Cascade of Traumatic Brain Injury: A Correlational Study of Cognition, Postconcussion Symptoms, and Quality of Life

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ABSTRACT

Introduction: Traumatic brain injury (TBI) constitutes a significant burden on health care resources in India. TBI is a dynamic process which involves damage to the brain thus leading to behavior cognitive and emotional consequences. **Aim:** To study the cognitive profile, post-concussion symptoms (PCS), quality of life (QOL), and their correlation. **Methods:** A total of 60 patients with TBI were recruited and assessed for neuropsychological profile, PCS, and QOL, the correlation among the variables were analyzed. **Results:** The results suggest that TBI has series of consequences which is interrelated, and the study has implications for rehabilitation of TBI. **Conclusion:** The study highlights the deficits of cognition, and its correlation with PCS and QOL, emphasizing integrated rehabilitation approach for patients with TBI.

Key words: *Cognition, post-concussion symptoms, quality of life*

INTRODUCTION

Traumatic brain injury (TBI) is a "silent epidemic" that creates a significant burden on health care resources across the globe. TBI is a dynamic process that involves damage to the brain, thus leading to behavioral, cognitive, and emotional consequences and poor quality of life (QOL).[1] Post-TBI, a person, often presents an association of neuropsychological deficits and emotional-behavioral problems.[2] Postconcussion syndrome/symptoms (PCS) is a constellation of cognitive, emotional, and somatic symptoms that occurs following a TBI.[3] Lippert-Grüner *et al*.[4] highlighted the course and relation of symptoms post-TBI with neurobehavioral rating scale at 6 and 12 months postinjury. Behavioral changes did not show any significant improvement between the period of posttrauma for anxiety, expressive deficit, emotional withdrawal, depressive mood, hostility, suspiciousness, fatigability, hallucinatory behavior, motor retardation, unusual thought content, and liability of mood and comprehension deficit. However,

Access this article online	
Website: www.ijpm.info	Quick Response Code
DOI: 10.4103/0253-7176.198940	

How to cite this article: Reddy RP, Rajeswaran J, Devi BI, Kandavel T. Cascade of traumatic brain injury: A correlational study of cognition, postconcussion symptoms, and quality of life. Indian J Psychol Med 2017;39:32-9.

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improvement was reported in attention, somatic concern, disorientation, guilt feelings, excitement, poor planning, and articulation deficits. Changes between 6 and 12 months post-TBI were statistically significant for disorientation (improvement), inattention/reduced alertness (improvement) and excitement (deterioration). Along with post-concussion symptoms (PCS), QOL is also compromised in TBI. World Health Organization (WHO) defines QOL[5] as an individual's perception of their position in life in the context of their cultural and value systems in which they live in relation to their goals, expectations, standards, and concerns (WHO, 1994). Jakola *et al*.[6] investigated the prevalence of PCS and QOL using Rivermead PCS Questionnaire (RPQ), Health related QoL (HRQOL) – EuroQol-5D, and EuroQol Visual Analog Scale (EQ-VAS). The results indicated that patients reported significantly more PCS and lower HRQOL than the controls. In another study, Teasdale and Engberg[7] assessed subjective well-being and QOL in patients with TBI. The outcome was that the group with cerebral lesions had markedly poorer QOL and subjective well-being than the group with cranial fractures, and this did not vary across time. However, in both groups, the most common symptoms concerned were cognition. Cognitive functions were assessed by Scheid *et al*.[8] in patients with TBI ($n = 299$). Results showed deficits in memory and executive dysfunctions 4–55 months post-TBI.

In summary, the studies indicate that the patients with TBI, experience PCS and poor QOL and diminished cognitive functions. Studies have focused on all the functions independently or in combinations, however, there are limited studies exploring the correlation among them. The aim was to study the correlation of PCS, QOL, and cognitive functions in relation to age and education. It is hypothesized that patients who experience PCS would have poor QOL and thus would have impaired cognitive functions.

