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Original Article

Cognitive Profiles of Mild Traumatic Brain Injury and mild Vascular Cognitive Impairment: A Comparative Study

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Abstract

Objective The cognitive profile of any neurological disorder is very important throughout the duration of a person's treatment. It has a role in diagnosis, prognosis, and even after remission of active symptoms. It is a common trend among clinicians to monitor and compare the cognitive profiles of different disease conditions to locate the area of maximum dysfunction, with respect to a particular diagnosis. This study correlates the cognitive profiles of mild traumatic brain injury (mTBI) and mild vascular cognitive impairment (mVCI).

Methods The study population comprised 30 mTBI and 30 mVCI patients medically diagnosed by a neurologist. The patients were been selected from the neuromedical outpatient department (OPD) and neurosurgery OPD of the Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum. Simple random sampling had been used to select the sample. The patients diagnosed with the stated disease conditions were referred for neuropsychological assessment. Testable and cooperative patients were recruited for the study. To stabilize the data and for a transparent comparison, 30 healthy controls with no medically diagnosed illnesses were also added to the study. The results were analyzed using R.

Result and Conclusion The study concluded that cognitive profiles of mTBI and mVCI patients were significantly different from the cognitive profiles of healthy controls, but there was no statistically significant difference between the cognitive profiles of mVCI and mTBI patients except in confrontation naming and recognition memory.

Keywords

- mild vascular cognitive impairment
- mild traumatic brain injury
- cognitive profile

Introduction

The cognitive profile of any neurological disorder is very important throughout the duration of a person's treatment.[1] It has a role in diagnosis, prognosis, and even after remission of active symptoms. It is a common trend among clinicians to monitor and compare the cognitive profiles of different disease conditions to locate the area of maximum dysfunction, with respect to a particular diagnosis.

Yang et al reported that executive and memory dysfunctions were improved after cerebrovascular disorders, but language functions remained unchanged, and was resistant to change.[2] Cognitive impairment in mild traumatic brain injury (mTBI) preferably relates to lower educational level and the functional impairment depends upon the site of lesion, if there is any. Gardner et al, in a population-based study of community dwelling older adults, found that mTBI easily affects memory and

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executive functions.[3] Executive dysfunction is common in patients who are unconscious for a longer duration after TBI. Darshini et al in a study that correlated the triad of cognition, communication, and language functions found a significant correlation between aphasia, language, and executive functions.[4] Ghate et al reported the cognitive dysfunction in TBI is severe but treatable.[5] Mild vascular cognitive impairment (mVCI) is characterized by executive dysfunction, slowed information processing, memory deficit, and mood and personality disorders.[6] Cognitive impairment as a consequence of stroke would likely depend not only on timing and anatomical location of the stroke but also the laterality, severity, and extent of the lesion; further impairments are seen in memory, executive, and language functions.[7] This is a comparative study on mild cognitive impairment in mTBI and mVCI to find out the differences in their cognitive profiles especially with special reference to memory, language, and executive functions.

Methodology

Sample

Simple random sampling was the chosen method for data collection. The data were collected from the neuromedical and neurosurgery outpatient departments of Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum. A total of 90 patients were selected, with patients equally distributed between the mTBI and mVCI groups (30 each, with 30 controls). The age of the patients was between 18 and 60 years. The male-to-female ratio was based on the availability of the sample. Inclusion criteria were set to collect the sample.

Inclusion Criteria

- One to 2 years after the diagnosis of mTBI and mVCI.
- Patients belonging to the age group of 18 to 60 years.
- Patients who can read, write, and speak Hindi, Tamil, English, and Malayalam.
- Patients with average intelligence, and without psychosis and without medical diagnosis of epilepsy.
- Patients with family support and stable bystanders.

Based on the inclusion criteria, patients were referred by the neurosurgeon and the neurologist with a diagnosis of mild cognitive impairment comorbidly with the condition of TBI and vascular disease. Standardized neuropsychological tests were used to quantify the functions of language, naming, verbal memory, visual memory, recognition memory, visuospatial functions, visuospatial construction, and executive functions.

