The Montreal Cognitive Assessment Test (MoCA) as a screening tool for cognitive dysfunction in fibromyalgia

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Abstract

Objective

Cognitive dysfunction is one of the criteria for the diagnosis of fibromyalgia (FM) and is typically based on self-report questionnaires such as the Symptom Severity Scale. However, recent studies have shown that there is no correlation between these subjective measures of cognitive dysfunction and more lengthy objective measures of cognitive functioning. This points to the need for a briefer valid evaluation tool for cognitive dysfunction in FM.
The aim of this study is to examine whether the Montreal Cognitive Assessment (MoCA) test is a valid measure of cognitive assessment in FM patients, by comparing it to a comprehensive computerised cognitive assessment battery.

Method

Sixty-two FM patients (55 women, 7 men, mean age = 46.17 years, sd=12.56) were administered the MoCA and a computerised cognitive assessment battery. FM symptoms were assessed on the Fibromyalgia Impact Questionnaire (FIQ), the Widespread Pain Index (WPI), the Symptom Severity Scale (SSS), and the Beck Depression Inventory (BDI-2). Patient effort was controlled on the TOMM (Test of Memory Malingering).

Results

*Moderate positive correlations were found between the MoCA and the computerised cognitive scores as follows: Global Cognitive Score (r=0.493**, p=0.00), Memory Index Score (r= 0.384**, p=0.002), Executive Function Index Score (r=0.461**, p=0.00), Attention Index Score (r=0.310*, p=0.016), Information Processing Speed Index Score (r=0.435**, p=0.001), and Motor Skills (r=0.406**, p=0.002).*

Conclusion

The MoCA is an acceptable cognitive screening test for the cognitive evaluation of FM patients.

Key words
fibromyalgia, Montreal Cognitive Assessment Test (MoCA), cognitive impairment, cognitive assessment

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Introduction

Fibromyalgia (FM) is a complex condition characterised by generalised chronic pain (1) that affects both physical and mental health (2), resulting in impaired quality of life and daily functioning (3). Chronic widespread pain is the defining feature of FM and is usually attributed to abnormalities in the central nervous system, including hyper-active glia cells and central sensitisation (1). This widespread pain tends to escalate in times of stress (4) and is associated with sleep problems (5), fatigue and mood swings (6), anxiety (7) somatic symptoms (8) and cognitive dysfunction (9).

Over the last twenty years, there has been a sharp rise in the diagnosis of FM (1, 10). In the Israeli population, the prevalence of FM is estimated at 2%-2.6% (11). Worldwide, the prevalence is roughly 1.78%, and is higher in women (3.98%) than in men for whom the prevalence is about 1.8% (8). Roughly 70% of all individuals diagnosed with FM have cognitive dysfunctions which contribute to the overall disability associated with this syndrome (12). Cognitive dysfunction in FM, also called "dyscognition", emerges in self-reported cognitive complaints as well as in objective cognitive difficulties observed on neuropsychological tests (9). The term "fibrofog" is also common and refers to the loss of mental clarity and impaired attention and memory frequently reported by FM patients which is sometimes considered more disabling than the pain itself. Despite being a very disturbing symptom, cognitive dysfunction is not well studied and seems to have been overlooked in research on FM (9). However, clinicians and researchers have highlighted the need for further research into the cognitive dysfunction experienced by FM patients. In 2010-2011, The American College of Rheumatology introduced two new sets of diagnostic criteria based on the Widespread Pain Index (WPI), a self-report questionnaire reflecting the degree of pain dispersion, and the Symptom Severity Scale (SSS), which assesses accompanying symptoms, including cognitive complaints (13). These new criteria were designed to evaluate FM-related symptoms such as fatigue, decreased cognitive abilities and unrefreshing sleep. The addition of the SSS to the current FM diagnosis makes the cognitive dysfunction reported by FM patients an integral diagnostic feature (14-17). These cognitive dysfunctions include distractibility (18), declines in executive functions (3, 14, 19), attention (20), psychomotor speed and inhibitory control (21), lower processing speed (20, 22) and learning difficulties (14). In addition, FM patients tend to report memory deficits (23), specifically in visuospatial memory (21), working memory (9, 14, 20), and long-term memory (16).

