Current Opinions in Neurological Science
ISSN: 2575-5447

Opinion Article Volume 5 Issue 3 • 2020

Mild Traumatic Brain Injury (mTBI): Is it Truly Mild? A One-Year Follow-Up on Symptomatology, Cognition, Disability and Life Satisfaction

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Received : November 22, 2020
Published : November 28, 2020

Abstract

Objective: To determine cognitive functions, symptoms, disabilities and life satisfaction of patients with first time concussed patients during acute injury and subsequent follow-up visits (3, 6 and 12 months).

Materials and Methods: Seventy five patients with single mTBI answered questionnaires about symptoms, disabilities (RHFUQ) and life satisfaction (LiSat-11) apart from neuropsychological evaluation at each subsequent follow-up (F/U) visits. Thirty healthy control subjects also underwent same tests for comparison with study group (mTBI patients).

Results: At1year post-injury: 21% had persistent post-concussion symptoms (PCS), with statistically significant difference between the number of symptoms at 1 year F/U visit for study group (4.8 ± 1.8) and the healthy control group (1.3 ± 1.5), (p-value = 0.03). The total RHFUQ score (13.0 ± 8.8) was statistically significant compared to the control group (3.2 ± 2.3), (p-value<0.001). The number of disability items in the study group (5.4 ± 2.8) was also significant compared with the healthy control group (1.1± 2.2) with p-value <0.001. The study group exhibited statistically significant (p=0.01) lower level of life satisfaction (40.8 ± 9.5) compared with the control group (56.7 ± 11.5). In the study group, the number of cognitive tests with outcomes below cut-off limits (± 2SD) was statistically significant compared with control group.

Conclusion: The high frequency of persistent PCS, disabilities along with lower level of life satisfaction and decline in cognitive function appears to characterize single mTBI patients in our study at 1 year post-injury. This highlights the need to carefully evaluate a single mTBI for long-term implications.

***Keywords*:** *Mild traumatic brain injury; Head trauma; Post-concussion syndrome; Cognitive impairment; Disability; Life satisfaction*

Introduction

According to World Health Organization (WHO), mild traumatic brain injury (mTBI) is defined as an acute brain injury resulting from external forces to the head that causes one or more of the following: confusion or disorientation; loss of consciousness (LOC) ≤ 30 minutes or other transient neurological abnormalities; post-traumatic amnesia (PTA) ≤ 24 hours; Glasgow Coma Score (GCS) ranging from 13 to 15. [1] Mild TBI has been named the "'silent epidemic", [2] and is the most common neurological disease. [3] In the acute phase, it can cause array of symptoms (e.g. headache, fatigue, dizziness, irritability to name a few) apart from impaired cognitive function, collectively

known as post-concussive syndrome (PCS). [4] The time it takes for symptoms to resolve in the majority of individuals is approximately 3 months, however, some individuals persist to experience symptoms, even beyond 1 year post-injury. [4, 5] As initially reported by Rutherford *et al*., persistent PCS defined as symptoms that persists beyond 3 months after acute mTBI is estimated to impact 15% of individuals with a first-time concussion. [6-8]

McInnes *et al*., [9] in his scoping review article on mTBI and chronic cognitive impairment revealed that in contrast to the prevailing views, persistent PCS with long-term cognitive impairment persists in approximately half of the individuals with a single mTBI. This is further supported by the prospective study performed by Stalnacke *et al*., [10] on mTBI patients (n=69) which reported high frequency of post concussive symptoms, disability, cognitive impairment along with lower level of life satisfaction 1 year post-injury in patients seeking consultation.

An emerging debate on mTBI patients is that- is it truly mild? Mounting evidence suggest a "chronic condition" may be added to higher frequency of patients with mild TBI than previously reported. Accumulating research indicates a considerable number of patients with mild TBI (14-50%) may exhibit long term-dysfunction, probably pertaining to persisting cognitive impairment. [11-13] Pathophysiological changes like altered white matter structure and function (e.g. diffuse axonal injury, DAI) as well as so called ' neurometabolic cascade' that is characterized by altered neurotransmitter activity and subsequently altered levels of brain excitability has been reported. [14-17]

In the light of emerging yet scarce data on long term implications in patients with a single mTBI especially in respect to cognitive function in the chronic stage post-injury, we decided to probe it further. We conducted a prospective study to assess the impact of a single concussion (mTBI patients) in the chronic stage of post-injury. We enrolled 75 first time concussed patients with subsequent follow-up at 3, 6 and 12 months after acute mTBI and estimated the incidence of persistent PCS with presence/absence of cognitive impairment, disability and decline in quality of life.