The initial interview, case history extraction, and cognitive evaluation were conducted at the department of neurology. Later, the assessment scores were quantified and analyzed.

Since this was purely a study on cognitive profiles, there was no need for collection of biological samples, human immunodeficiency virus (HIV) test, and genetic test.

Procedure

Neuropsychological assessments were carried out after obtained informed consent of the patients. The neuropsychological tests used were developed and standardized in Department of Neurology, SCTIMST, Trivandrum. The entire battery took about 2 hours to complete. No travelling allowances (TA) were given for their participation.

Neuropsychological Tests

The neuropsychological tests were selected very carefully on the basis of their capacity to quantify the level of different cognitive functions.

- The Rey Auditory Verbal Learning Test: Standardized in SCTIMST by Mathuranath et al in 2000.
- The Wechsler Memory Test: Three types of Wechsler Memory Tests—the Verbal Memory Test, the Visual Memory Test, and Recognition Memory Test—were standardized in SCTIMST by Mathuranath et al in 2000.
- Confrontation Naming: This test was developed in SCTIMST by Mathuranath et al in 2000.
- Wisconsin Card Sorting Test: Adapted and standardized in SCTIMST by Mathuranath et al in 2000.
- Language Functions: The language functions were adapted from Addenbrooke's Cogntive Examination II (ACE-II) (Mathuranath et al 2000).
- Verbal Fluency and Phonemic Fluency tests were adapted from fluency tests in ACE II (Mathuranath et al 2000).
- Visual Object Space Perception Test (Mathuranath et al 2000).

Results

The neuropsychological assessment test scores were compared across three groups (normal controls, VCI, and TBI) using the software R. One way analysis of variance (ANOVA), chi-squared test, and post hoc Bonferroni test were used to find out the statistically significant differences among the variables. ►**Table 1** indicates the distribution of age, gender, occupation, and duration of illness. The three study groups were denoted as G1 (control), G2 (mTBI), and G3 (mVCI). ►**Fig. 1** indicates the mean distribution of age among the study samples.

A total of 90 patients were included in the study: 30 healthy controls, 30 mTBI patients, and 30 mVCI patients. Men comprised 62% of the total population and 28% were women. In all, 67% of the patients were employed and 23% were unemployed. The duration of illness was 1 year in 48% patients and 2 years 42% patients. Among the characteristics of patients in the three groups, there was a significant difference in gender, while all other variables were statistically not significant.

►**Table 2** and ►**Fig. 2** show a comparison of the memory functions (verbal memory, visual memory, and recognition memory) between the three study groups. The results of one way ANOVA test revealed a significant difference. Further a post hoc Bonferroni test was done and it was found that there was a significant mean difference between healthy controls and mTBI patients, and between healthy controls and mVCI

Table 1 Demographic profiles of the three study groups

Patient characteristics	Control ($N = 30$)	mTBI ($N = 30$)	mVCI ($N = 30$)	*p*-Value
Age				
Mean (SD)	47.8 (14)	46.3 (14.7)	53.2	0.009
Gender				
Male	16 (53.3)	20 (66.7)	26 (86.7)	0.019
Female	14 (46.7)	10 (33.3)	4 (13.3)	
Education				
Up to 12	19 (63.3)	15 (50.0)	17 (56.7)	0.581
Above 12	11 (36.7)	15 (50.0)	13 (43.3)	
Occupation				
Employed	19 (63.3)	23 (76.7)	25 (83.3)	0.195
Unemployed	11 (36.7)	7 (23.3)	5 (16.7)	
Illness duration				
1 y	15 (50)	14 (46.7)	11 (53.3)	0.392
2 y	15 (50)	16 (53.3)	11 (36.7)	

Abbreviations: mTBI, mild traumatic brain injury; mVCI, mild vascular cognitive impairment.

patients. There was a difference in verbal memory functioning between the mTBI and mVCI groups. But the difference was not statistically significant.