In FM clinical settings, physicians generally evaluate cognitive symptoms (24) on a self-report measure (the Symptom Severity Scale; SSS) using ACR criteria (8). However, this scale was recently found to fail to correctly assess cognitive dysfunction. Specifically, several studies have documented the lack of correlation between subjective measures of cognitive dysfunction on the SSS and objective computerised cognitive batteries (19, 23, 25). However, the SSS was reported to be highly correlated with the Fibromyalgia Impact Questionnaire (FIQ) that measures daily functioning (25).

This situation highlights the need for objective, reliable and valid measures of cognitive functioning when diagnosing FM in clinical settings (26). However, standardised objective measures of cognitive functioning (*i.e.* neuropsychological tests including computerised cognitive batteries) are both expensive and time-consuming (27). Moreover, due to their fatigability (6), FM patients may not be able to fully complete these comprehensive tests (28). Taken together, there is a need for a short, accurate and applicable evaluation tool for cognitive functioning in FM. The aim of the current study was to fill this gap by investigating whether the Montreal Cognitive Assessment Screening test (MoCA) constitutes a valid tool to evaluate cognitive functioning in FM. The MoCA is a brief, 10-minute cognitive screening tool that detects cognitive dysfunction in various conditions including mild cognitive impairment

(29), post-stroke patients (30), chronic kidney disease (CKD) (31), systemic lupus erythematous (SLE) (32), etc. (33-35). It is easy to administer and interpret and is also easy to discuss with other clinicians and colleagues (36). The MoCA has been found to have greater diagnostic accuracy than the Mini-Mental State Examination (MMSE) and to better assess memory impairments (37-39). The MoCA test covers more cognitive domains than the MMSE, such as executive functions (36), which are usually impaired in patients with FM (3, 14, 19).

To the best of our knowledge, there is only one recent study examining the MoCA test in fibromyalgia (on 36 women) (40). The findings indicated that the MoCA test may be a more sensitive cognitive screening tool than the MMSE for patients with fibromyalgia. Therefore, the MoCA test has yet to be examined in the context of FM patients in general.

Table I. General demographics and group outcomes on the self-report questionnaires and the computerised cognitive scores.

Variable	N	Mean (SD)	Range
Age (years)	62	46.17 (12.56)	21-78
Education(years)	62	13.82 (2.7)	0-20
Female (%)	55	(88.7%) (n=55)	
Male (%)	7	(11.2%) (n=7)	
WPI (0-19)	62	12.46 (5.13)	1-20
SSS (0-12)	62	9.21 (2.06)	2-12
SS-cog (0-3)	62	2.01 (0.78)	0-3
BDI-II (0-63)	62	23.03 (10.48)	0-48
GAD-7(0-21)	62	12.72 (5.37)	0-21
FIQ (0-100)	61	69.61 (16.97)	16.29-98.96
TOMM (0-50)	62	48.43 (1.94)	45-50
MoCA (0-30)	62	24.47 (3.14)	18-30
Neurotrax computerised cognitive battery (M=100, SD=15)			
Global cognitive score	61	86.03 (13.05)	59.1-109.8
Memory	60	89.35 (18.08)	25-110.3
Executive function	58	88.40 (12.58)	58.5-120.4
Attention	60	84.49 (16.73)	34.8-114.6
Information processing speed	57	81.84 (17.95)	48.3-113.1
Motor skills	56	87.05 (18.45)	40.1-110.3

*WPI: Widespread Pain Index; SSS: Symptom Severity Scale; SS-Cog: Cognitive Symptoms Score; BDI-II: Beck Depression Inventory; GAD-7: Generalized Anxiety Disorder 7-Item Scale; FIQ: Fibromyalgia Impact Questionnaire; TOMM: Test of Memory Malingering; MoCA: Montreal Cognitive Assessment.

Method

Participants

The sample was composed of 62 FM patients (55 women, 7 men, mean age = 46.17, sd=12.56) who presented at a specialised FM clinic at the Tel Aviv Sourasky Medical Centre, Israel. The inclusion criteria were as follows: a diagnosis of FM according to the 2010/2011 ACR diagnostic criteria, a WPI score above 7 combined with an SSS score above 5 or a WPI between 4 and 6 with an SSS above 9. The participants' age was limited to above 18 and under the age of 80. We excluded patients who were diagnosed with "secondary" FM, *i.e*. those who presented with another disease that causes chronic pain. Patients were also excluded if they were not fluent in Hebrew, could not use a computer, or did not understand the instructions.

