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Evaluation of extent and pattern of neurocognitive functions in mild and moderate traumatic brain injury patients by using Montreal Cognitive Assessment (MoCA) score as a screening tool: An observational study from India

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ABSTRACT

Introduction: Cognitive impairment is one of the most important culprit influencing the long-term neurological outcome commonlyobserved in TBI survivors.

Aims: To examine the performance of patients with Mild and Moderate traumatic brain injury (TBI) on the Montreal Cognitive Assessment (MoCA) using as a screening tool.

Results: Total 228 (127 Mild TBI & 101 Moderate TBI) patients were recruited in this study. Results showed that patients with moderate TBI had lower score on the MoCA as compared to patients with mild TBI (p Value = 0.031). This difference was observed statistically significant among mild and moderate TBI for the cube copy (p = 0.039) and clock (p = 0.017) i.e. visuospatial/executive function, Digit span test (p value = 0.040) i.e. concentration and recall memory (p = 0.04). MoCA Score were higher for patients with higher GCS score at admission. Education status was also correlated with MoCA scores; those patients with higher level of education had significant association with higher MoCA scores (p value = 0.012). This study showed that age and gender were insignificant variables to determine cognitive function.

Conclusion: Assessment of cognitive impairment should be considered as a mandatory protocol while evaluating post TBI patients, even in cases of mild TBI. Visuospatial/Executive function, memory and attention are the most commonly impaired cognitive functions in patients of TBI, and these are the main domain of cognition which differentiates mild impairment from moderate impairment. This information enables us and provides insight to our experience to predict the burdens of problem and plan to develop post TBI dedicated rehabilitating programme.

1. Background

Traumatic brain injury is a major public health issue because; it is one of the largest causes of brain damage, resulting in high rate of morbidity and mortality worldwide and is estimated to surpass many diseases as a major cause of death and disability by 2020 (Hyder et al., 2007; Lopez and Murray, 1998). More than 90% of the Traumatic Brain Injury (TBI) burden is shared by low- and middle-income developing countries like India, especially in the younger and more productive age groups with grave financial & cognitive implications (Hofman et al., 2005). The high incidence of traumatic brain injury (TBI) in India is a result of rapid development in transportation, fast growing construction industry and urbanizations over the past decades (Puvanachandra and Hyder, 2009).

Cognitive impairment is one of the most important culprit influencing the long-term neurological outcome commonly observed in TBI survivors (Brown et al., 2004). Cognitive deficits caused by TBI directly interfere with work, activities of daily living, relationships, social image, and impose an economic burden on society and Nation. Impact on cognition due to TBI have received a great attention worldwide in past two decades and had been an interesting topic for researcher, many excellent reviews are available (Erlanger et al., 1999; Ewing-Cobbs and BarneS, 2002; Dikmen et al., 2009; Cicerone, 2011; Barman et al., 2016). Cognitive deficits reported in literature after moderate to severe TBI include memory, executive functions, attention concentration and information processing speed impairment (Goleburn and Golden, 2001; Maroon et al., 2000; Lezak et al., 2012). However, TBI rehabilitation has tremendous advancement in last one decade for acute head trauma

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all over world and contrary to this in India we are still at an early developmental stage and there is no specific rehabilitation system for the post-TBI cognitive impairment. Most patients with TBI still receive the either a traditional cognitive evaluation protocol or not at all. India being an overburden nation, mild and moderate TBI patients is largely neglected and under treated population. Therefore, it is strongly necessary to establish the evaluation tool along with establishment of rehabilitation system dedicated to post-TBI cognitive impairment. So we conducted this study with intent to investigate the profiles of cognitive impairment in mild and moderate traumatic brain injury (TBI) patients through Montreal Cognitive Assessment (MoCA). Our study may provide some insight to our experience in selecting a suitable tool for evaluating post-TBI cognitive impairment.

2. Materials and methods

2.1. Study design

This is a hospital based cross sectional observational study of mild and moderate TBI patients who were admitted in department of Neurosurgery, at a tertiary care centre in India from August 2016 to Feb 2018. The institutional ethical committee clearance was taken before commencement of this study. Official approval of MoCA version 7.01 (Hindi) for research purpose was also taken from its copyrighter in the beginning of study.