METHODS

Before starting of the study, the protocol was evaluated by the human ethics committee. In the main study, pre- and post-intervention study was adopted; however, the current analysis is a cross-sectional data. After obtaining the informed consent, the sociodemographic details (developed for the study), Edinburgh Handedness Inventory[9] Rivermead Head Injury Follow-up Questionnaire (RHIFQ),[10] RPQ,[11] and World Health Organization QOL Assessment-BREF,[12] were administered. The neuropsychological assessment was carried out using NIMHANS battery.[13] The battery consists of the tests measuring different areas, such as motor speed, mental speed, sustained attention, executive functions, visuoconstructive ability, and learning and memory. The sample comprised of 60 patients with TBI. Right-hand patients with the ability to read and write, the first episode of mild, moderate, or severe head injury (Glassgow coma scale [GCS] - score of 3–15) between the 18 and 50 years of age with normal or corrected vision/hearing were recruited at random. Patients with a history of psychiatric disorder, neurological illness, and neurosurgical conditions other than TBI, mental retardation, substance dependence, medical conditions such as hypertension, cardiac complications, exposure to cognitive rehabilitation or any form of psychotherapy and with post-traumatic epilepsy, were excluded from the study. The exclusion criteria were based on clinical interview. Patients with psychotherapy were excluded as this study was part of the intervention program, and any therapy would have confounding effects for intervention analysis. Patients were recruited post 3 months of injury (3 months duration to account for plasticity changes). The sample was collected from inpatient and outpatient services of Department of Neurosurgery, NIMHANS, Bangalore.

RESULTS AND DISCUSSION

The sociodemographic details were obtained from patients and the significant others. Details of age, education, gender, marital status, urban-rural background, occupation, and socioeconomic status were obtained. The mean age group was 28.27 ± 7.66 years. The mean number of years of education was 11.97 ± 2.71 years. The male-female ratio was 54:6, there were 90% males. The marital status indicated that 66.7% were married. In terms of employment, 50% patients were employed. The socioeconomic status indicated that the majority of patients were from the middle socioeconomic status (46.7%). As far as background was concerned, 80% patients were from urban. The clinical details of the groups were obtained for severity, imaging reports, duration, and information about surgery through patients and medical record files. The severity was determined with the scores of GCS (score of 13–15 was mild TBI, 9–12 moderate TBI, and 3–8 severe TBI). In terms of severity, there were 56.7% severe patients. The information about imaging and structural involvement was obtained from computed tomography/magnetic resonance imaging scans. In about 53.3% patients had frontal and temporal lobe involvement, parietal lobe was found in 30%, and occipital lobe involvement was found in 10% of patients, 16% of patients were left lateralized, 16% were right lateralized, and 23% were with bilateral involvement. Following TBI, the number of patients who underwent surgery was 43.3%.

Neuropsychological profiles in traumatic brain injury

The degree of cognitive impairments determines the bio-socio-occupational functioning of the patients [Table 1]. The analysis of test results on neuropsychological assessment reveals >50% of patients with TBI had deficits in mental speed (55.88% on digit symbol substitution test [DSST]). Mental speed is a composite measure, which requires rapid processing of information. Due to injury, patients are unable to process and allocate the resources efficiently. Binder *et al*.[14] in a review study found deficits in speed of processing in patients with TBI. Madigan *et al*.[15] found that speed of processing in the TBI group was disproportionately slower. Deficits in intelligence, memory, attention, speed of processing, and cognitive flexibility were documented.[16] The structure implicated with mental speed of information processing is dorsolateral prefrontal cortex.[17] There was severe impairment found in verbal learning and memory [54.90% on auditory verbal learning test immediate recall (AVLT); 65.69% on delayed recall (AVLT)], indicating that there was difficulty in encoding, retrieval of verbal material. Verbal learning and memory is the capacity to learn and remember verbal material. Curtiss *et al*.,[18] found patterns of memory dysfunctions in patients with TBI. Similarly, de Guise *et al*.[19] found deficits in the areas of attention and memory. Lesion studies have shown acquisition of new information is mediated by a wide network of structures such as anterior temporal cortex, amygdala, hippocampus, entorhinal cortex, prefrontal cortex, and retrosplenial cingulate cortex.[20] The present study showed deficits in speed of information processing and memory, which is corroborated by earlier studies.[21-25] The cognitive deficits observed in the domains can be explained as abnormalities in the frontal and temporal lobe functions. The neuropsychological localization associated with the functions is prefrontal and left medial temporal.[26,27]

Correlation of the study variables

The results obtained on various tests were analyzed using descriptive statistics, such as mean and standard deviation for continuous variables; frequency and percentages, for qualitative variables. The neuropsychological assessment data were analyzed using nonparametric test since the distribution for neuropsychological assessment was not normal. Spearman's correlation test was used to study the correlation between different variables. Data were analyzed using SPSS 15.0 for Windows SPSS, NIMHANS licensed version, Department of Biostatistics. The correlation analysis was carried out to understand the relationship between the sociodemographic variables; neuropsychological performance [Table 1]. Age and education being continues variable was used for correlation [Tables 2 and 2.1-2.3].

