)
7	Forgetting personal dates	21 (32.3)	18 (27.7)	26 (40.0)
8	Forgetting what to buy from store	18 (27.7)	27 (41.5)	20 (30.8)
9	Forgetting what you are doing	17 (26.2)	27 (41.5)	21 (32.3)
10	Losing thoughts in conversation	16 (24.6)	26 (40.0)	23 (35.4)

Table 5 Memory status of study subjects (n = 65) determined using Remembering Past Event Scale for various tests

S. No.	Test used	Very bad n (%)	Fair n (%)	Very good n (%)
1	Events during last month	29 (44.6)	19 (29.2)	17 (26.2)
2	Events between 6 mo and 1 y	12 (18.5)	19 (29.2)	34 (52.3)
3	Events between 1 and 5 y	4 (6.2)	16 (24.6)	45 (69.2)
4	Events between 6 and 10 y	2 (3.1)	12 (18.5)	51 (78.4)

in 9 cases, that is, 37.5%. DAI was observed in 5 cases; out of these, 4 developed memory loss, that is, 80% cases.

Memory loss may negatively impact an individual's ability to perform activities of daily living and function at job/office or as independently as they did prior to the impairment. It may also impact an individual's ability to work, remember work-related appointments, or remember coworkers' names. Most importantly, memory impairments may impact an individual's safety within the home or community. An individual suffering from memory loss may forget to turn off the stove after cooking, or may even get lost in the community and be unable to return home.[37] Further, 16.9% (n = 11) TBI patients were unable to perform digit span test (immediate memory test), 44.6% (n = 29) cases could not perform three-word recall at 5 minutes (short-term memory test), and 15.4% (n = 10) cases could not perform long-term memory test. Chung et al has also reported poorer performance on digital span test in cases with mild TBI affecting the superior longitudinal fasciculus, which is critical for attention and short-term memory.[38]

Present study also revealed that 32.3% victims had frontal lobe injury with memory loss and 75.4% of the cases had mild TBI. Kim et al[39] had also suggested that in mild TBI patients, memory-facilitating functions of frontal lobe are comparatively preserved hence less chances of memory loss while memory functions are more affected in moderate TBI patients. Temporal lobe has frontal lobe projection that is necessary for various aspects of movement control, short-term memory, and affect. In our study, probably this is the reason for short-term memory loss in 50% of cases of TBI in rural setting. There was no memory impairment observed in TBI patients with injury to occipital lobe. This is because occipital lobe is not involved in memory storage and retrieval. Memory functions were significantly impaired in TBI with DAI (based on magnetic resonance imaging findings) as 80% of DAI patients were not able to perform various tests for memory assessment. DAI is the result of traumatic shearing forces that occur when the head is rapidly accelerated or decelerated, as may occur in car accidents, falls, and assaults.[40]

Conclusion

Memory play a major role in our life as it allows us to remember skills that we have learned or retrieve information that is stored in the brain, or even recall a previous moment that happened in the past. The study showed that memory loss was observed in 41.5% of TBI cases following treatment from 3 weeks to 6 months. Thus, periodic ongoing memory assessment of individuals with TBI is important as neurological recovery can keep occurring for several months or longer after certain types of severe brain injury. The ongoing assessment can also be used to examine an individual's response to rehabilitation and to improve his/her life after the injury and thus help in the better management of TBI cases. This can also assist in declaring these cases fit for memory-related works.

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Conflict of Interest
None declared.

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