Methods

The present prospective study was conducted at Manmohan Memorial Medical College and Teaching Hospital, a tertiary neuro-trauma referral center in Kathmandu, Nepal. The study was conducted from March 2019 to October 2020 on patients presenting to emergency department (ED) with acute mild TBI, with outpatient follow-up visits at 3, 6 and 12 months after the incident. We admit on an average of 1-2 acute mild TBI patients per day (412 total patients in hospital registry admitted in the study period) for observation and appropriate care. Institutional review board clearance was obtained prior to study initiation and written informed consent were obtained from the eligible patients. Only 200 patients were eligible for the study based on inclusion and exclusion criteria determined at the time of admission. However, only 75 patients completed the requisite 1 year follow-up visit, which was the final sample size of this study.

Inclusion Criteria: First time mTBI patients with Glasgow Coma Scale (GCS) of 13-15 during first evaluation at the ED, loss of consciousness (LOC) <30 minutes, post traumatic amnesia <24 hours, aged between 18 and 60 years old, education level- at least 12th grade pass, must have fulfilled required outpatient follow up visit at all three time intervals (3, 6 and 12 months after the insult), who agreed to participate by providing written informed consent.

Exclusion Criteria: Patients with epilepsy, history of previous head trauma or neurosurgical operation, neurological disorder (e.g. previous stroke or neurodegenerative disorder), penetrating skull injury, skull fracture, acute intracranial findings on brain scan, dementia, diagnosed case of depression, significant sensory impairment and noncooperation with tests on cognition.

Demographic, educational level, clinical and neuropsychological data were obtained using a pre-set questionnaire/data collection sheet. The study group were compared with the control group for sound study design and validation of the outcome of the study. The control group was compose of 30 healthy participants recruited from our hospital (doctors, nurses, paramedics and ancillary staff) whose education level were obviously high (≥12th grade pass). The control group was matched for age, sex and education level with the

study group. They were aged 18-60 years-old, who agreed to participate by providing written informed consent and had no history of head trauma or neurosurgery, depression, neurological disorders and significant sensory impairment. Specifically, neuropsychological tests were performed by the same clinical psychologist (initial PS) who was blinded to whether the subjects belonged to study or control group. To make the study robust, all the eligible patients were humbly requested to participate in this novel study, rather than screening on patients who had regular visits due to persistent post-concussion symptoms.

Clinical Evaluation

Apart from socio-demographic and medical questionnaire, following tests were performed at all the required time interval for the study group.

1) Rivermead Post-Concussion Symptoms Questionnaire (RPQ) to register symptomatology pertaining to TBI. [18]
2) Rivermead Head Injury Follow-up Questionnaire (RHFUQ) to evaluate the prevalence of disability during follow up.[19]
3) LiSat-11 questionnaires which has eleven elements to judge life satisfaction post head injury. [11]

Neuropsychological Testing

4) Mini Mental-State Examination-MMSE to evaluate global cognition. [20,21]
5) Frontal Assessment Battery-FAB to assess frontal lobe functions mediating executive functioning. [22,23]
6) Digital Span Subtest from the Wechsler WAIS-III which evaluates ability to perform repetitive tasks, constituted by two tasks-digit span forward and backward-which evaluate attention and environmental autonomy. [24]

Statistical Analysis

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 22.0 (SPSS INc., Chicago, IL, USA). For a clinical evaluation, raw scores for each test was transformed to standardized score according to the test manuals, and, when possible, with respect to sex and age. We have chosen -2 Standard Deviation (SD) as a cut-off level score for lowered test performance, which is considered significant deviation from the test's normative data in clinical practice. As the majority of the investigated variables were not normally distributed, evaluation was performed with non-parametric tests both for independent (Mann- Whitney test) or related (Wilcoxon Signed-rank test) samples of variables and Spearman's correlation coefficients were calculated for the analysis of bivariate correlations. Categorical variables were compared using the Pearson Chi-Square test. For the study of the complex relationship between a dependent variable and independent variables, binary logistic regression analysis was used. The statistical significance level was set at 0.05.

