

## Analysis of Montreal Cognitive Assessment and Minimental State Examination in Patients with Mild Traumatic Brain Injury

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### Abstract

**Background:** 5-20% of patients may have persistent symptoms including cognitive deficits following mild traumatic brain injury (mTBI). The Montreal Cognitive Assessment (MOCA) is a simple tool specifically designed to screen for mild cognitive impairment. **Objective:** To compare MOCA with the commonly used Mini Mental Status Examination (MMSE). **Setting:** The study was conducted at the institute of neurosurgery, Madras Medical College from April to June 2017. **Subjects:** A non-randomized cohort of 50 patients presenting to the trauma ward with an antecedent history of trauma to the head (irrespective of cause). **Results:** A total of 28 patients were deemed to have cognitive impairment by the MOCA, 8 patients were deemed to have cognitive impairment by the MMSE representing a highly significant difference (p value <0.01). Both the scores agreed in a total of 30 cases, of which 22 cases were deemed to have no cognitive impairment by both tests and 8 patients were deemed to have cognitive impairment by both tests. Of particular importance is that no patient found to be cognitively impaired by the MMSE was deemed normal by the MOCA. **Conclusion:** The number of patients being categorized as being cognitively impaired by the MOCA, while being higher than that of the MMSE, conforms more to the pattern of cognitive deficits that are currently seen in patients with mTBI. MOCA may be superior to the MMSE to detect mild cognitive deficits in the setting of neurotrauma and at the very least maybe used in its stead.

**Keywords:** MOCA; MMSE; Traumatic Brain Injury; Cognitive Defects.

### Introduction

Traumatic brain injury and its consequences remain an important public health concern with a dramatic rise in the incidence of cases over the years, especially due to the prevalence of two wheeler transport and increased motorization [5]. While a large amount of research has gone into the treatment and rehabilitation of patients with moderate to severe traumatic brain injuries, mild traumatic brain injuries (mTBI) remain an enigma. Although Indian statistics are lacking, it is estimated that in the

United States that the incidence is as high as 503.1/100 000, with greater numbers being males (590/100 000) [1]. It is safe to assume that a country on the cusp of being a developed nation also shares a similar disease burden.

The definition of mild traumatic brain injury remains fluid and controversial. For the purposes of this study and at our institution we adhere to the WHO Collaborating Centre for Neurotrauma Prevention, Management and Rehabilitation on Mild Traumatic Brain Injury Task Force Guidelines which states that 'MTBI is an acute brain injury resulting from mechanical injury to the head from external physical forces. Operational criteria for clinical identification include: 1. one or more of the following: confusion or disorientation, loss of consciousness for 30 minutes or less, post-traumatic amnesia for less than 24 hours. and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesions not requiring surgery and 2. Glasgow Coma Scale score of 13-15 after 30 minutes post-injury or later upon presentation for health care. These manifestations of MTBI must not be due to drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g. systemic injuries,

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facial injuries or intubation), caused by other problems (e.g. psychological trauma, language barrier or coexisting medical conditions) or caused by penetrating cranio-cerebral injury' [2].

Although most patients completely recover following mTBI, up to 5-20 % of patients may have persistent symptoms including cognitive deficits which require treatment and rehabilitation before they can be reintegrated into society [10]. It is imperative to identify these patients early and assess them for treatment. The role of cognitive rehabilitation is well established and patients with mTBI show significant improvement with treatment [16] provided that they are identified appropriately by the attending neurosurgeon and then referred for neuropsychological assessment and necessary treatment.

The Mini Mental Status Examination (MMSE) has been used extensively to identify cognitive deficits in patients over the years. However it is now being discovered that it has a significant 'ceiling effect' i.e. the test is unable to differentiate among patients with milder cognitive deficits [14,18]. As most patients with mTBI have subtle and milder forms of cognitive deficits we hypothesized that the MMSE in reality under-diagnoses patients in the setting of mTBI.

In contrast the Montreal Cognitive Assessment (MOCA) is a freely available screening tool specifically designed to screen for mild cognitive impairment [11]. The MOCA is a paper-and-pencil tool that requires approximately 10 minutes to administer, and is scored out of 30 points [7]. Although the possible score below which a patient may be deemed to have a cognitive deficit is still under debate [17], a cut off score of 26 is generally accepted.

## Methods

The study was conducted at the institute of neurosurgery, Madras Medical College from April to June 2017 after obtaining clearance from the institutional ethics committee.

The objective was to compare MOCA with the commonly used MMSE

### *Participants and Procedure*

A non-randomized cohort of 50 patients presenting to the trauma ward with an antecedent history of trauma to the head (irrespective of cause) with the following criteria were screened after obtaining informed consent from each patient :

Patients above the age of 12 and patients with at least 4 years of formal school education (i.e. literate patients) with a history of injury to the head and any one of the following:

- Confusion or disorientation, loss of consciousness for 30 minutes or less, post-traumatic amnesia for less than 24 hours. And/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesions not requiring surgery.
- Glasgow Coma Scale score of 13-15 after 30 minutes post-injury or later upon presentation.