2.2. Participants

Patients admitted to our center for Mild& Moderate traumatic brain injury of age group from 15 to 65 years were enrolled. Clinical criteria as per Glasgow Coma Scale (GCS) at the time of admission was taken to classified mild and moderate Traumatic brain injury (TBI). Patients with initial GCS score range from 9 to 12 defined as moderate TBI and GCS score between 13–15 were classified as mild TBI. Verbal and informed consent was taken from either patient or his/her close relative because they were only subjected to MoCA test without any intervention. All patient were later followed in outdoor patient department (OPD) on subsequent visits once they recovered from acute phase of trauma and discharged successfully from the trauma centre.

Patients with major psychiatric or neurological disorders, previously diagnosed case of substance abuse, clinical evident of mental retardation, previous history of Alzheimer disease, Parkinson disease, degenerative diseases of nervous system or incapability of completing cognitive test for any cause, such as motor dysfunction of dominant hand and language disorders were excluded.

The baseline demographic profile, mode of injury, education level, clinical status (Glasgow Coma Scale [GCS]), radiological findings (intracranial pathology and midline shift as assessed on a head computed tomography (CT)), operative decision were recorded in details in a pre-prepared performa.

2.3. Evaluation method

All patients were evaluated while awake, co-operative and in comfortable state in a chamber accompanied with one family member by us using MoCA (Hindi version 7.01) during follow up visits in OPD. A cutoff score of < 26 on the MoCA was taken to indicate cognitive impairment (an additional point being added to the total score for patients with less than 12 years of education), according to the recommendation from published references.

2.4. Montreal Cognitive Assessment (MoCA)

The MoCA is a cognitive screening test, initially developed for mild cognitive impairment in degenerative central nervous system diseases (Nasreddine et al., 2005). Since the invention of the test multiple versions has been developed in different languages worldwide (Rahman and El Gaafary, 2009; Wong et al., 2009; Fujiwara et al., 2010; Thissen et al., 2010; Tsai et al., 2012). Validity of MoCA has been established in many pathologies (Nasreddine et al., 2016; Krishnan et al., 2015) and now a day's has become one of the most common choice for quick cognitive function evaluation. This is single page test, administered in about 10 min and is scored on a maximum of 30 points. The MoCA contain 12 subsets that tap on 7 cognitive functions (Table 1) as visuospatial/executive function (Trail making test -1, Cube copy-1, Clock drawing -3), Attention and concentration (Digit span test-2. serial substraction-3, Tapping-1) Language(naming-3, repetition-2, Fluency-1) Memory (delayed recall-5), Abstraction- 2, orientation- 6.

Table 1
Cognitive Functions, MoCA items and allocated maximum score for each function and items.

Cognitive Function	MoCA items/Domain	Score
1.)Visuospatial/executive function	Trail making test	1
	Cube copy	1
	Clock drawing	3
2 &3.) Attention and concentration	Digit span test	2
	Serial subtraction	3
	Tapping	1
4.) Language	Naming	3
	Repetition	2
	Fluency	1
5.) Memory	Delayed Recall task	5
6.)Abstraction	Abstraction	2
7.)Orientation	Orientation	6

3. Results & statistical analyses

Statistical analyses were done using computer software (SPSS trial version 23 and primer). The qualitative data were expressed in proportion and percentages and the quantitative data were expressed as mean and standard deviations. The difference in proportion was analyzed by using chi square test and the difference in means were analyzed by using student *t*-test or one way ANOVA. Correlation analyses were performed using Pearson correlation coefficient (r = at least 0.8 very strong, 0.6 up to 0.08 moderately strong, 0.3 to 0.5 good and < 0.3 is poor). Significance level for tests were determined as 95% ($p < 0.05$).