Table 1: Neuropsychological deficits in patients with TBI (*n*=60)

Cognitive domains	Variables	*n*	%
Motor speed (Average number of units taped)	FTR	28	27.45
	FTL	22	21.57%
Mental speed (Time in seconds)	DSST	57	55.8
Sustained attention (Time in seconds)	DVT	36	35.29
Category fluency (Total number of words)	ANT	47	46.08
Working memory (Total number of correct Hits)	WM 1 B H	8	7.84
	WM 2 B H	19	18.63
Planning (Total number of moves)	TOL	4	3.92
Set shifting (Number of perseverative responses)	WCST PR	47	46.08
Concept formation (Total conceptual level responses)	WCST CLR	48	47.06
Response inhibition (Time in seconds)	STROOP	23	22.55
Comprehension (Total number of responses)	TOKEN	21	20.59
Verbal learning and memory (Total words recalled)	AVLT	63	61.76
	AVLT IR	56	54.90
	AVLT DR	67	65.69
Visuo spatial construction (details of design reproduced)	CFT copy	44	43.14
Visual learning and memory	CFT IR	47	46.08
	CFT DR	47	46.08

FTR – Finger Tapping Test (Right), FTL – Finger Tapping Test (Left); DSST – Digit Symbol Substitution Test; DVT – Digit Vigilance Test; ANT – Animal Names Test; WM 1 B H – Working Memory 1 Back Hits; WM 2 B H – Working Memory 2 Back Hits; TOL – Tower of London Test; WCST PR – Wisconsin Card Sorting Test (Perseverative Responses); WCST CLR – Wisconsin Card Sorting Test (Conceptual Level Responses); STROOP – Stroop Test; AVLT – Auditory Verbal Learning Test (IR – Immediate Recall, DR – Delayed Recall); CFT – Complex Figure Test (IR – Immediate Recall, DR – Delayed Recall

PCS are among the most common complaints after TBI. Symptoms such as dizziness, headache, impaired attention, and poor memory are frequently reported by the patients. The symptoms disable the patients significantly in the domains of occupational, social, emotional, and day to day functioning. This has an impact on their personal lives. Results of the present study indicate that PCS, which was measured by RHIFQ and RPQ, was not correlated with age, indicating that increase or decrease in age does not influence PCS. The intensity of the symptoms varies with severity of TBI. Since this study had 50% of severe TBI category, it could be hypothesized that PCS occurs due to injury *per se* and age has no significant correlation. QOL is subjective well-being in relation to self and society. According to Tarter *et al*.[28] QOL was a multi-faceted construct that encompasses the individual's behavioral and cognitive capacities, emotional well-being and abilities requiring the performance of domestic, vocational, and social roles. QOL is, therefore, a dynamic concept that not only incorporates physical, psychological, and social domains but individual perceptions and values of their role function. The well-being of individuals is based on the idea of good health and life satisfaction. Variables such as age and education were correlated to analyze whether it has an impact on the well-being

Table 2: Correlation between post-concussion Symptoms (PCS) and Quality of life (QOL) with age and education (*n*=60)

Variables	Sig	PCS			QOL				
		RHIFQ	RPQ	VAS	PHY	PSY	SOC	ENVN	TOT
Age in years	rho	0.157	−0.046	−0.039	0.019	−0.031	0.066	−0.025	−0.007
	P value	0.232	0.727	0.765	0.884	0.817	0.615	0.849	0.958
Educatio (number of years)	rho	−0.099	−0.038	0.103	−0.087	0.161	0.040	0.310*	0.159
	P value	0.454	0.774	0.432	0.507	0.220	0.763	0.016	0.225

* – Significance at 0.05 level; RHIFQ – Rivermead Head Injury Follow up Questionnaire; RPQ – Rivermead Post Concussion Questionnaire; VAS – Visual analog Scale, QOL Phy – Quality of life physical; QOL Psy – Quality of life psychological; QOL Soc – Quality of life social; QOL Envn – Quality of life environment

Table 2.1: Correlation between motor speed, mental speed and sustained attention with age and education (*n*=60)

Variables	Sig	FTR	FTL	DSST	DVT
Age	rho	0.056	0.216	0.273*	0.034
	P value	0.675	0.103	0.038	0.800
Education	rho	0.152	0.162	−0.482**	−0.113
	P value	0.250	0.225	0.000	0.399