Patients under the influence of alcohol, drugs or other causes of impaired consciousness, patients with a presenting Glasgow Coma Scale score of less than 13, patients with major systemic injuries causing hypotension and/or impairment of consciousness patients with penetrating injuries to the brain patients who were deemed illiterate and patients who did not consent to being included in the study were excluded.

### *Procedure*

After confirming that the patients were fluent in Tamil, patients were tested using the MMSE followed by MOCA with an interval of one hour between both the tests to prevent habituation, by the same examiner. The examiner in all cases was the neurosurgical resident examining the patient. The Tamil variant of the MOCA test was administered to the patients (available at [http://www.mocatest.org/pdf\\_files/test/MoCA-Test-Tamil.pdf](http://www.mocatest.org/pdf_files/test/MoCA-Test-Tamil.pdf)) and for the MMSE appropriate fields were translated into Tamil with the help of the department of neurology.

Patients were scored out of 30 for both tests with a cut off score of 26 being used for both tests. Patients with a score of less than 26 in the MMSE were deemed cognitively impaired, similarly those scoring less than 26 by MOCA were also deemed cognitively impaired. The high cut off score for MMSE was intentionally chosen to increase the possible yield by MMSE.

### *Statistical Analysis*

Along with descriptive statistics of the patient population screened, the scores obtained in both tests were compared using the independent T test. The percentages of patients deemed cognitively impaired by both tests were also compared using Fishers exact test. All statistical analyses were

performed using the IBM SPSS software for windows.

*Patient Characteristics*

A significant proportion of the patients were males, 42 patients (84%), this is predominantly as most trauma centers in India show a significantly higher number of male patients. As the inclusion criteria included all patients above the age of 12, patients of various ages were included, with the minimum age being 16 years and the maximum being 67 (standard deviation 14.02 , mean 37.6 ) .

**Results**

The average score (mean) obtained on the MOCA was 24.82, in contrast with an average score of 26.44 on the MMSE with a standard deviation of 1.86 and 1.03 respectively. The minimum score obtained on the MOCA was 21 and in the MMSE was 24, the highest score obtained in both tests was 28. The difference between the two tests is highly significant with a p value of <0.01. This is illustrated in Table 1.

A total of 28 (56 percentage) patients were deemed to have cognitive impairment by the MOCA , while

only 8 (16 percentage ) patients were deemed to have cognitive impairment by the MMSE representing a highly significant difference (p value <0.01), this is shown in table 2. Both the scores agreed in a total of 30 cases, of which 22 cases were deemed to have no cognitive impairment by both tests and 8 patients were deemed to have cognitive impairment by both tests. Of particular importance is that no patient found to be cognitively impaired by the MMSE was deemed normal by the MOCA. This correlation is illustrated in Table 3.

Of the 28 patients found to have cognitive impairment by the MOCA, only 8 of these patients were concurrently found to have a cognitive impairment by the MMSE. A detailed comparison of the patients found to have cognitive impairment on the MOCA and their corresponding MOCA scores can be found in Table 4.

The majority of the patients with a normal MMSE yet abnormal MOCA had abnormal delayed recall (80%) or language (80%), followed by impairment in visuo-spatial or executive (70%), abstraction (25%), attention (35%), naming (20%), and orientation (15%), as determined by the MOCA. The cut-offs between normal and impaired in each domain were based on the original MOCA validation study in mild cognitive impairment.

**Table 1:** Average scores obtained in the MMSE and MOCA

	No. of Pt.	Mean	Stand. Deviation	Minimum	Maximum
MMSE	50	26.44	1.03	24	28
MOCA	50	24.82	1.86	21	28

**Table 2:** Cognitive impairment diagnosed by the MMSE and MOCA

	MOCA	MMSE	P value
Cognitively Impaired (%)	56	16	<0.01

**Table 3:** Correlation between MOCA and MMSE

	Abnormal MMSE	Normal MMSE
Abnormal MOCA	8	20
Normal MOCA	0	22

**Table 4:** Patients with normal MMSE yet cognitively impaired via the MOCA

MMSE Scores	Proportion of MOCA-impaired patients (%)
26	9/28 (32)
27	8/28 (28)
28	3/28 (10)
29	0/28 (0)
30	0/28 (0)

## Discussion

To truly diagnose patients with cognitive deficiencies, formal neuropsychological batteries remain the gold standard. However they are cumbersome, time consuming and expensive [8] and therefore rarely feasible in an acute trauma care center, especially so in a high volume center. These tests usually require a trained neuropsychologist to administer and even the most abbreviated of these batteries takes up to 30 minutes to administer. The blanket administration of neuropsychological testing to all patients showing features of mTBI is neither feasible nor practical as it places a tremendous strain on hospital resources. Therefore identification of patients of mTBI with cognitive deficit requires an effective screening tool that must be rapidly administered and should not be cumbersome to both the patient and the attending neurosurgeon.