A total of 228 patients (127 Mild TBI & 101 Moderate TBI) were recruited in our study. Their baseline data with statistical comparison between Mild and Moderate is shown in Table 2. No significant difference was observed in sex distribution, age at presentation and educational status, between two groups ($p > 0.05$), although majority of patients were less than 40 years in both group (Mild vs. Moderate: 71.65% vs. 75.25%). More males were present in both groups (Mild vs. Moderate: 79.53 vs. 80.20%). More bilateral and diffuse lesions on brain imaging were observed in patients with moderate group ($p < 0.01$), while unilateral lesions particularly in right frontal location more frequently found in patients with mild TBI group ($p < 0.01$). There was no statistical significant difference found between two groups for lesion on imaging in temporal, parietal, capsuloganglionic and multiple lesions. Most common mode of injury in this study was found Road traffic Accident among both groups (Mild vs. Moderate: 74.02% vs. 81.19%), followed by fall from height (Mild vs. Moderate: 17.32% vs.13.86%). Education less than 12 years was observed most frequent education level in our study (Mild vs. Moderate: 40.16% vs. 50.5%).

Mean MoCA score obtained in our sample were 20.26 ± 4.87 for Mild TBI and 18.92 ± 4.2 for Moderate TBI (Table 3). Detailed statistics using student *t*-test for different subsets score of MoCA between two groups is shown in Table 3. Each subsets score mean with standard

Table 2
Comparisons of base line and demographic data between Mild and Moderate TBI group.

Variables	Mild (N = 127)	Moderate (N = 101)	Total (n = 228)	P Value
Age (years)				
> 40	36 (28.35%)	25 (24.75%)	61(26.87%)	0.53NS
≤40	91 (71.65%)	76 (75.25%)	167 (73.57%)	
Sex (Gender)				
F	26(20.47%)	20 (19.80%)		0.98NS
M	101 (79.53%)	81 (80.20%)	181 (79.74%)	
Mode of TBI				
Assault	11 (8.66%)	5 (4.95%)	16 (7.05%)	0.35NS
FFH	22 (17.32)	14 (13.86%)	36 (15.86%)	0.74NS
RTA (+)	94(74.02%)	82 (81.19%)	176 (77.13%)	0.15NS
Occupation				
Professionals	17 (13.39%)	17 (16.87%)	34(14.97%)	0.69NS
Self employed	30 (23.62%	29 (28.71%)	59(25.99%)	0.52NS
Student	36 (28.35%	22 (21.78%)	58 (25.43%)	0.45NS
Un Skilled	13 (10.24%)	13 (12.87%)	26(11.45%)	0.65NS
Unemployed	31 (24.41%)	20 (19.80%)	51(22.47%)	0.53NS
Educational status				
Graduate	34(26.77%)	24 (23.76%)	58(25.43%)	0.27NS
Up to 12 th	51 (40.16%)	51 (50.50%)	102(44.73 %)	
Up to 8th	42 (33.07%	26 (25.74%)	68(29.82%)	
Laterality of lesions				
B/L	25 (19.69%)	42 (41.58%)	67(29.52%)	< 0.01S
LT	44 (34.65%)	30 (29.70%)	74(44.93%)	0.52 NS
RT	58 (45.67%	29 (28.71%)	86(37.89%)	0.013S
Affected area				
Capsulo.	2(1.57%)	1 (0.99%)	3(1.31%)	0.84NS
Cerebelum	4 (3.15%)	0 (0.00%)	4(1.75)%	0.19NS
Diffuse	2 (1.57%)	23 (22.77%)	25(10.96)%	< 0.01S
FP	2 (3.15%)	3 (2.97%)	5(2.19)%	0.75NS
Frontal	31 (24.41%)	13 (12.87%)	44(19.29%)	0.043S
FT	9 (7.09%)	4 (3.96%)	13(5.70)%	0.47NS
FTP	8 (6.30%)	4 (3.96%)	12(5.26%)	0.62NS
Occipital	6 (4.72%)	0 (0.00%)	6(2.61%)	0.07NS
Parietal	11 (8.66%)	4 (3.96%)	15(6.57%)	0.25NS
Temporal	8 (6.30%)	13 (12.87%)	21(9.21%)	0.45NS
TP	16 (12.60%)	19 (18.81%)	35(15.35%)	0.27NS
More than two lesion	26 (20.47%)	20 (19.80%)	46(20.17%)	0.88NS

deviation were calculated, and then these values subjected to a comparison. Mean scores performed by Moderate TBI group were low in all MoCA subsets as compared to Mild TBI. A significant difference ($p < 0.05$) was observed among mild and moderate TBI for the cube copy ($p = 0.039$) and clock ($p = 0.017$) i.e. visuospatial/executive function, Digit span test (p value = 0.040) and recall memory ($p = 0.04$). There was also statistically significant difference for total MoCA score with both type of TBI patients ($p = 0.031$). The mean score for trail test in both group of TBI was less (mild vs. moderate: 0.25 ± .44 vs 0.23 ± .42) but difference was also not significant. It was observed that patients of both groups performed significantly low in trail test.