A study subject with even one symptom attributable to head trauma 3 months post-injury was considered to have persistent post-concussion syndrome. A mild TBI patient with even a single occurrence of disability on RHFUQ questionnaire was considered to have disability on any of the subsequent follow-up visit after hospital discharge from acute mild TBI.

Results

The final sample size for the study group (mTBI patients) was 75 and 30 for the control group (healthy control patients). Comparison was made between study group and control group on RFQ, RHFUQ, and cognition and life satisfaction/quality of life.

Sex	Number (n)	Percentage (%)
Male	45	60
Female	30	40
Education Level (in years)		
12th grade pass (=12 years)	30	40
12th pass to graduate (12-16 years)	30	40
Post graduate and above (19-22 years)	15	20

Hospital stay during acute mTBI		
Total hospital stay (in days), mean (SD)	1-4, 2.2 (1.8)	
Median	1.5	
Score at GCS		
GCS 13	5	7
GCS 14	15	20
GCS 15	55	73
Cause of TBI		
Motor vehicle accidents	40	53
Physical Assault	20	27
Fall (from variable height)	11	15
Fall (from same height)	3	4
Others	1	1
Loss of Consciousness (LOC)		
Yes	40	53
No	30	40
Unknown	5	7
Post traumatic amnesia (PTA)		
Yes	50	67
No	25	33

Table 1: *Sociodemographic and clinical features of patients with acute mild traumatic brain injury (n=75)*

Sociodemographic and clinical data (Table 1): In study group, 60% (n=45) were male, 40% (n=30) were female. All the study group patients were at least 12th grade pass. Educational level: 12th grade pass only, 12th grade to graduate and postgraduate and above were 40 %, 40% and 20% respectively. The percentage of patients with GCS 15, 14 and 13 are 73%, 20% and 7% respectively. The most common cause of TBI was motor vehicle accidents, physical assault and fall; the percentage are 53%, 27% and 19% respectively. LOC was present in 53%, absent in 40% and undetermined in 7%. 67% had PTA and 33% did not have it.

Symptoms	mTBI patients at hospital discharge* (%)	F/U visit at 3 months (%)	F/U visit at 6 months (%)	F/U visit at 12 months (%)	Healthy Control Group
Headache	35 (46%)	20 (26%)	18 (24%)	16 (21%)	2 (6%)
Dizziness	20 (27%)	12 (16%)	11 (14%)	10 (13%)	2 (6%)
Fatigue	15 (20%)	10 (13%)	8 (11%)	8 (11%)	2 (6%)
Nausea/Vomiting	14 (19%)	8 (11%)	7 (9%)	6 (8%)	0 (0%)
Irritability	12 (16%)	7 (9%)	6 (8%)	6 (8%)	1(3%)
Poor memory	12 (16%)	10 (13%)	9 (12%)	9 (12%)	3 (10%)
Sleep disturbance	10 (13%)	8 (11%)	8 (11%)	8 (11%)	4 (13%)
Blurred vision	10 (13%)	6 (8%)	5 (7%)	5 (7%)	0 (0%)
Poor concentration	9 (12%)	5 (7%)	5 (7%)	5 (7%)	3 (10%)
Feeling depressed	8 (11%)	7 (9%)	6 (8%)	6 (8%)	0 (0%)

Feeling frustrated	7 (9%)	6 (6%)	5 (7%)	4 (5%)	2 (6%)
Taking longer to think	7 (9%)	5 (7%)	5 (7%)	5 (7%)	0 (0%)
Noise sensitivity	4 (5%)	2 (2%)	2 (2%)	2 (2%)	1 (3%)
Sensitivity to light	3 (4%)	1 (1%)	1 (1%)	1 (1%)	0 (0%)
Double vision	3 (4%)	1(1%)	1(1%)	1 (1%)	0 (0%)
Restlessness	3 (4%)	1(1%)	1 (1%)	1 (1%)	1 (1%)
Number of Symptoms, mean (SD)	8.5 (4.3)	5.5 (2.8)	5.0 (2.2)	4.8 (1.8)	1.3 (1.5)
Frequency of patients with PPCS (n, %) @	NA	20 (26%)	18 (24%)	16 (21%)	NA