►**Table 3** and ►**Fig. 3** show a comparison of the language functions between the three study groups. The results of one way ANOVA revealed a significant difference in scores across groups. Further, a post hoc Bonferroni test was done and significant mean differences between healthy controls and mTBI patients and between healthy controls and mVCI patients were found. But there is no statistically significant difference in language functions between mTBI group and mVCI group.

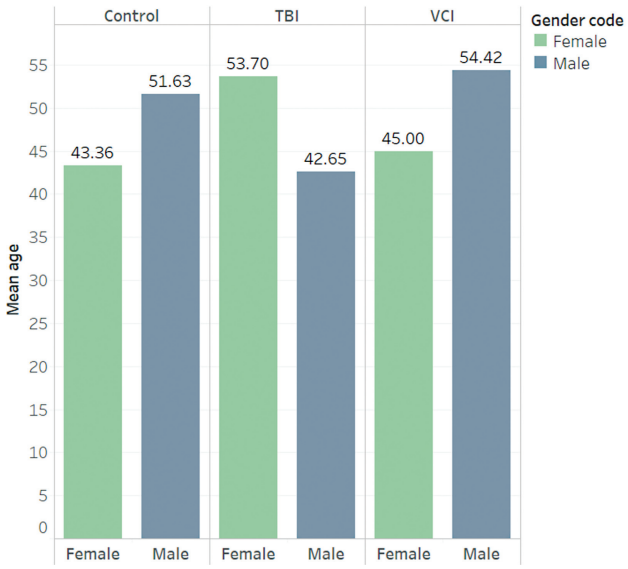

Fig. 1 Graphical representation of mean age among the group. TBI, mild traumatic brain injury; VCI, vascular cognitive impairment.

►**Table 4** and ►**Fig. 4** shows a comparison of the visuospatial and executive functions between the three study groups. The results of one way ANOVA revealed a significant difference. Further a post hoc Bonferroni test was done and significant mean differences in the scores of executive functions were found between healthy controls and mTBI patients and healthy controls and mVCI patients, but there was no statistically significant difference in the visuospatial functions, constructions, and executive functions between the mTBI and mVCI groups.

Discussions

The main objective of this study was to find out the differences in the cognitive profiles of mVCI and mTBI patients. Memory impairment in mTBI and mVCI patients was significantly different from that of healthy controls, especially in visual memory ($p < 0.001$), verbal memory ($p < 0.001$), and recognition memory ($p < 0.\ 001$). The same difference could be observed for the executive and language functions ($p < 0$). 001. However, when compared to healthy controls, the difference was not statistically significant between the study groups (mTBI and mVCI).

Statistical comparison of the memory functions among the three groups showed that verbal memory was affected more in the mVCI (70 ± 38.2) group compared to the mTBI (85.3 ± 47.1) group and controls (220.9 ± 10.6). There was an impairment in consolidation of memory process in the mTBI group and more working memory impairment in VCI.[8,9] The VCI patients have poor verbal memory outcome in a 2-year continuous clinical study.[10]

Among the three groups, visual memory was more impaired in mTBI (30.56 ± 27.8), mVCI (38.7 ± 30.8), and control (67.3 ± 26.2), but the difference with mVCI was not statistically significant. This finding was contrary to previous

Table 2 Memory function scores and its significance between and among the groups of controls, mTBI, and mVCI

Group	Control ($N = 30$)	mTBI ($N = 30$)	mVCI ($N = 30$)	p value[a] (F test)	p-Value[b] between groups and among groups
Verbal memory	220.9 (10.6)	85.3 (47.1)	70 (38.2)	< 0.001	G1 and G2: < 0.001 G1 and G3: < 0.001 G2 and G3: 0.298
Visual memory	67.3 (26.2)	30.56 (27.8)	38.7 (30.8)	< 0.001	G1 and G2: < 0.001 G1 and G3: < 0.001 G2 and G3: 0.808
Recognition memory	20.03 (7.28)	16.63 (7.69)	12.33 (8.25)	< 0.001	G1 and G2: < 0.279 G1 and G3: < 0.001 G2 and G3: 0.104

Abbreviations: mTBI, mild traumatic brain injury; mVCI, mild vascular cognitive impairment.
[a]One way analysis of variance (ANOVA) test.
[b]Post hoc Bonferroni test.