One hundred and six medical records of FM patients were screened. One hundred and two patients met the inclusion criteria and were asked to participate in the study. Four subjects were ineligible (due to inability to use a computer, pregnancy or being diagnosed with other pain-related conditions). Thirty-five declined for personal reasons, 2 were discharged before the testing sessions began, and 3 did not complete the questionnaires. Of the original sample contacted, 62 FM patients were recruited: 55 women (88.7%) and 7 men (11.3%) with an average age of 46.17. The patients' demographics are presented in Table I.

Procedure

After providing their written informed consent, the participants filled in a demographic questionnaire, and then completed the SSS and WPI. The participants next underwent cognitive testing composed of the MoCA screening test and the Neurotrax computerised cognitive battery (NeuroTrax™ Corp). This study was approved by the Helsinki Committee (IRB) of the Tel Aviv Sourasky Medical Center (TASMC) (0676-17-TLV), and all patients provided informed consent.

Research tools

-The Montreal Cognitive Assessment (MoCA) test. The MoCA is a brief cognitive screening tool for mild cognitive impairment (29). The maximum total score is 30 points, with a 1-point scoring correction for individuals with 12 years of education or less. A score of 26 or above is considered normal, whereas a score lower than 26 has been suggested to be the optimal cut-off point for a diagnosis of cognitive impairment (29) (Supplementary Fig. S1).

The MoCA test assesses a range of cognitive domains including:

a. Visuospatial/executive (5 points): trail making test (1 point), cube copy (1 point), clock draw (3 points);
b. Naming (3 points): lion (1 point), rhino (1 point), camel (1 point);
c. Memory: Immediate (no points);
d. Attention (6 points): digit forwards and backwards (2 points), tapping at each letter A (1 point), serial 7 subtraction (3 points);
e. Language (3 points): sentence repetition (2 points), verbal fluency, words beginning with F (1 point);
f. Abstraction (2 points): train-bicycle (1 point), watch- ruler (1 point);
g. Memory: delayed recall (5 points): face (1 point), velvet (1 point), church (1 point), daisy (1 point) red (1 point);
h. Orientation (6 points): date (1 point), month (1 point), year (1 point), day (1 point), place (1 point), city (1 point).

Here, the Hebrew version of the MoCA was used, which was validated and found to be a reliable tool for MCI screening (41). The MoCA has excellent test-retest reliability (correlation coefficient = 0.92, $p<0.001$) and adequate internal consistency, with a Cronbach's α of 0.83 (on the standardised items of the test) (29).

The NeuroTrax™ computerised cognitive battery (42) was used for the cognitive evaluation. The NeuroTrax has been validated for the detection of mild cognitive impairment in both clinical and research settings (43). It utilises standard neuropsychological tests adapted for computerised delivery, where the patient responds with the computer mouse or the keyboard. The test results are automatically uploaded to a central server, on which the raw outcome parameter data are corrected for age and education. The correction utilises an existing pool of individuals with no cognitive, neurological, or psychiatric impairments, adjusted to a standardised IQ scale (mean=100, SD=15) and index scores are computed for the average performance of individuals with similar cognitive performance (44). Neurotrax was found to be effective for mild cognitive impairment detection and able to provide a comprehensive profile of cognitive functioning (45). The Cronbach's α in the current study was 0.893.

The entire computerised cognitive battery takes 45 to 60 minutes and has been validated in English, Hebrew, Russian, and Spanish (46). Here, the Hebrew version of the Neurotrax was used. The following domains were evaluated: (1) memory, (2) attention, (3) information processing speed, (4) executive function, (5) motor skills.

Specifically, the subtasks were:

a. Verbal and non-verbal memory (memory).
b. Go-no-go response inhibition (attention + executive function).
c. Stroop interference (attention + executive function).
d. Staged information processing speed (attention + speed of processing).
e. Finger tapping, catch game (motor skills).

The outcome parameters include mean accuracy across trials, mean response time across trials and its standard deviation, and a composite score, computed as the mean accuracy divided by the mean response time.

