COGNITIVE SEQUELAE IN SURVIVORS OF TRAUMATIC FRONTAL LOBE INJURY: COMPARISON BETWEEN MILD AND MODERATE INJURY EFFECTS

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ABSTRACT

Objective: To determine the frequency of cognitive deficits in the survivors of traumatic frontal lobe injury of mild to moderate severity.

Study Design: Mix method study.

Place and Duration of Study: Nishter Hospital Multan, Bahawal Victoria Hospital, Bahawalpur and Sheikh Zaid Hospital Rahim Yar Khan, from Sep 2010 to Jun 2011.

Material and Methods: The sample consisted of 55 participants. Fifteen of these were taken from healthy population with the age range of 20-30 years (Mean = 25.7 ± SD = 4.6) and 40 participants were medically documented patients of frontal lobe injury of mild (20) to moderate (20) severity. The age range of mild traumatic frontal lobe injury patients was 20-32 years (Mean= 26.5 ± SD = 4.9). The age range of moderate severity patients was also 20-32 years (Mean= 26.4 ± SD = 5.0). Wechsler Adult Intelligence Scale revised and case history interview were administered to determine cognitive deficits following traumatic frontal lobe injury.

Results: Statistical test, one way analysis was used to compare the performance of all these three (control, mild and moderate) groups. Results of present study reflected that cognitive deficits like memory deficits, language problems, trouble in concentrating and difficulty in planning are the major consequences of traumatic frontal lobe injury.

Conclusion: To conclude, frontal lobe injury patients not only showed poor performance in clinically-driven structured and comprehensive memory tests when they were compared with healthy people but their performance also varied according to the severity of injury.

Keywords: Cognitive deficits, Frontal lobe, Traumatic brain injury.

INTRODUCTION

Traumatic frontal lobe injury impacts millions of people and also affects countless others who care for suffered individuals. Most of the burden is on developing countries where thousands of people suffer in traumatic frontal lobe injury every year[1]. Damage to the frontal lobe cortex can result in dramatic loss of memory and overall functionality of daily life, such as ability to work or to form social relationships. Thus, understanding the relationship between traumatic frontal lobe injury and cognitive sequelae is not only important for researchers and clinicians working with patients, who have suffered traumatic frontal lobe injury[2], but also for the clients and caregivers to take the better decision for treatment.

The major cause of frontal lobe injury is motor vehicle accidents. Other studies have included, in their sample, patients with penetration injury, falls or assaults[3,4]. The most effected part of brain due to traumatic brain injury is the frontal lobe[5]. The frontal lobe location, closeness to sphenoid wing, large size and widespread links to other brain regions are the most important risk factors of injury. MRI studies also support these findings[2].

Many studies have shown a strong relationship between traumatic frontal lobe injury and cognitive impairments[2,5]. These impairments are worst in the acute post injury stages and significant recovery is usually seen in the first few months[1,2,6] while persistent cognitive deficits

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Received: 15 Aug 2011; revised received: 17 May 2016; accepted: 21 Jun 2016

are observed in moderate to severe traumatic brain injury patients[2].

Impairments differ according to the severity and affected area of the frontal lobe. Frontal lobe is divided into three regions. The motor cortex is responsible for fine motor coordination. The premotor cortex organizes body movements. The prefrontal cortex is involved in executive functions, including attention and concentration, judgment, memory and orientation of place, day, date and time etc. So attention and memory deficits following traumatic brain injury are often linked with lesions to the prefrontal cortex[7]. The impairment of these relatively basic cognitive functions may cause or exacerbate additional disturbance in executive functions, communication and other relatively more complex cognitive functions[8]. Although few studies describe that patients with frontal lobe injury can work normally on standardized memory tests[9,10,] other studies have found significant impairments on memory related tasks[11].

Glasgow coma scale (GCS) developed by Teasdale and Jannett[12] is considered a reliable measure to categorize among mild, moderate and severe head injury. According to the rating of GCS 13 to 15 are classified as mild, 9 to 12 as moderate and eight or less are considered as indicative of severe head injury patients.The immense population of traumatic brain injury patients are mild in severity[13]. It is estimated that between 80 to 90 percent are rated as mild injured[14]. Researchers have frequently studied cognitive sequelae of mild traumatic frontal lobe injury[2,5]. However, some questions are not discussed in earlier studies. So, the present research will not only measure the cognitive effects following mild to moderate traumatic frontal lobe injury but will also differentiate between the effects of mild to moderate injury and control group. Secondly, although considerable studies have been conducted in the West on the effects of traumatic frontal lobe injury, few researches have been done on this issue in Pakistan. So the present research was planned to enhance the knowledge of researchers, clinicians and policy makers about the cognitive deficits and prevalence of these deficits across the cultures in sustained TBI patients.