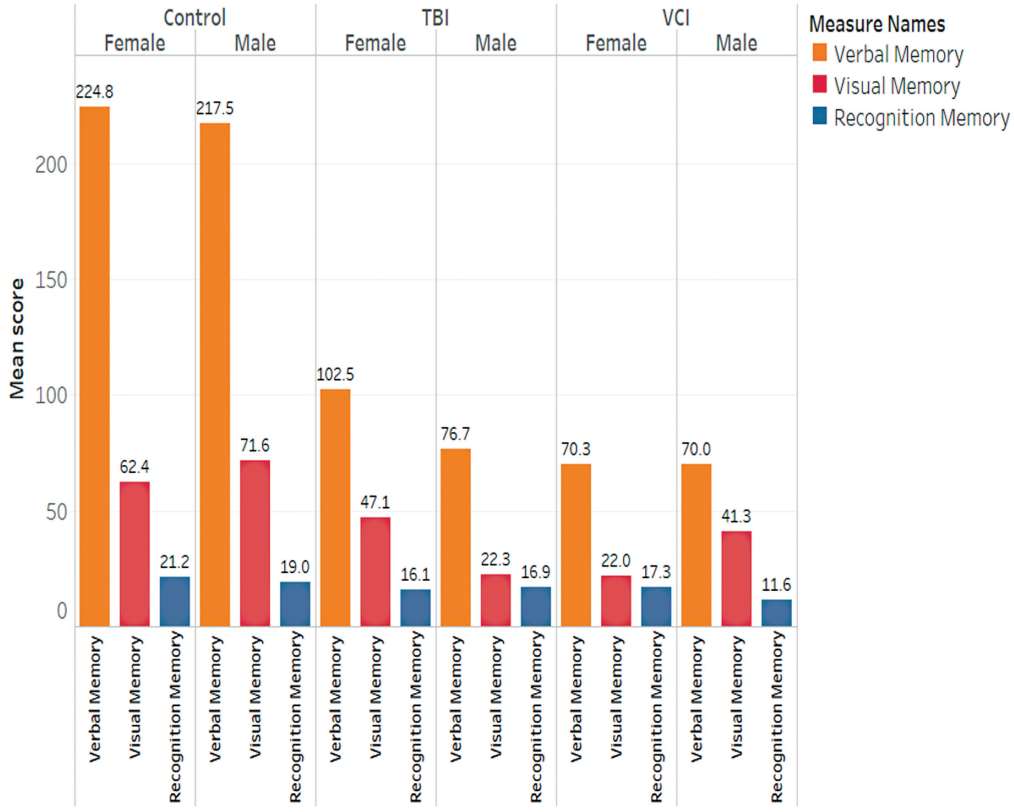

Fig. 2 Graphical representation of memory functions. TBI, mild traumatic brain injury; VCI, vascular cognitive impairment. (Adapted from Menon et al 2023)

studies, which found significant impairment in verbal memory post-TBI.[11–14]

Recognition memory was more impaired in mVCI (12.33 ± 8.25) than mTBI (16.63 ± 7.69) and controls (20.03 ± 7.28). More white matter changes are associated with memory impairment in VCI, but more lobar functional impairment is associated with mild cognitive impairment in mTBI.[15,16]

Language functions, especially confrontation naming (mTBI: 36.8 ± 20.26; mVCI: 42.46 ± 13.85) and verbal fluency (m TBI: 9.36 ± 2.93 and mVCI: 8.8 ± 3.67) were significantly impaired in the two study groups than in healthy controls (47.43 ± 10.63 and 11.9 ± 2.24, respectively).