* – Significance at 0.05 level; ** – Significance at 0.001 level FTR – Finger Tapping Test (Right); FTR – Finger Tapping Test (Left); DSST – Digit Symbol Substitution Test; DVT – Digit Vigilance Test

of the individual. The present study indicated that there was no correlation between age and QOL. Both younger and older adults experience poorer QOL post-TBI. The findings are corroborated by the study conducted by Rahman *et al*.[29] who hypothesized that increased age would be associated with decreased QOL. The study revealed that increased age was associated with lower QOL in Caucasians, whereas no relationship was observed between age and QOL measures among African Americans. The environment domain of QOL was positively correlated with number of years of education. Education has been found to be the protective factor which increases the QOL. The findings are corroborated by studies, conducted with spinal cord injury, Clayton and Chubon[30] found in a sample of 100 persons with spinal injury, that education was associated with perceived life quality. Education is considered to increase access to work and economic resources. According to Albrecht and Devlieger,[31] education increases a sense of control over life for a person with disabilities and creates opportunities for social relationships. It is therefore hypothesized that in patients with TBI, severity, age, and concussion symptoms influence HRQOL and early social reintegration.[32] The correlation carried out for neuropsychological assessment with age and education showed that age was positively correlated with mental speed (DSST), indicating that older the individual the better is the performance of mental speed. Age was found to be negatively correlated with category fluency (animal naming test [ANT]), concept formation (Wisconsin Card Sorting Test [WCST]) and verbal comprehension (Token test), indicating that younger individuals could generate alternatives, form sets and comprehend better than older adults. Number of years of education was higher in IG, which was found to be positively correlated with working memory (N-back test), concept formation (WCST) and visuoconstructive ability (complex figure test [CFT]). The findings were corroborated by a study by Reitan and Wolfson.[33] They evaluated the variables of age and education with relation to the neuropsychological functions. It is postulated that higher education level decreases vulnerability to cognitive deficits after a TBI. It is also indicated that higher educational levels, along with mild symptoms predicted a low likelihood of significant cognitive dysfunction.[34] The present study also indicates that the ability to shift sets was negatively correlated with education on perseveration score (WCST). Planning (tower of London), response inhibition (Stroop test), learning and memory (AVLT and CFT) had no significant correlation with age and education in the intervention group (IG) and wait list group (WG). The neuropsychological assessments performance was correlated with PCS and QOL. It is expected that higher PCS result in poorer QOL and poor neuropsychological test performances. This study indicates motor speed (finger tapping test [FT]), category fluency (ANT), working memory (N-back), concept formation, comprehension (Token test), visuoconstructive ability (CFT), verbal and visual learning and immediate memory (AVLT and CFT) were negatively correlated with PCS (RHIFQ, RPQ, and VAS). Set shifting (WCST) and response inhibition (Stroop) were positively correlated with PCS (RHIFQ and VAS). Motor speed (FT) and visual memory (CFT) were positively correlated with psychological domain and overall QOL. Positive correlation was found between physical, psychological, environmental, and overall QOL with category fluency and verbal delayed memory (AVLT) [Tables 2.4-2.6]. Results of the present study indicate that neuropsychological functions were correlated with PCS and QOL. As expected, the higher the PCS patient's experience, poorer will be the neuropsychological test performance. This indicates that the QOL and PCS are interrelated. It is indicated that people with disabilities are incapable of experiencing a good QOL. A model of disability given by Kasonde-Ng'andou[35] points out that disability

Table 2.2: Correlation between executive functions with age and education (*n*=60)

Variable	Sig	ANT	WM 1B	WM 2 B	TOL	WCST PR	WCST CLR	STROOP
Age	rho	−0.275*	0.027	0.066	−0.079	0.171	−0.272*	−0.006
	P value	0.035	0.840	0.630	0.565	0.215	0.048	0.970
Education	Rho	−0.044	0.318*	−0.083	−0.007	−0.297*	0.498**	0.135
	P value	0.743	0.016	0.543	0.958	0.029	0.000	0.354

* – Significance at 0.05 level; ** – Significance at 0.001 level ANT – Animal Names Test; WM 1 B H – Working Memory 1 Back Hits; WM 2 BH – Working Memory 2 Back Hits; TOL – Tower of London Test; WCST PR – Wisconsin Card Sorting Test (Perseverative Responses); WCST CLR – Wisconsin Card Sorting Test (Conceptual Level Responses); STROOP – Stroop Test

Table 2.3: Correlation between comprehension, learning and memory with age and education (*n*=60)