MoCA score ranges from 12 to 30 in our study. For better understanding, clarity and significance patients were divided into four category based on total MoCA score as MoCA- G_1 (score > 26), MoCA- G_2(score18-25), MoCA -G_3 (score 9–17) and MoCA-G_4(score < 8). Total n = 37 patients fall in MoCA-G_1, while n = 90 and n = 101 fall in MoCA- G_2 and MoCA -G_3 respectively. No patient came under fourth category i.e. MoCA-G_4. Using one way ANOVA tukey HSD test and Pearson correlation coefficient, correlation between all three groups were calculated among different MoCA subset. Between MoCA-G_1 & MoCA -G_3 all subsets score had significant difference ($p < 0.001$), i.e. patients belong to MoCA -G_3 had poor performances. On the other hand comparisons among MoCA-G_1 & MoCA- G_2 showed that patients of MoCA- G_2 also perform statistically proven low scores in majority of subset. However, Digit span test (p value = 0.432), Serial subtraction (p value = 0.623) and orientation (p value = 0.17) were statistically insignificant between MoCA-G_1 & MoCA- G_2 (Table 4). Results indicates that patients belong to MoCA- G_2 were equally oriented and attentive as of patients of MoCA-G_1. Majority of subsets score between MoCA- G_2 & MoCA -G_3 were statistically significant except repetition (p value = 0.25).

Chi square test considering neurological status (GCS), age, education, gender and employment status was used to attempt to determine what variables could predict cognitive function. For GCS, Chi-square = 8.473 with 2 degrees of freedom; p value = 0.014 significant ($p < 0.05$), which showed that patients whose score belongs to MoCA –G_1 & MoCA –G_2 category were statistically significantly fall under mild TBI as compared to MoCA-G_3, which were more frequently observed in moderate group. (i.e. MoCA Score were higher for patients with higher GCS score at admission). Our studied showed that age and gender were insignificant variables to determine cognitive function (Table 5). Education was also correlated with MoCA scores; those patients with higher level of education had significant association with higher MOCA scores (p value = 0.012).

Table 6 shows the association between severity of TBI and degree of cognitive impairment based on obtained total MoCA scores. In Mild TBI majority of patients (43.30%) were in MoCA-G2, as compared to MoCA-G3 & MoCA-G1 (36.22% and 20.47% respectively). On applying one way ANOVA test for multiple comparisons MoCA-G2 (Fujiwara et al., 2010; Thissen et al., 2010; Tsai et al., 2012; Nasreddine et al., 2016; Krishnan et al., 2015; Dikmen et al., 1986; Heitger et al., 2006; Blankenship, 1988; Ponsford et al., 2000) with in mild TBI were

Table 3
Mean and standard deviation of different MoCA domain performance of patients of Mild and Moderate TBI with concerning cognitive functions.

Cognitive Function	MoCA DOMAIN	Mild (n = 127) Mean ± SD	Moderate (n = 101) Mean ± SD	Total (n = 228) Mean ± SD	p value
1. Visuospatial/executive function	Trail test	0.25 ± .44	0.21 ± .41	0.23 ± .42	0.436
	Cube copy	0.44 ± .50	0.31 ± .46	0.38 ± .49	0.039
	Clock drawing	1.66 ± 1.10	1.32 ± 1.05	1.51 ± 1.09	0.017
2 & 3. Attention and concentration	Serial subtraction	2.60 ± .63	2.51 ± .61	2.56 ± .62	0.315
	Digit Span	1.72 ± .45	1.58 ± .52	1.66 ± .48	0.040
	Tapping	0.56 ± .50	0.60 ± .49	0.58 ± .49	0.497
4. Language	Naming	2.33 ± .49	2.29 ± .52	2.31 ± .50	0.515
	Repetition	0.89 ± .70	0.76 ± .69	0.83 ± .70	0.174
	Fluency	0.28 ± .45	0.37 ± .48	0.32 ± .47	0.184
5. Abstraction	Abstraction	0.57 ± .64	0.50 ± .59	0.54 ± .62	0.384
6. memory	Recall	3.02 ± 1.01	2.63 ± .95	2.85 ± 1.00	0.004
7. Orientation	Orientation	5.46 ± .72	5.34 ± .72	5.40 ± .72	0.214
Total Score		20.26 ± 4.87	18.92 ± 4.28	19.67 ± 4.66	0.031

Table 4
Mean and standard deviation of different MoCA domain performance of patients classified on the basis of total (Global) MoCA Score.