In this study the performance of mTBI and mVCI patients were significantly worse compared to healthy controls on naming. Gauthier et al observed that patients with mTBI performed significantly worse than controls on naming when evaluated within 2 weeks of TBI.[17–19] Naming difficulty can be associated with increased age; in the current study, we did not consider it as a comparison variable. Additionally, the present study

Table 3 Language function scores and its significance between and among the groups of controls, mTBI, and m VCI

Group	Control, G1 ($N = 30$)	mTBI, G2 ($N = 30$)	mVCI, G3 ($N = 30$)	p value[a] (F test)	p -Value[b] between groups and among groups
Language	26.86 (2.27)	23.9 (6.61)	23.67 (5.86)	< 0.036	G1 and G2: < 0.096 G1 and G3: < 0.063 G2 and G3: 1
Confrontation naming	47.43 (10.63)	36.8 (20.26)	42.46 (13.85)	< 0.032	G1 and G2: < 0.027 G1 and G3: < 0.649 G2 and G3: 0.477
Verbal fluency	11.9 (2.24)	9.36 (2.93)	8.8 (3.67)	< 0.001	G1 and G2: < 0.005 G1 and G3: < 0.001 G2 and G3: 1.000
Phonemic fluency	6.33 (.84)	4.96 (1.58)	4.71 (1.95)	< 0.001	G1 and G2: < 0.003 G1 and G3: < 0.001 G2 and G3: 1.000
Category naming	5.633 (1.40)	4.4 (1.71)	4.13 (1.97)	< 0.002	G1 and G2: < 0.020 G1 and G3: < 0.003 G2 and G3: 1.000

Abbreviations: mTBI, mild traumatic brain injury; mVCI, mild vascular cognitive impairment.
[a]One way analysis of variance (ANOVA) test.
[b]Post hoc Bonferroni test.