Variables	Sig	Token	AVLT	AVLT IR	AVLT DR	CFT	CFT IR	CFT DR
Age	rho	−0.380**	−0.257	−0.119	−0.170	−0.195	−0.234	−0.197
	P value	0.003	0.052	0.375	0.202	0.147	0.077	0.138
Education	rho	0.174	0.091	−0.054	0.032	0.332*	0.105	0.077
	P value	0.188	0.499	0.686	0.812	0.012	0.433	0.565

* – Significance at 0.05 level; ** – Significance at 0.001 level AVLT – Auditory Verbal Learning Test (IR – Immediate Recall, DR – Delayed Recall); CFT – Complex Figure Test (IR – Immediate Recall, DR – Delayed Recall)

Table 2.4: Correlation between motor speed, mental speed and sustained attention with PCS and QOL (*n*=60)

Variables	Sig	PCS		QOL					VAS
		RHIFQ	RPQ	PHY	PSY	SOC	ENVN	TOT	
FTR	rho	−0.230	−0.356**	0.221	0.321*	0.192	0.232	0.281*	−0.379**
	P value	0.080	0.006	0.092	0.013	0.145	0.078	0.031	0.003
FTL	rho	−0.042	−0.228	0.127	0.274*	0.151	0.144	0.189	−0.273*
	P value	0.755	0.086	0.340	0.037	0.259	0.279	0.155	0.038
DSST	rho	0.178	0.237	−0.090	−0.241	−0.065	−0.327*	−0.226	0.232
	P value	0.181	0.073	0.500	0.068	0.629	0.012	0.088	0.080
DVT	rho	0.295*	0.365**	−0.119	−0.201	−0.030	−0.114	−0.130	0.273*
	P value	0.024	0.005	0.374	0.131	0.825	0.395	0.329	0.038

* – Significance at 0.05 level; ** – Significance at 0.001 level PCS – Post concussive symptoms; FTR – Finger Tapping Test (Right); FTL – Finger Tapping Test (Left); DSST – Digit Symbol Substitution Test; DVT – Digit Vigilance Test; RHIFQ – Rivermead Head Injury Follow up Questionnaire; RPQ – Rivermead Post-concussion Questionnaire; VAS – Visual analog Scale; QOL Phy – Quality of life physical; QOL Psy – Quality of life psychological; QOL Soc – Quality of life social; QOL Envn – Quality of life environment

Table 2.5: Correlation between executive functions with PCS and QOL (*n*=60)

Variables	Sig	PCS		QOL					VAS
		RHIFQ	RPQ	PHY	PSY	SOC	ENVN	TOT	
ANT	rho	−0.446**	−0.265*	0.274*	0.350**	0.162	0.319*	0.355**	−0.423**
	P value	0.000	0.042	0.036	0.007	0.221	0.014	0.006	0.001
WM 1B	rho	−0.270*	−0.144	−0.092	0.142	0.017	0.042	0.047	−0.218
	P value	0.042	0.285	0.497	0.291	0.901	0.757	0.730	0.104
WM 2 B	rho	−0.228	−0.283*	0.127	0.150	0.003	0.184	0.173	−0.422**
	P value	0.091	0.034	0.352	0.269	0.982	0.174	0.203	0.001
TOL	rho	−0.040	−0.116	0.112	0.053	0.015	0.214	0.114	−0.238
	P value	0.768	0.393	0.409	0.697	0.912	0.112	0.405	0.078
WCST PR	rho	0.441**	0.294*	−0.118	−0.232	−0.029	−0.194	−0.174	0.458**
	P value	0.001	0.031	0.395	0.092	0.837	0.160	0.209	0.000
WCST CLR	rho	−0.464**	−0.219	0.042	0.269	0.139	0.345*	0.255	−0.362**
	P value	0.000	0.116	0.764	0.051	0.321	0.012	0.066	0.008
STROOP	rho	0.376**	0.214	−0.174	−0.254	−0.221	−0.217	−0.209	0.513**
	P value	0.008	0.140	0.231	0.078	0.126	0.134	0.149	0.000

* – Significance at 0.05 level; ** – Significance at 0.001 level ANT – Animal Names Test; WM 1 B H – Working Memory 1 Back Hits; WM 2 B H – Working Memory 2 Back Hits; TOL – Tower of London Test; WCST PR – Wisconsin Card Sorting Test (Perseverative Responses); WCST CLR – Wisconsin Card Sorting Test (Conceptual Level Responses); STROOP – Stroop Test; RHIFQ – Rivermead Head Injury Follow up Questionnaire; RPQ – Rivermead Post-Concussion Questionnaire; VAS – Visual analog Scale; QOL Phy – Quality of life physical; QOL Psy – Quality of life psychological; QOL Soc – Quality of life social; QOL Envn – Quality of life environment