Table 2: *Frequency of occurrence of post-concussion symptoms at hospital discharge and subsequent follow-up# for study group (n=75) Versus Control group (n=30). Rivermead Post-Concussion Symptoms Questionnaire (RPQ).*

Only mild TBI patients who had all the three follow-up visits (3, 6 and 12 months after hospital discharge after head trauma) were included in the study. Total patients (n=75)

*Acute mild traumatic brain injury patients were evaluated for their symptomatology at the time of hospital discharge following regain of full consciousness (GCS=15).

@ PPCS (n, %) meant Persistent Post-Concussion Syndrome (number, percentage)

NA- Not applicable

Incidence of persistent PCS (Table 2): Post-concussion symptoms were evaluated at the time of hospital during discharge during acute mild TBI and then at subsequent follow-up (F/U) visits (3, 6 and 12 months). During F/U visits at 3, 6 and 12 months, the incidence of persistence PCS and average number of symptoms was 26%, 24% and 21%, and 5.5, 5.0 and 4.8 respectively. The average number of symptoms during acute mTBI was 8.5 (SD of 4.3). There was statistically significant difference between the number of symptoms at 1 year F/U visit for study group 4.8 (SD 1.8) and the healthy control group 1.3 (SD 1.5), (p-value = 0.03). P-value was <0.05 when each subsequent F/U visit average number of symptoms were compared with control group, not just at 1 year. In the study group, the most common symptoms were: headache (46%), dizziness (27%), fatigue (20%) and nausea/vomiting (19%). In contrast, sleep disturbance (13%), poor memory and poor concentration (10% each) were most frequent symptoms reported by the control group.

Frequency of occurrence of disabilities at follow-up	**F/U* at 3 months (n,%)**	**F/U at 6 moths (n,%)**	**F/U at 1 year (n,%)**	**Healthy control (n,%)**
Ability to participate in conversation with one person	12 (16%)	11 (14%)	10 (13%)	1 (3%)
Ability to participate in conversation with 2 or more persons	15 (20%)	13 (17%)	12 (16%)	2 (6%)
Performance of routine domestic activities	13 (17%)	11 (14%)	10 (13%)	3 (10%)
Ability to participate in previous social activities	15 (20%)	13 (17%)	11 (14%)	3 (10%)
Ability to enjoy previous leisure activities	22 (29%)	20 (26%)	18 (24%)	4 (13%)
Ability to maintain previous standard of workload	23 (30%)	20 (26%)	18 (24%)	4 (13%)
Finding work more tiring	25 (33%)	22 (29%)	20 (26%)	7 (23%)
Relationship with previous friends	14 (18%)	12 (16%)	10 (13%)	3 (10%)
Relationship with partner	13 (17%)	11 (14%)	10 (13%)	3 (10%)
Ability to cope with family demands	14 (18%)	12 (16%)	10 (13%)	4 (13%)
Number of disability items, mean (SD)	6.4 (2.8)	5.8 (3.1)	5.4 (2.8)	1.1(2.2)
Total score of RHFUQ, mean (SD)	16.6 (11.4)	14.5 (10.2)	13.0 (8.8)	3.2 (2.3)

P- value when healthy control group compared to study group during each follow-up for number of disability items	*P*<0.001	*P*<0.001	*P*<0.001	
P- value when healthy control group compared to study group during each follow-up for total RHFUQ score	*P*<0.001	*P*<0.001	*P*<0.001	

*F/U denotes follow-up of mild TBI patients after hospital discharge. (n, %) means (number, percentage)

Table 3: *Rivermead Head Injury Follow-Up Questionnaire (RHFUQ) at 1 year follow-up for mild TBI patients (n=75) compared with healthy controls (n=30)*

Disability (Table 3): At least 1 disability item on the RHFUQ was reported by 76% (n=57) in the study group as compared to 30% (n=9) in the control group. The total RHFUQ score at each F/U visit after post-injury (3, 6 and 12 months) (maximum disability score=40) was 16.6 (SD 11.4), 14.5 (SD 10.2) and 13.0 (SD 8.8) was statistically significant (*p*-value<0.001) compared to the control group 3.2 (SD 2.3). The same picture emerged when the number of disability items in the study group at each subsequent F/U visit [3, 6 and 12 months- 6.4 (SD 2.8), 5.8 (SD 3.1) and 5.4 (SD 2.8)] were compared with the healthy control group 1.1 (SD 2.2) with p-value <0.001.