MOCA domain	MG1 (> 26) (N = 37) (Mean ± SD)	Group 2 (18–25) N = 90 (Mean ± SD)	Group 3 (8–17) N = 101 (Mean ± SD)	CO-relation b/w Gp 1 & 2 t value	CO-relation b/w Gp 1 & 3 t value	CO-relation b/w Gp 2 & 3 t value
Trial/1	0.89 ± 0.31	0.16 ± 0.37	0.05 ± 0.42	.001	.001	.023
Cube/1	0.92 ± 0.27	0.50 ± 0.21	0.07 ± 0.27	.001	.001	.001
Clock/3	2.78 ± 0.41	2.01 ± 0.75	0.59 ± 0.66	.001	.001	.001
Naming/3	2.73 ± 0.45	2.42 ± 0.54	2.05 ± 0.31	.001	.001	.001
Digit Span /2	1.94 ± 0.22	1.84 ± 0.39	1.38 ± 0.48	.432	.001	.001
Attention /1	0.94 ± 0.23	0.73 ± 0.44	0.30 ± 0.46	.031	.001	.001
Calculation /3	2.91 ± 0.27	2.82 ± 0.57	2.19 ± 0.56	.623	.001	.001
Repetition /2	1.29 ± 0.81	0.82 ± 0.61	0.67 ± 0.76	.001	.001	.258
Fluency/1	0.81 ± 0.39	0.31 ± 0.46	0.14 ± 0.69	.001	.001	.018
Abstraction /2	1.37 ± 039	0.60 ± 0.49	0.16 ± 0.37	.001	.001	.001
Recall /5	4.29 ± 0.61	2.98 ± 0.74	2.18 ± 0.67	.001	.001	.001
Orientation /6	5.97 ± 0.16	5.64 ± 0.52	4.98 ± 0.76	0.17	.001	.001

*The mean difference is significant at the 0.05 level. Pearson correlation coefficient (r = at least 0.8 very strong, 0.6 up to 0.08 moderately strong, 0.3–0.5 good and < 0.3 is poor.

observed most frequent cognitive pattern (p value < 0.01). High GCS at admission favors better neurocognitive outcome. With in moderate TBI majority of patients fall under MoCA-G3 (54.55%) as compared to MoCA G2 & MoCA 1 (34.65% and 10.89% respectively) and this distribution was also statistically significant (p value < 0.01).

4. Discussion

We planned this study with an aim to explore the cognitive pattern, evaluation with the MoCA in mild and moderate TBI patients as well as to establish a quick, short duration screening tool for same purpose. We also explored to isolate demographic, severity and other associated factor that could predict cognitive outcome.

The persisting cognitive impairments are associated with moderate and severe TBI and there are considerable interest in and always remain a debate about the extent to which mild TBI is associated with cognitive difficulties. Studies comparing cognitive functioning of mild and moderate TBI are very few and full of contraindication because of differences in the definition of severity (mild and moderate) of injury and neuropsychological tool for evaluation. (Dikmen et al., 1986) examined 20 patients of mild TBI along with age, gender and education matched controlled and they observed that patients with mild TBI performed on cognitive test less than controlled at one month post injury, However difference in performance was insignificant at 1 year post injury. Heitger et al. (2006) reported similar results and they observed that cognitive impairment in mild group were significant up to 6 month post injury.