Table 2.6: Correlation between comprehension, learning and memory with PCS and QOL (*n*=60)

Variables	Sig	PCS		QOL					VAS
		RHIFQ	RPQ	PHY	PSY	SOC	ENVN	TOT	
TOKEN	rho	−0.367**	−0.194	0.124	0.181	0.047	0.382**	0.241	−0.341**
	P value	0.004	0.141	0.350	0.171	0.726	0.003	0.066	0.008
AVLT Total	rho	−0.474**	−0.293*	0.323*	0.424**	0.295*	0.359**	0.422**	−0.652**
	P value	0.000	0.026	0.013	0.001	0.024	0.006	0.001	0.000
AVLT IR	rho	−0.357**	−0.293*	0.272*	0.334*	0.258	0.254	0.328*	−0.608**
	P value	0.006	0.026	0.039	0.010	0.051	0.054	0.012	0.000
AVLT DR	rho	−0.390**	−0.296*	0.279*	0.387**	0.242	0.250	0.330*	−0.564**
	P value	0.002	0.024	0.034	0.003	0.067	0.058	0.011	0.000
CFT	rho	−0.129	−0.133	0.043	0.201	0.102	0.253	0.173	−0.264*
	P value	0.340	0.325	0.749	0.134	0.449	0.057	0.199	0.047
CFT IR	rho	−0.391**	−0.200	0.173	0.285*	0.153	0.195	0.232	−0.513**
	P value	0.002	0.133	0.194	0.030	0.251	0.141	0.080	0.000
CFT DR	rho	−0.419**	−0.279*	0.166	0.278*	0.178	0.152	0.227	−0.525**
	P value	0.001	0.034	0.213	0.034	0.180	0.255	0.086	0.000

* – Significance at 0.05 level; ** – Significance at 0.001 level AVLT – Auditory Verbal Learning Test (IR – Immediate Recall, DR – Delayed Recall); CFT – Complex Figure Test (IR – Immediate Recall, DR – Delayed Recall); RHIFQ – Rivermead Head Injury Follow up Questionnaire; RPQ – Rivermead Post-concussion Questionnaire; VAS – Visual analog Scale; QOL Phy – Quality of life physical; QOL Psy – Quality of life psychological; QOL Soc – Quality of life social; QOL Envn – Quality of life environment

Table 2.7: Correlation between PCS and QOL (*n*=60)

Variables	Sig	QOL					VAS
		PHY	PSY	SOC	ENVN	TOT	
RHIFQ	rho	−0.510**	−0.600**	−0.468**	−0.375**	−0.604**	0.597**
	P value	0.000	0.000	0.000	0.003	0.000	0.000
RPQ	rho	−0.493**	−0.547**	−0.315*	−0.223	−0.485**	0.539**
	P value	0.000	0.000	0.014	0.086	0.000	0.000
correVAS	rho	−0.370**	−0.530**	−0.453**	−0.345**	−0.505**	–
	P value	0.004	0.000	0.000	0.007	0.000	–

* – Significance at 0.05 level; ** – Significance at 0.001 level RHIFQ – Rivermead Head Injury Follow up Questionnaire; RPQ – Rivermead Post Concussion Questionnaire; VAS – Visual analog Scale; QOL Phy – Quality of life physical; QOL Psy – Quality of life psychological; QOL Soc – Quality of life social; QOL Envn – Quality of life environment

is perceived to be a “sickness,” “personal tragedy,” and “object of charity.” As the patients with TBI are limited in function (self-care, occupational) and role performance, they perceive and experience poorer quality in different domains. Results of this study are in accordance with the literature. PCS (RHIFQ) were negatively correlated with all the domains of QOL, physical, psychological, social, environmental, and overall QOL. PCS on RPQ was also found to be negatively correlated with physical, psychological, social domains, and with overall QOL. RHIFQ and RPQ were positively correlated with VAS, indicating that, higher the PCS, higher is the subjective distress experienced by patients with TBI. The VAS was negatively correlated with all domains of QOL, physical, psychological, social, environmental domain, and overall QOL. It indicates that those patients who experience more subjective symptoms tend to have lower QOL. Poor QOL is positively correlated with PCS [Table 2.7]. Whittaker *et al*.[36] found that perception of the illness itself may have an effect on the development of post-concussive syndrome. Emanuelson *et al*.[37] reported significant correlation between higher rates of PCS and poorer well-being.