At 1 year F/U visit post head trauma, the most common disabilities in the study group were "finding work more tiring" (29%), "ability to maintain previous standard of workload" (26%) and "ability to enjoy previous leisure activities" (26%). The same disability items mentioned under study group was found to be the most frequent complains in the control group, albeit the frequency with which it occurred was significantly low.

	Study group (n=75)	**Control group (n=30)**	**Control group vs Study group**
Items of LiSat-11	Mean (SD)	Mean (SD)	*p*-value
Life as a whole	3.2 (1.4)	4.8 (0.7)	0.040
Vocation	3.0 (1.3)	5.0 (0.8)	0.001
Economy	3.3 (1.2)	4.4 (0.6)	0.223
Leisure	3.0 (1.2)	5.1 (0.6)	0.010
Contacts	3.7 (1.6)	5.2 (0.7)	0.072
Sexual Life	3.5 (1.4)	4.8 (0.8)	0.112
Activities of Daily Living (ADL)	5.0 (0.8)	6.0 (0.8)	0.210
Family life	4.2 (1.3)	5.4 (0.6)	0.005
Partner	4.2 (1.1)	5.2 (0.6)	0.112
Somatic health	4.0 (1.2)	5.3 (0.7)	0.004
Psychological health	3.7 (1.4)	5.5 (0.9)	0.005
Total LiSat-11 score, (SD)	40.8 (9.5)	56.7 (11.5)	*P*=0.01

Table 4: *Comparison of ratings of life satisfaction (items of LiSat-11) between study group (mild TBI patients) at 1 year follow-up on the one hand and the healthy control group on the other hand.*

Life Satisfaction (Table 4): The level of life satisfaction or quality of life was overall lower in the study group compared with the control group. The patients with mTBI at 1 year follow-up visit post-injury exhibited statistically significant (*p*=0.01) lower total scores of LiSat-11 (40.8, SD 9.5); (maximum possible score=66) compared with the control group (56.7, SD 11.5). In fact, many individual items in LiSat-11 score were found to be statistically significant (p<0.05) when study group was compared with the control group (life as a whole, vocation, leisure, family life, somatic health and psychological health).

Variables	Study group- Median (percentile 25-75)	Control group- Median (percentile 25-75)	Mann-Whitney Test
Number	75	30	-
MMSE	24 (22-27)	28 (27-29)	*P*<0.001
FAB	11 (10-14)	15 (12-16)	*P*=0.032
VMT-Naming	10 (10-10)	10 (10-10)	*P*=0.070
VMT-incidental memory	6(5-7)	8(6-8.8)	*P*=0.001
VMT-immediate memory	8(7-9)	9 (8-9)	*P*=0.002
VMT-learning	8(7-9)	10 (9-10)	*P*<0.001
VMT-delayed recall	7 (6-9)	9(8-10)	*P*<0.001
VMT- recognition	10 (10-10)	10 (10-10)	*P*=0.120
Digital span forward	5 (4-5)	5 (4-6)	*P*=0.82
Digital span backward	3(2-4)	3 (3-4)	*P*=0.10

TBI-traumatic brain injury, MMSE-mini mental status examination, FAB-frontal assessment battery, VMT-Visual memory test

Table 5: *Cognitive performance comparison between study group (mild TBI patients) and the healthy control group at 1 year follow-up visit.*

Neuropsychological assessment (Table 5): Regarding cognitive performance at 1 year post-injury, mTBI patients presented with following means and standard deviations: MMSE (23.2, SD 3.7), FAB (12.0, SD 2.9), Visual Memory Test naming (9.6, SD 0.6), VMT incidental memory (5.5, SD 1.1), VMT immediate recall/memory (7.5, SD 1.6), VMT learning (8.0, SD 1.3), VMT delayed recall (7.2, SD 1.5), VMT recognition (9.7, SD 0.5), Digital Span Forward (4.8, SD 1.1) and Digit Span Backward (3.1, SD 1.4). Patients had significantly differed (p-value<0.05) from the healthy controls on MMSE, FAB, VMT-incidental memory, VMT-immediate memory, VMT-learning and VMT-delayed recall. No statistically significant difference between subject group and control group on VMT recognition, Digit Span Forward and Digit Span backward scores.