SUBJECTS AND METHODS

This triangulation method based study was conducted in Multan, Bahawalpur and Rahim Yar Khan from 10 Sep 2010 to 14 June 2011. The sample for the present research comprised of 55 individuals; 15 from healthy population and 40 (20 mild and 20 moderate) medically documented patients of traumatic frontal lobe injury selected through purposive sampling. The individuals selected for sample were those traumatic frontal lobe injury patients who were present at the time of data collection and agreed to participate with no record of amnesia, psychiatric complaints and a history of alcohol or substance abuse. All the participants were examined prior to discharge. All mild injury patients were assessed during the first week and moderate injury patients within two weeks after injury when they were able to respond. To examine the cognitive deficits of mild to moderate frontal lobe injury, patients were selected on the basis of their GCS scores. A total of 15 healthy participants (control group) were selected from community to serve as a control group with approximate demographic distribution matching of actual sample.

Case history interview was used to take complete personal and social history with the patients' mental status examination. The general areas that were covered in the mental status examination were state of consciousness (alert, hyper alert, lethargic) attention and concentration, speech (language deficits, goal directedness), orientation (to name, day) form of thought, ability to think abstractly, perception, memory (immediate, recent, remote) insight and judgment. In order to explore cognitive deficits of frontal lobe injury, informations about patients were also collected from their caregivers and doctors in the best possible manner. WAIS-R[15] is known to be sensitive to frontal lobe

dysfunctions[16] and its selected subsets are used in a number of studies[17,2]. In the present study, Digit span subset of the WAIS-R was used. It is a measure of short term memory and focused attention. There are two subsets of digit span of WAIS-R, digits forward (DSF) and digits backward (DSB). The DSF is administered first and subject repeats in the same order as presented, whereas in the DBS, subject is asked to repeat the number of series in backward order. A score below seven in each subset was considered as an evidence of poor effort. In the present research, picture completion subset of WIAS-R (1981)[15] was used. Picture completion is used to measure concentration[18] where subject identifies missing parts of picture printed on card.

Data Analysis

Statistical analysis was conducted on SPSS version 16. Mean ± SD were calculated for quantitative variables. Frequency and percentage were calculated for qualitative variables. Independent t-test was applied for the clinical description of GCS and time since injury. Chi-square test was applied for the gratification of occupation among groups. Post HOC LSD test was applied for the mean difference. One way analysis was used to compare the performance of all these three control, mild and moderate) groups. A *p*-value less than or equal to 0.05 were considered statistically significant. For the analysis of case history interview Bruce Strait procedure was employed[19].

RESULTS

A *p*=0.771 (greater than 0.05) no statistical significant difference was found in the education of mild, moderate and control group. There was insignificant statistical difference in age *p*=0.976 (*p*>0.05) among all three groups. So, all groups are comparable with respect of their age and education. Most of TBI patients were male (table-I).

Table-I: Demographics details of the study groups.

Variables	Mild n=20	Moderate n=20	Control n=15
Age (Mean ± SD)	26.9 ± 4.9	26.4 ± 5.0	25.7 ± 4.6
Education (Mean ± SD)	6.9 ± 1.6	6.8 ± 1.7	6.8 ± 1.5
Gender Male%	90	95	93
Occupation			
1. Merchant	3 (15%)	4 (20%)	3 (20%)
2. Farmer	13 (65%)	11 (55%)	10 (66%)
3. Driver	4 (20%)	5 (25%)	2 (14%)

Table-II: Clinical description of the patients.

Parameters	Mild n=20	Moderate n=20	*p*-value
GCS Mean ± SD	13.8 ± 0.7	10.4 ± 1.0	<0.001
Time since injury Mean ± SD	5.6 ± 1.3	13.5 ± 1.3	<0.001
Cause of injury %			
1. Road accident	42.5 (n=17)	45 (n=18)	
2. Fall	12.5 (n=5)	0 (n=0)	

Significant difference, Time since injury.

Mean of the Glasgow coma scale of both groups significantly differ (*p*=<0.001) according to standard criteria. According to the results of above table major cause of injury was road accident.

Analysis of variance revealed significant cognitive deficits following traumatic frontal lobe injury in mild and moderate severity patients on both digit span and picture completion test.

According to individual comparison, we concluded that the group with mild injury was different on picture completion and digit span test significantly from the group with moderate injury. Both mild and moderate injury groups

were also significantly different from the control group (table-III).