CONCLUSIONS

The neuropsychological profile of patients with TBI showed significant impairment in speed of information processing and verbal learning and memory. There was a negative correlation of postconcussive symptoms with QOL. Positive correlation was found between neuropsychological functioning and QOL. Age and education were positively and negatively correlated with some aspect of symptoms and neuropsychological functioning. The cascade of TBI includes impairment of various domains and each of them, directly and indirectly, influencing the outcome. Following TBI, initially, neuronal plasticity occurs and aids in the recovery of cognitive functions to some extent leaving the patient with residual symptoms and cognitive dysfunctions. If rehabilitation is introduced, the recovery occurs through a process of autoregulation and homeostasis and aiding the patient to reintegrate back to society. The implications of the study are that TBI has become a burden on health care creating impact at personal and societal level which needs to be addressed on priority. The limitations of the study are that the distribution of gender and severity of injury was not equal and follow-up could not be carried out for all the patients. The study has highlighted the cognitive profile along with correlation with PCS and QOL, which indicates the need for bio, psychosocial integrated rehabilitation approach for patients with TBI.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Reddy RP, Rajeswaran J, Devi BI, Kandavel T. Neurofeedback training as an intervention in a silent epidemic: An Indian scenario. J Neurother 2013;17:213-25.
2. Viguier D, Dellatolas G, Gasquet I, Martin C, Choquet M. A psychological assessment of adolescent and young adult inpatients after traumatic brain injury. Brain Inj 2001;15:263-71.
3. Morton MV, Wehman P. Psychosocial and emotional sequelae of individuals with traumatic brain injury: A literature review and recommendations. Brain Inj 1995;9:81-92.
4. Lippert-Grüner M, Kuchta J, Hellmich M, Klug N. Neurobehavioural deficits after severe traumatic brain injury (TBI). Brain Inj 2006;20:569-74.
5. WHO Group. Development of the WHOQOL rational and current status. Int J Ment Health 1994;2:2456.
6. Jakola AS, Müller K, Larsen M, Waterloo K, Romner B, Ingebrigtsen T. Five-year outcome after mild head injury: A prospective controlled study. Acta Neurol Scand 2007;115:398-402.
7. Teasdale TW, Engberg AW. Subjective well-being and quality of life following traumatic brain injury in adults: A long-term population-based follow-up. Brain Inj 2005;19:1041-8.
8. Scheid R, Walther K, Guthke T, Preul C, von Cramon DY. Cognitive sequelae of diffuse axonal injury. Arch Neurol 2006;63:418-24.
9. Oldfield RC. The assessment and analysis of handedness: The Edinburgh inventory. Neuropsychologia 1971;9:97-113.
10. Crawford S, Wenden FJ, Wade DT. The Rivermead head injury follow up questionnaire: A study of a new rating scale and other measures to evaluate outcome after head injury. J Neurol Neurosurg Psychiatry 1996;60:510-4.
11. King NS, Crawford S, Wenden FJ, Moss NE, Wade DT. The Rivermead post concussion symptoms questionnaire: A measure of symptoms commonly experienced after head injury and its reliability. J Neurol 1995;242:587-92.
12. Development of the World Health Organization WHOQOL-BREF quality of life assessment. The WHOQOL Group. Psychol Med 1998;28:551-8.
13. Rao SL, Subbakrishna DK, Gopukumar K. NIMHANS Neuropsychology. Battery-2004. Bangalore: NIMHANS Publication; 2004.
14. Binder LM, Rohling ML, Larrabee GJ. A review of mild head trauma. Part I: Meta-analytic review of neuropsychological studies. J Clin Exp Neuropsychol 1997;19:421-31.
15. Madigan NK, DeLuca J, Diamond BJ, Tramontano G, Averill A. Speed of information processing in traumatic brain injury: Modality-specific factors. J Head Trauma Rehabil 2000;15:943-56.
16. Hellawell DJ, Taylor RT, Pentland B. Cognitive and psychosocial outcome following moderate or severe traumatic brain injury. Brain Inj 1999;13:489-504.