When compared to normative data, 27% of patients showed deficit at MMSE and 11% at the FAB. In the Visual Memory Test, 18% exhibited deficit on naming, 4.5% on VMT incidental memory, 17% on VMT immediate recall, 20% on VMT learning, 14% on VMT delayed recall, and 8.2% on VMT recognition. There was no patients with deficits at the Digit Span Test. Control had no significant difference from mTBI patients on age (p=0.082), sex (p=0.34), years of education (p=0.13) and presence or absence of LOC (p=0.10).

Noteworthy, all the patients in our study group had education of at least 12th grade school pass and patients with first time concussed patients were only included in the study. We enrolled all mTBI patients who were eligible, rather than just providing care to patients who continued to seek medical help due to persistence of post-concussion symptoms. No patient or healthy control was found to be depressed as per the Montgomery-Asberg Depression Rating scale which were filled by all subjects. [25]

Discussion

Mild Traumatic brain injury (MTBI), also referred as concussion is the most common neurological disease. Prevailing understanding in the medical community is that mTBI is truly mild, and there is really no "consequential trauma to the brain". However, with time, it is gaining traction as a "silent epidemic" with chronic sequels. A widely cited figure in the literature suggests that only 15% of first-time concussed individuals will go on to experience persistent PCS and associated long-term cognitive dysfunction. [6-8] There is a shift in the paradigm among researchers who have shown that both single and multiple mTBI(s) induce pathophysiological changes in the brain that can be detected in both acute and chronic phase post-injury. This includes damage to the white matter fibers in the brain along with aberration in neurometabolic cascade, [26,27] which reflects in the form of measurable long term cognitive impairment.

McInnes *et al*. in his scoping review of 45 articles which included prospective analysis of patients with mTBI and chronic cognitive

impairment at various time intervals revealed approximately 50% of the first time concussed individuals will demonstrate long-term cognitive function. [9] A seminal paper by Stalnacke *et al*. with 1 year follow-up of mTBI patients showed high frequency of disabilities, high incidence of persistent PCS and lower cognitive functioning, together with lower level of life satisfaction appear to characterize patients choosing consultation compared to the ones not seeking it. [10] The limitation of this study is that its primary goal was to compare consultation seeking concussed patients having persistent PCS (consultation group) with the patients not seeking it (non-consultation group). Our study provided a blanket coverage of all single mTBI patients without segregating them based on whether they sought repeated doctor consultation for persistent symptoms post-injury. Not to mention, we had serial follow-up visits (3, 6 and 12 months post-injury) for first time concussed patients as compared to single point follow-up visit by Stalnacke *et al*. at 1 year post-injury.

In light of the discrepancy between these longer-term mTBI-related symptoms, particularly impaired cognitive function probably due to accumulating evidence of longer-term pathophysiological changes in the brain from head trauma, it has become imperative to conduct a befitting research to probe it further. We performed a robust and comprehensive prospective follow-up study in patients with first time concussed patients (i.e. mTBI patients) at various time intervals. The study final sample size included 75 mTBI patients (study group) who were found eligible after rigid inclusion and exclusion criteria, with a comparison group comprising of healthy controls subjects (n=30). We included mTBI patients with first time head injury with no known neurological or psychiatric disorder, higher education level, who had all the subsequent follow-up visits (3,6 and 12 months) after acute mild TBI. We performed a blanket coverage of all eligible mTBI patients through humble request in the name of science rather than focus on patients with persistent symptoms post-injury who are more willing to seek repeated consultation. Higher frequency of patients who seek consultation due to persistent PCS, compared with patient who may not seek consultation following discharge after acute mTBI will lead to overestimation of long-term effects of concussion. This was eliminated in our study by providing blanket coverage to all participating patients with mTBI who were eligible, irrespective of presence or absence of long term sequel of head injury.