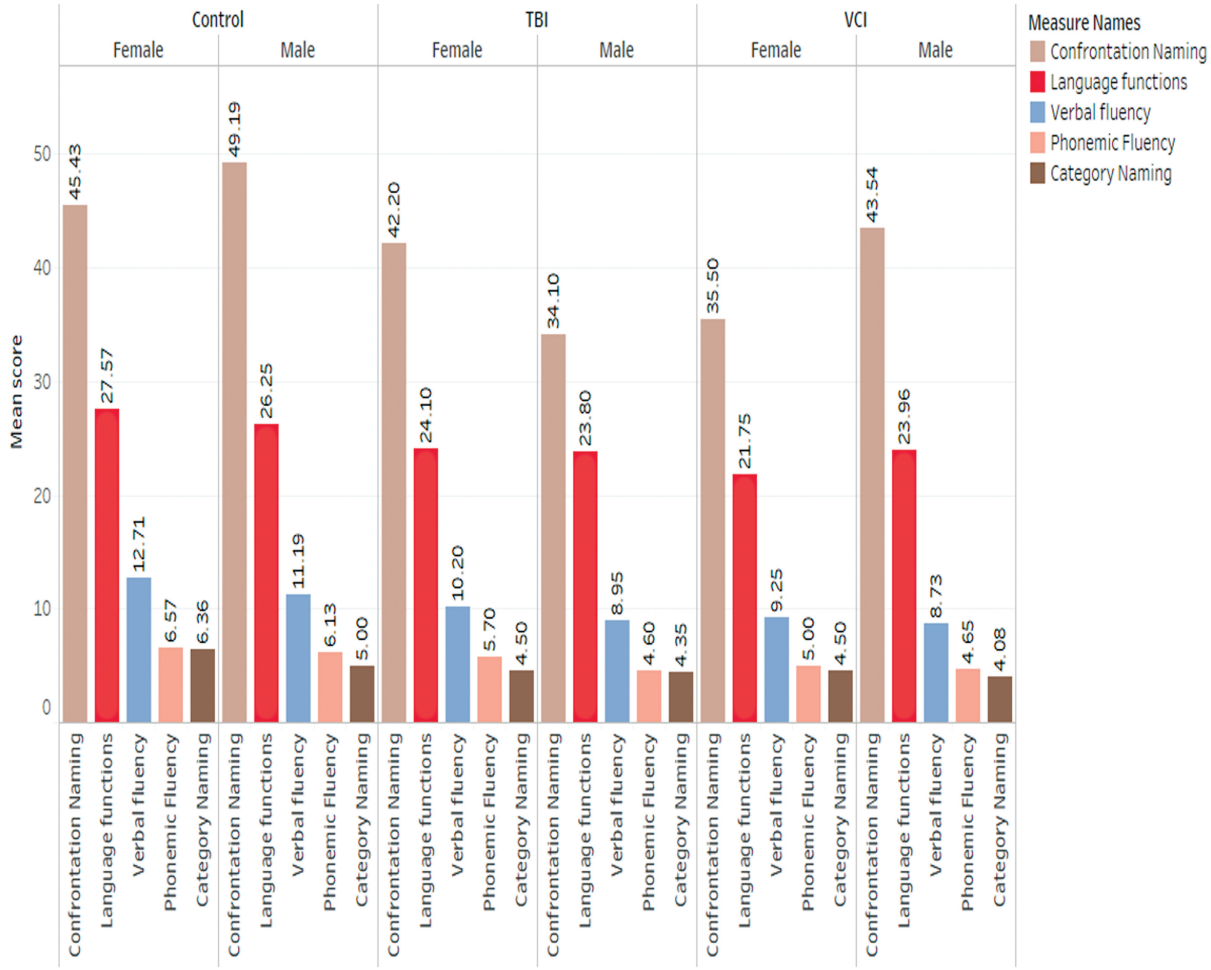

Fig. 3 Graphical representation of language functions. TBI, mild traumatic brain injury; VCI, vascular cognitive impairment. TBI, mild traumatic brain injury; VCI, vascular cognitive impairment. (Adapted from Menon et al 2023)

Table 4 Construction, visuospatial functions, and executive function scores and its significance between and among the groups of controls, mTBI, and mVCI

Group, variable	Control, G1 ($N = 30$)	mTBI, G2 ($N = 30$)	mVCI, G3 ($N = 30$)	p value[a] (F test)	p -Value[b] between groups and among groups
Construction	4.73 (1.04)	3.7 (1.8)	3.86 (1.99)	< 0.041	G1 and G2: < 0.057 G1 and G3: < 0.144 G2 and G3: 1.000
Visuospatial function	25 (0)	8.73 (20.26)	8.73 (8.23)	< 0.001	G1 and G2: < 0.001 G1 and G3: < 0.001 G2 and G3: 1.000
Executive function	5.83 (–912)	4.23 (2.31)	4.3 (2.30)	< 0.002	G1 and G2: < 0.006 G1 and G3: < 0.010 G2 and G3: 1.000

Abbreviations: mTBI, mild traumatic brain injury; mVCI, mild vascular cognitive impairment.
[a]One way analysis of variance (ANOVA) test.
[b]Post hoc Bonferroni test.