As an early study into the feasibility and applicability of the MOCA in the setting of trauma, this study has shown a difference between the MOCA and the MMSE as screening tools. While comparing the results of this study to established statistics available in literature, it is immediately apparent that there is a significant amount of under reporting of cognitive deficits with the MMSE [4]. In the absence of detailed neuropsychological examination we are limited to hypothesis generation at present, but it seems apparent that the MOCA has numerous advantages over the MMSE. As the MOCA is also a rapid screening test, the utility remains the same as that of the MMSE in the setting of trauma. The number of patients being categorized as being cognitively impaired by the MOCA, while being higher than that of the MMSE, conforms more to the pattern of cognitive deficits that are currently seen in patients with mTBI. This indicates that when used the MMSE is used as a single screening tool, a large proportion of patients (nearly 40% in this study) are being under reported and consequently under treated.

Another significant advantage of the MOCA is the fact that it is readily available in a number of languages (46 languages at the time of writing this); this was of considerable utility in this study as all the patients examined were fluent in the regional language alone. While administering the MMSE, in contrast, a significant portion of the test had to be translated from English to Tamil, with the translation being unstandardized. Moreover, the MOCA is constantly under review and is frequently updated with the availability of literature (version 8.1 at the time of writing this). With the development of the

MOCA electronic assessment designed for electronic devices the ease of use of this test is bound to increase dramatically.

A number of studies have already shown a difference between the MOCA and the MMSE when it comes to screening mild cognitive dysfunction in a number of setting such as dementia [13] and stroke [6]. The MOCA is routinely being used in the field of neurology to the extent that the Montreal Cognitive Assessment is currently recommended over the MMSE by the US National Institute of Neurological Disorder, in the chronic post-stroke setting [11]. In the field of neurosurgery the role of the MOCA is now under active investigation with studies showing superiority in the setting of aneurysmal SAH [19] and early investigations are underway in the setting of neurotrauma, specifically recent studies have shown that the MOCA ( as well as the MMSE ) can be used for disability prediction [3] and in assessing cognition in patients with traumatic intracerebral hematomas [20]. MOCA has also shown utility in detecting cognitive deficits in patients with multisystem trauma [15]. This study indicates that the MOCA may be superior to the MMSE to detect mild cognitive deficits in the setting of neurotrauma and at the very least maybe used in its stead .

The shortcomings of this study include the significant difference in sex distribution with a large proportion of the participants being male. This however represents the average distribution of patients of trauma in our institution. However further studies are required to assess if gender is a factor in the MOCA score of trauma patients,

Another point of contention is the MOCA cut off score of 26. Although this score is generally accepted as the threshold for diagnosis of cognitive deficits in patients [7,12], none of the studies were considered in the setting of trauma. While this study assumes 26 as the threshold, larger studies are required to arrive at a more appropriate score. However, most of the data obtained for MOCA and in the computation of MOCA scores involved older patients and as cognition is generally better in younger patients (such as the majority of patients in this study and trauma in general), 26 appears to be a valid score.

Finally, in the absence of detailed neuropsychological testing (i.e. a gold standard test) the exact sensitivity and specificity of the MOCA and MMSE in the field of trauma could not be calculated. We expect to have this data as well as follow up data at the end of three months and six months, as the patients in this study are currently being followed up with neuropsychological examination. At this juncture,

we hypothesize that the MOCA may be used as a screening tool in the setting of mild traumatic brain injuries.

## Conclusion

Cognitive deficits in trauma is an under explored facet of neurotrauma with the amount of literature available at present being woefully inadequate [9]. This is in part due to the under diagnosis of cognitive deficits in these patients due to the unavailability of an effective, easy to use, screening tool. The MOCA addresses many of these issues and this study shows that it may be used in trauma as well. In addition, the broad inclusion criteria and high participation rate suggest that these results are generalizable. Furthermore, the MOCA classified a highly significant proportion of patients cognitively impaired that the MMSE classified as cognitively intact, which, we hypothesize, occurred because the MOCA is more sensitive than the MMSE. In this study, we believe, we have shown that MOCA can be feasibly administered to patients with mild traumatic brain injury. The paucity of literature on the subject warrants further studies to establish the role of MOCA in neurotrauma as well as validation studies which are currently underway at our institute.

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## Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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*Conflict of Interest:* None

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