For the analysis of case history interview Bruce Strait procedure was used[19]. The major cause of frontal lobe injury was road accident (table-II). So, there was no difference regarding the cause of injury in Pakistan and other countries.

Mental Status Examination

Although patients of mild injury appeared alert, some impairment in their attention and concentration was noted (n=16), especially when they experienced difficulty repeating a series of digits and performing simple calculations. No language deficits were noted, although their speech was at times difficult to understand (n=17). They were oriented to name and place (n=20) but not sure of date (n=17). Immediate memory of the patients was impaired (n=15) and remote memory was mildly impaired (n=10). Attention and concentration were worse in moderate injury patients (n=18) as compared to mild injury patients. Difficulty was noted in the patients of moderate injury to articulate words and form sentences and their speech was at times difficult to understand (n=17). The orientation was good about name (n=15) but it was poor about place (n=17) and date (n=18). The recent memory (n=18) as well as the remote memory (n=11) of these patients was impaired (table-IV).

DISCUSSION

The objective of present research was to determine cognitive deficits following traumatic frontal lobe injury in mild to moderate severity patients and to compare the frequency of cases with other cultures. Tests sensitive to frontal lobe dysfunctions were administered. In the present study, triangulation method was used, which was one of the major strengths of this research. This method was used in very few traumatic frontal lobe injury studies earlier. Comparison of two groups, with different levels of education, revealed a significant difference on memory assessment[17]. Previous studies also described age effects on memory and other cognitive functions. Therefore, in the present research, all participants matching the approximate demographic distribution were included. All other factors that can affect the cognitive performance,e.g. substance abuse, past neurological history and dementia etc. were eliminated/controlled. Vehicle accidents were a major cause of TBI in other countries as well[2].

A critical analysis of all the cases, in the context of viewing the prevalence of cognitive deficits in frontal lobe injury patients, leads to the

Table-III: Analysis of variance of digit span and picture completion test.

Groups	Digit span test	Picture completion test
	Mean ± SD	Mean ± SD
Mild (n=20)	6.10 ± 1.71	6.05 ± 1.70
Moderate (n=20)	4.05 ± 1.79	4.95 ± 2.16
Control (n=15)	8.86 ± 2.55	8.0 ± 1.81
p-value	<0.001	<0.001

SD= Standard deviation.

Table-IV: Multiple comparisons among mild and moderate TFLI and control group using least significant difference test.

	Picture completion test		Digit span test	
Multiple comparison	Mean difference	*p*-value	Mean difference	*p*-value
Mild vs moderate	1.10000	0.004**	2.05000	0.001**
Mild vs control	-1.95000	0.001**	-2.76667	0.001**
Moderate vs control	-3.05000	0.001**	-4.81667	0.001**

**Significant difference

TFLI= traumatic frontal lobe injury

following findings. Memory impairment was one of the most significant residual deficits following traumatic brain injury[20]. In the present research as well, both mild and moderate group performed below average on memory tests as measured by the WAIS-R (digit span, picture completion). The average score of mild injury patients was 6.1 on digit span test which was less than the average score 8.86 of control group. It was noted that mild injury patients with impaired long-term memory also had poor concentration with the average score of 6.05. In the present study patients of moderate severity level also performed poorly in all tests as compared to patients of mild severity. Their average score was 4.05 on digit span and 4.95 on picture completion. Second aim of present research was to compare the overall results with other cultures. In the present study the proportion of the probable cases of cognitive deficits was 80-85%. This was greater in frequency to data obtained from UK[21] where TBI population was 25-70% and also from other countries e.g. New Zealand[22]. One possible reason of this difference may be low educational level. Education affects memory and other cognitive functions[17]. It was also a fact that most TBI patients admitted in hospitals of Pakistan have low level of education and belongs to poor socioeconomic status. So, the present research suggests that in future, researchers should pay sufficient attention to the moderating effects of educational level on TBI related outcomes.

Results of the present research were also consistent with Vakil's study findings[23] that patients of traumatic frontal lobe injury have a variety of attention deficits along with impaired memory. This is still largely an unexplored area[24]. So, more research is required to enhance the better understanding of the interrelation between these two cognitive domains.

CONCLUSION

In conclusion, patients of frontal lobe injury showed poor performance in clinically-driven structured and comprehensive memory tests when they were compared with healthy people and this performance varied according to the severity of injury.

Secondly present research showed high frequency in all aspects of cognitive deficits in TBI population of Pakistan as compared to other countries. So in the light of present study, previous findings of traumatic brain injury should be reinterpreted particularly in developing countries.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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