The healthy control group was matched with study group for age, sex and educational level, to avoid any of these factors being a confounding variable. The comprehensive review in our study included incidence of persistent PCS at various time intervals (using RPQ), disability (using RHFUQ), and life satisfaction (using LiSat-110 and cognitive impairment (MMSE, FAB and Digit Span Subtest from the Wechsler WAIS-III). The neuropsychological evaluation was performed by the same registered clinical psychologist in the study (initial PS) to maintain homogeneity in evaluation of all the subjects. Our results indicate that, in contrast to the prevailing view that most symptoms of concussion are resolved within 3 months post-injury, significant number of patients had array of clinical and neuropsychological impairment, apart from long term disability and decline in quality of life.

Our study showed male predominance (60%) and more than half of the patients had GCS of 15, LOC and PTA. The median duration of stay following acute mTBI was 1.5 days. The most common cause of head trauma was road traffic accident. At 1 year follow-up visit, 21% had persistent PCS with statistically significant difference in average number of symptoms (4.8, SD 1.8) compared to the healthy control group (1.3, SD 1.5), (p-value = 0.03). Headache, dizziness and fatigue were most common symptoms post-injury in the study group in contrast to sleep disturbance, poor memory and concentration in the control group at 1 year post-trauma. Overwhelming number of patients (76%) had disability (using RHFUQ scoring system) after mTBI at 1 year follow-up visit. The most frequently affected facet of life was "finding work more tiring", "inability to maintain previous standard of workload" and "inability to enjoy previous leisure activities". There was statistically significant difference in total RHFUQ score and number of disability items when study group (mTBI patients) were compared with healthy control group at 1 year follow-up visit. This indicates disability in patients following mTBI in long term is a reality and the incidence of patients affected with it is quite high.

The level of life satisfaction or quality of life was overall lower in the study group compared with the control group. The patients with mTBI at 1 year follow-up visit post-injury exhibited statistically significant (p=0.01) lower total scores of LiSat-11 (40.8, SD 9.5) compared with the control group (56.7, SD 11.5). Patient's vocation, leisure activities, family life as a whole and (somatic and psychological) heath were affected. Neuropsychological test clearly revealed that cognitive impairment at each subsequent follow-up visit including 1 year follow-up visit post-injury was significantly affected for first time concussed patients as compared to the healthy

controls (reaching statistical significance when study group was compared to control group). Cognitive tests like MMSE, FAB and various types of VMT exhibited startling decline in cognitive function in mTBI patients even at 1 year post-injury compared to healthy control subjects. It is important to emphasize that the incidence of persistent PCS and prevalence of disability had modest improvement during subsequent follow-up visits (3, 6 and 12 months post-injury) but not marked considerable difference suggesting limited neuroplasticity and regenerative capacity of the brain.

It will not be farfetched to comment that mTBI once thought to be relatively inconsequential "mild" injury, is now being ironically resonating with its latter there words of its acronym- "traumatic brain injury". An evolving concept, which is debatable is whether neurological damage (pathophysiological changes to the brain) is the main cause of persisting late symptoms, cognitive impairment and disability after mild head injury. Notwithstanding our research, accumulating literature suggests that longer term symptomatology and cognitive impairment should be sought after seemingly inconsequential mild traumatic brain injury. Due to logistic and financial constraint on patient's part, we could not perform brain imaging like MRI brain with Diffusion Tensor Imaging (DTI) to look for white matter fiber disruption. We did not have resource to evaluate the levels of biochemical markers of brain damage like S-100B and Neuron Specific Enolase (NSE).

Conclusion

Our study highlights the longer-term implications of mTBI, or concussion including high frequency of persistent PCS and disability, confounded by decline in quality of life. The presence of worrisome cognitive decline in so called mild traumatic brain injury patients reflects underlying pathophysiological changes to the brain post-injury. These findings highlights the need to carefully examine the patients with first time concussed patients for long-term consequences of a single mild traumatic brain injury.

Acknowledgment

We owe an unpayable debt and gratitude from the bottom of our heart to clinical psychologist Ms. Pujan Sharma who was instrumental in carrying out neuropsychological testing in this study.

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