Fibromyalgia Impact Questionnaire (FIQ)

The FIQ measures the overall effect of FM symptoms (47). The FIQ 1991 version has 19 items measuring three main domains: (a) "function"- ten items assessing the physical functions of the participant which address their ability to perform each activity. This domain is rated on a 4-point Likert scale from 0 to 3 (0= always, 1=frequently, 2=occasionally, 3=never). (b) "overall impact"- composed of two items assessing the number of days in the past week the participants felt well and the number of days they were not able to work due to FM symptoms. For example, the first item reads: "out of the seven days of the last week, for how many days did you feel good?" This domain is rated on a scale of 0 to 7, with one item about the number of days the participant felt well (where higher scores indicate impairment) and the second item about the number of days on which the patient missed work. The FIQ test-re-test reliability ranged from r=0.56–0.95 for the pain score and for a rating of 7 on physical function, respectively. Content validity for the physical functioning items was r=0.67, r=0.69 for the pain items, r=0.73 for depression items and r=0.76 for anxiety items (48). The FIQ has been translated into various languages, including the Hebrew version, which was used here (49).

The Widespread Pain Index (WPI)

The WPI is a valid scale of pain extent, which was previously described as a regional pain scale (50) and is composed of a list of 19 painful body areas, where patients indicate whether a specific area is painful or not on a scale ranging from 0 to 19 (51). The instructions are as follows: "mark the areas in which you felt pain in the past week"; for example, the left chest area. Here, the overall scale reliability was 0.94, the overall coefficient of scalability (H) was 0.52, representing a strong scale, and the Cronbach's α reliability=0.91 (50).

The Symptom Severity Scale (SSS)

The SSS assesses symptom severity in patients with or without FM and for those who do not fit the ACR criteria. The scale has 3 subscales: tiredness (on a scale of 0–3), unrefreshed waking (on a scale of 0–3) and cognitive symptoms (on a scale of 0–3). The instructions read "please note the severity of symptoms in the past week while using the following scales".

In addition to these subscales, respondents indicate whether they felt any of the following three symptoms (in the last six months): headache (1 point if present), lower abdominal pain/cramping (1 point if present) and depression (1 point if present). The total SSS scale score is the total sum and ranges from 0 to 12. The SSS was shown to be strongly correlated with the WPI (r=0.733) and with the Tender Point Count (r=0.680) (52).

The Beck Depression Inventory II (BDI-II)

The BDI-II is a 21-item questionnaire measuring the severity of depression symptoms, which is rated as a four-point scale (a 0–3 range) that yields a total score ranging from 0 to 63. For example, the first item is as follows: "(a) I don't feel sad (b) I feel sad (c) I am sad all the time and cannot stop it (d) I am so sad or miserable that I cannot stand it". The BDI-II has excellent internal consistency, with a Cronbach's α of 0.94. In addition, the BDI-II was shown to be a valid tool in primary medical care settings (53).

The General Anxiety Disorder Questionnaire (GAD-7)

The GAD-7 questionnaire is a 7-item scale measuring general anxiety disorder in both research and clinical settings (54), which is rated on a four-point scale (a 0–3 range) with a total score of 0 to 21. The instructions state: "during the last two weeks, how much have you been bothered by the following issues: feeling nervous, tense or on edge, on the above-mentioned scale?" The GAD-7 has excellent internal consistency with a Cronbach's α of 0.92 (54).

The Test of Memory Malingering (TOMM)

The TOMM is composed of two learning trials, each containing 50 pictures of common objects that are individually administered, such as a box of tissues, a mouse, a piece of cake, a suitcase, etc. Each learning trial is followed by a series of 50 two-choice recognition questions, in which the participant is requested to choose the picture that appeared in the learning trial. In addition, a retention trial is included in which only the 50 two-choice recognition panels are administered. The TOMM test is a valid and clinically useful measure of malingering or memory impairment. It has excellent face value as a memory and learning test and as a measure of memory function and is considered an appropriate measure of performance validity test (55).

Data analysis

An *a-priori* power analysis to estimate the required sample size (using GPower 3.1) (56) with an α=0.05 and power =0.80 indicated that the projected sample size required to detect a medium effect size (f=0.30) was approximately n=64 for correlations, with a point biserial model. Thus, a sample size of 62 patients was satisfactory.