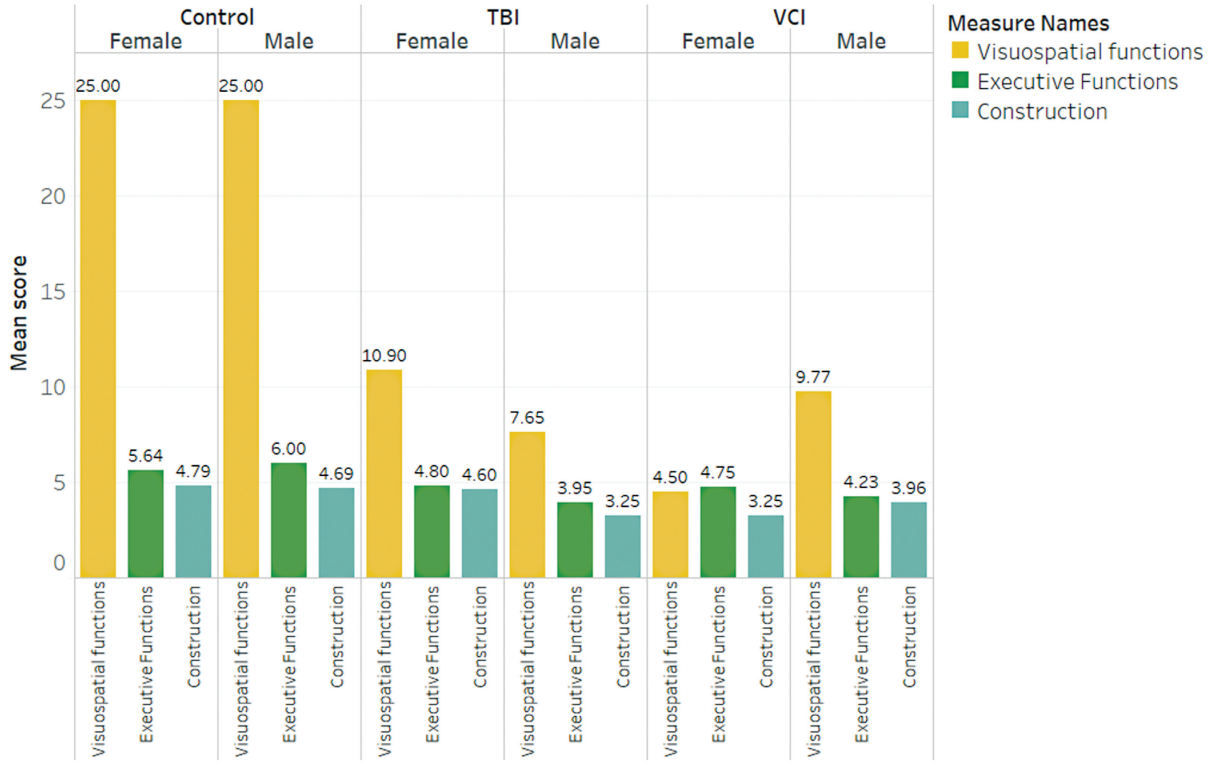

Fig. 4 Graphical representation of executive functions, visuospatial functions, and constructions. (Adapted from Menon et al 2023)

did not consider the educational profile of the subjects as a variable, but low level of education can also interfere with naming tasks.

In study by Kumar et al, the authors reported that the mTBI group had severe impairment of executive functions compared with normal controls.[20] Executive dysfunctions can be caused by degeneration, neuronal death, and frontal lesions, which can happen in TBI and VCI.[21] Emotional distress can be a cause for impaired executive functions and that can also be suspected in mTBI and mVCI.[22] mTBI patients showed reduced visuomotor integration, form recognition, and motor deficits as well as visuospatial attention impairment, in a comparative study with 10 normal healthy controls.[21,22] Even if visuospatial impairment is common in vasculitis, there is no original research substantiating a significant difference in the visuospatial function between mTBI and mVCI. With special reference to mTBI and mVCI, a longitudinal study with prolonged duration could lead to markers emphasizing more impact on the severity of cognitive decline.

Conclusion

The results of our study show that there are significant impairments in memory functions (verbal, visual, and recognition). Language functions, executive functions, and

construction differed between mTBI patients and controls and between mVCI patients and controls, but the differences were not statistically significant. The study highlights that memory functions are more affected than the executive and visuospatial functions among the study groups.

Note
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Conflict of Interest
None declared.

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