Blankenship (1988) reported that each individual with mild TBI will present unique difficulty relative to particular locations and extent of injury. Ponsford et al. (2000) conducted a study on 84 mild TBI patients and reported memory difficulties, begins with in one week and observed up to 3 month. They concluded that by the end of 3 month cognitive impairment reported at 1 week resolve completely. Contrary to this, results observed by Kemp et al. (2005) in case study suggest early appearance and prolonged cognitive impairment up to 8 month. Previous studies had established that difference in TBI severity is usually related to different kind of impact on cognitive function. This had been shown that moderate TBI is usually associated with less impairment than severe TBI (West et al., 2011) however difference between cognitive outcome of mild and moderate TBI is not statistically proved (de Guise et al., 2014). In present study, we did not obtained of same type of pattern of level of impairment. Recently published review about cognitive impairment in Mild TBI by McInnes (2017) showed that 55% patients may had impairment in cognition following injury, While results of our study showed that the cognitive impairment was present in 79.2% patients of Mild TBI. This high incidence in present study could be explained on the basis of characteristics of sample as majority of patients at our tertiary care trauma center came from remote areas. So patients group of less obvious symptom (e.g. concussion) do not reached to hospital, and this discrepancy of our cohort results in significant impairment in mild TBI group.

A large, high volume recently published prospective study of 863 patients in 2012 by Leitgeb et al. (2012) found that age, severity of TBI and neurological status were the main factors influencing the post TBI cognitive outcome. Similar results were also confirmed by other authors (West et al., 2011; de Guise et al., 2014), but a meta analytic review of 41 studies published in 2007. Mathias and Wheaton (2007) showed that age, education were not significantly related to attention deficit. Age at

Table 5
Association B/W type of TBI and different group of MOCA score.

Type of TBI	MOCA Group	N	%	Mean Std. Deviation	GP 1vs GP 2	GP 1 VS GP 3	GP 2 VS GP3
MLD	MoCA G_1	26	20.47%	26.38 ± 4.35	< 0.001S	< 0.001S	< 0.001S
	MoCA G_2	55	43.30%	21.55 ± 2.07			
	MoCA G_3	46	36.22%	15.26 ± 1.25			
	Total	127	100.00%	20.26 ± 4.87			
Moderate	MoCA G_1	11	10.89%	27.27 ± 1.49	< 0.001S	< 0.001S	< 0.001S
	MoCA G_2	35	34.65%	21.57 ± 1.69			
	MoCA G_3	55	54.45%	15.56 ± 1.24			
	Total	101	100.00%	18.92 ± 4.28			
Total	MoCA G_1	37	16.22%	26.65 ± 3.73	< 0.001S	< 0.001S	< 0.001S
	MoCA G_2	90	39.47%	21.56 ± 1.92			
	MoCA G_3	101	44.29%	15.43 ± 1.25			
	Total	228	10.00%	19.67 ± 4.66			

Table 6
Associations between different determinants and cognitive outcome.

Variables/MOCA Group	MoCA G_1	%	MoCA G_2	%	MoCA G_3	%	p value	Chi square
Severity								
MILD (N = 127)	46	45.54%	55	61.11%	26	70.27%	0.014	8.473
MODERATE(N = 101)	55	54.46%	35	38.89%	11	29.73%		
TOTALS(N = 228)	101	100 %	90	100%	37	100%		
Education status								
Graduate	19	18.81%	23	25.56%	16	43.24%	0.012	12.763
Up To 12th	43	42.57%	46	51.11%	13	35.15%		
Up To Eighth	39	38.61%	21	23.33%	8	21.62%		

presentation and sex distribution were observed insignificant variables in our study related to MoCA performances in spite of MoCA scores were higher for younger age patients. Patients with education level of more than 12 years had significantly better score as compared with those having education below 12 years (p value = 0.01) These results have been shown previously in many studies (de Guise et al., 2014; Freitas et al., 2012; Rossetti et al., 2011). Results obtained for TBI severity (GCS score at admission) in present study as a linear data showed that, TBI severity had influence on cognitions, as MoCA scores were higher for patients with better GCS Scores at admission(p value = 0.014) (Table 5).

Most of the studies have evaluated validity, sensitivity and specificity of MoCA and its utility in TBI has been demonstrated (Kwok et al., 2013). However a recent study conducted by Zhang et al. (2016) raised the question about the sensitivity of MoCA they found cognition compromised in 50% of patient, those found intact on MOCA evaluation.