17. Diamond A. Normal development of prefrontal cortex from birth to young adulthood: Cognitive functions, anatomy and biochemistry. In: Stuss DT, Knight RT, editors. Principles of Frontal Lobe Function. Newyork, NY, US: Oxford University Press; 2002. p. 483-4.
18. Curtiss G, Vanderploeg RD, Spencer J, Salazar AM. Patterns of verbal learning and memory in traumatic brain injury. J Int Neuropsychol Soc 2001;7:574-85.
19. de Guise E, Feyz M, LeBlanc J, Richard SL, Lamoureux J. Overview of traumatic brain injury patients at a tertiary trauma centre. Can J Neurol Sci 2005;32:186-93.
20. Nyberg L, Habib R, McIntosh AR, Tulving E. Reactivation of encoding-related brain activity during memory retrieval. Proc Natl Acad Sci U S A 2000;97:11120-4.
21. Dikmen SS, Machamer JE, Powell JM, Temkin NR. Outcome 3 to 5 years after moderate to severe traumatic brain injury. Arch Phys Med Rehabil 2003;84:1449-57.
22. Hanks RA, Rapport LJ, Millis SR, Deshpande SA. Measures of executive functioning as predictors of functional ability and social integration in a rehabilitation sample. Arch Phys Med Rehabil 1999;80:1030-7.
23. Kersel DA, Marsh NV, Havill JH, Sleigh JW. Neuropsychological functioning during the year following severe traumatic brain injury. Brain Inj 2001;15:283-96.
24. Masson F, Maurette P, Salmi LR, Dartigues JF, Vecsey J, Destaillats JM, *et al.* Prevalence of impairments 5 years after a head injury, and their relationship with disabilities and outcome. Brain Inj 1996;10:487-97.
25. Millis SR, Rosenthal M, Novack TA, Sherer M, Nick TG, Kreutzer JS, *et al.* Long-term neuropsychological outcome after traumatic brain injury. J Head Trauma Rehabil 2001;16:343-55.
26. Hughes DG, Jackson A, Mason DL, Berry E, Hollis S, Yates DW. Abnormalities on magnetic resonance imaging seen acutely following mild traumatic brain injury: Correlation with neuropsychological tests and delayed recovery. Neuroradiology 2004;46:550-8.
27. Wallesch CW, Curio N, Kutz S, Jost S, Bartels C, Synowitz H. Outcome after mild-to-moderate blunt head injury: Effects of focal lesions and diffuse axonal injury. Brain Inj 2001;15:401-12.
28. Tarter RE, Erb S, Biller PA, Switala J, Van Thiel DH. The quality of life following liver transplantation: A preliminary report. Gastroenterol Clin North Am 1988;17:207-17.
29. Rahman RO, Forchheimer M, Tate DG. Quality of life correlates among individuals with a spinal cord injury: Does race matter? Int J Psychosoc Rehabil 2004;9:153-65.
30. Clayton KS, Chubon RA. Factors associated with the quality of life of long-term spinal cord injured persons. Arch Phys Med Rehabil 1994;75:633-8.
31. Albrecht GL, Devlieger PJ. The disability paradox: High quality of life against all odds. Soc Sci Med 1999;48:977-88.
32. Bock WJ, Gobiet W, Lehmann U, Mayer K, Rickels E, Sens B, *et al*. Posttraumatic rehabilitation and one year outcome following acute traumatic brain injury (TBI): Data from the well defined population based German prospective study 2000-2002. Acta Neurochir Suppl 2008;101:55-60.

33. Reitan RM, Wolfson D. Influence of age and education on neuropsychological test results. Clin Neuropsychol 1995;9:151-8.
34. Sheedy J, Harvey E, Faux S, Geffen G, Shores EA. Emergency department assessment of mild traumatic brain injury and the prediction of postconcussive symptoms: A 3-month prospective study. J Head Trauma Rehabil 2009;24:333-43.
35. Kasonde-Ng'andou S. Bio-medical versus indigenous approaches to disability. In: Holzer B, Vredde A, Weigt G. Disability in Different Cultures, Reflections on Local Concepts. [presented and discussed at the Symposium "Konzepte und Vorstellungen zu Behinderung in verschiedenen Kulturen", Bonn 21.-24.5. 1998]. Bielefeld 1999. p. 114-21.
36. Whittaker R, Kemp S, House A. Illness perceptions and outcome in mild head injury: A longitudinal study. J Neurol Neurosurg Psychiatry 2007;78:644-6.
37. Emanuelson I, Andersson Holmkvist E, Björklund R, Stålhammar D. Quality of life and post-concussion symptoms in adults after mild traumatic brain injury: A population-based study in Western Sweden. Acta Neurol Scand 2003;108:332-8.