A detailed and qualitative analysis of cognitive domains by applying MoCA will certainly be more informative. The subset scores of MoCA showed that moderate TBI group had lower scores in all subsets as compared to mild TBI group, statistically significant low scores were observed in cube copy (p value = 0.03), clock drawing (p value = 0.017) (visuospatial/ executive function), digit span test (p value = 0.04) (attention and concentration) and recall memory (p value = 0.004) (Table 3). The results indicates that cognitive impairment is more extensive and severe in moderate TBI, especially for executive function, attention, concentration and memory which might be the critical differentiating trend of cognitive impairment in both group. Therefore executive function, attention, concentration and memory are main domains of cognition which contribute for difference in total MoCA score attains between TBI groups. Our results of moderate TBI cognitive domain in attention, concentration, & memory were also observed by Lannoo et al. (1998) and similar results were also published by Dikmen et al. (1995). Memory impairment is one of the most common cognitive impairments after TBI (Rees et al., 2007) It is frequently the first function to be notably impaired and one of the last function to be regained in the recovery process (Barman et al., 2016). Few Studies (Rees et al. and Barman et al.) in past revealed that language, orientation and, abstraction are more resistant cognitive function to traumatic brain injury (Rees et al., 2007; Barman et al., 2016).

We have observed that patients of both mild and moderate TBI had relatively low scores in some MoCA subsets: as trial making (0.25 ± .44 vs. 0.21 ± .41) and Fluency (0.28 ± .45 vs 0.37 ± .48). Poor performance in these subset in both group of TBI indicates that they are equally affected. However, there were no significant differences in these subsets among two groups of TBI. Therefore characteristics of mild and moderate TBI cognitive impairment may be similar in some aspects.

The severity and extensiveness of cognitive impairment in both groups may be mainly associated with lesions location and types. In our cohort most of the patients had frontal and temporal lobe lesions. These locations are most prone to develop cognitive impairment particularly memory and executive functions (Bigler et al., 2008; Teasdale and Jennett, 1974; Fleminger, 2008; Saunders et al., 2006; Ghajar and Richard, 2008). This study showed that more bilateral and diffuse lesions on brain imaging were observed in patients with moderate group ($p < 0.01$). Unilateral lesions particularly in right frontal more frequently found in patients with mild TBI group ($p < 0.01$). There was no statistical significant difference between two groups in temporal, parietal, capsuloganglionic and other more than two lesions.

To enhance our understanding, clarity and correlation of MoCA subsets, patients were categorized into four groups on the basis of total attained MoCA scores. Analysis was done by one way ANOVA test tukey HSD for multiple comparisons (Table 4). Results showed that all subsets score had statistically significant difference to each MoCA group (MoCA-G_1vs MoCA-G_2, MoCA-G_1 vs.MoCA-G_3 and MoCA-G_2 vs. MoCA-G_3), except digit span test (p value = 0.432), Serial subtractions (p value = 0.623), Orientation(p value = 0.17) between MoCA-G_1 vs. MoCA-G_2.These results indicates that patients with mild cognitive impairment is statistically equally attentive and oriented as normal persons. Cognitive domains other than attention and orientation contribute in the differences of MoCA score and responsible for moderate cognitive impairmen. Another inference drawn from these results is that attention, concentration and orientation were the domain which resist impairment in cognition. Executive function, language, and memory, were functions that were involved primarily, more frequently and tends to persist from several months to several years after TBI. Similar results were also published in 2010 by Miotto et al. (2010) he and his colleagues reported that episodic memory, language and execution were main altered cognitive functions.

The limitations of our study, was inability to defined and include post injury evaluation time. Secondarily this study did not include control to check the sensitivity and validity of MoCA evaluation scoring system.

5. Conclusion

Assessment of cognitive impairment should be considered as a mandatory protocol while evaluating post TBI patients, even in cases of mild TBI. MoCA is a quick and reasonably sensitive test for cognitive impairment following TBI. Visuospatial/Executive function, memory and attention are the most commonly impaired cognitive functions in patients of TBI, and these are the main domain of cognition which differentiate mild impairment from moderate impairment. GCS and education status have positive correlation with MoCA. A shorter and quick screening tool mainly focused on executive function, memory, attention and concentration should be develop, which can be administer on each and every patient on OPD basis. This is time to be focused on post TBI dedicated rehabilitating programme and needs to develop its centers nationwide.

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