Statistical analyses were performed using SPSS v. 26 software. In order to test the validity of the MoCA test, a Pearson test was conducted to examine possible correlations between the MoCA test and the Neurotrax computerised cognitive battery for the global scores and the indices of specific cognitive domains (Memory index score, Executive function index Score, Attention index score, Information processing speed index score and Motor skills).

Results

Descriptive statistics

Table I presents the means, standard deviations [SD], ranges and numbers of participants for the following demographic variables of age, gender, and education, and for the WPI, SSS, SS-cog (part of the SSS), BDI-II, GAD-7 and FIQ self-report questionnaires and cognitive score on the MoCA and for the Neurotrax computerised cognitive battery (global score and sub test scores).

Table II. Correlations between MoCA and the Neurotrax computerised cognitive battery.

	Pearson correlation	p (2-tailed)
Global cognitive score	0.493**	0.000
Memory	0.384**	0.002
Executive function	0.461**	0.000
Attention	0.310*	0.016
Information processing speed	0.435**	0.001
Motor skills	0.406**	0.002

*p<0.05; **p<0.01.

Table III. Correlations between MoCA and the study variables.

	Pearson Correlation	p (2-tailed)
SS-cog	-0.230	0.072
SSS-	0.186	0.148
WPI	-0.050	0.701
FIQ	-0.236	0.067
BDI-II	-0.180	0.162

*p <0.05; **p<0.01.
SS-Cog: Cognitive Symptoms Score; SSS: Symptom Severity Scale; WPI: Widespread Pain Index; FIQ: Fibromyalgia Impact Questionnaire; BDI-II: Beck Depression Inventory.

The Pearson correlations between the MoCA, the Global Cognitive score and the Neurotrax subtests were all significant, as shown in Table II.

The Pearson correlations between the MoCA test and the SS-cog, SSS, WPI, FIQ, BDI-II, FIQ and WPI questionnaires were not significant, as shown in Table III.

Discussion

The present study investigated whether the MoCA is an appropriate cognitive tool for assessing cognitive functioning in FM patients. We compared the MoCA scores against scores on the well-established Neurotrax computerised cognitive battery. The results indicated positive correlations between the MoCA and the global cognitive score and all the Neurotrax indices. All the correlations had a medium effect size (0.3–0.5), thus implying that the MoCA test is a satisfactory cognitive screening tool for evaluating cognitive functioning in FM patients.

These findings are consistent with previous studies. For example, the MoCA test was found to be a reliable cognitive screening tool as compared to the computerised cognitive battery (33) in patients with systemic lupus erythematosus patients (SLE), a rheumatological condition (exhibiting 16.2% comorbidity with FM). Moreover, a recent study demonstrated that the MoCA test may be a more sensitive cognitive screening tool than the MMSE for patients with fibromyalgia (40).

In line with the most recent ACR 2010 revision, cognition in FM clinical settings is mainly assessed on the SSS (12) self-report cognitive scales, which some studies have found to be invalid for evaluating cognitive dysfunction among FM patients (15, 19, 25, 26). Overall, the findings here indicated that the MoCA test can satisfactorily screen cognitive functioning among FM patients and has the advantage of being easy to administer by medical care practitioners and physicians.

In the present study, the overall cognitive functioning of our sample was below the cut-off according to the MoCA (<26; M=24.47 (3.14)) suggesting that as a group, the FM patients in our cohort suffered from cognitive "dysfunction". Note that all our patients passed the cognitive effort test (TOMM>45), thus indicating that the cognitive results obtained in the present study reflect actual dysfunction and not insufficient effort or response bias.

Consistent with the MoCA test results, the scores on the Neurotrax computerised cognitive assessment battery were in the "low average" range (all the subtest scores were between 80-89):

the lowest cognitive domains were attention (z=-1.1, 14%) and processing speed (z=-1.3, 10%). These findings are in line with previous works reporting that FM patients suffer primarily from attention deficits and lower processing speeds (20, 22).

In the present study no correlations were found between the subjective measure of cognitive decline (SS-Cog) and the MoCA score. This aligns with previous data indicating a discrepancy between self-report cognitive tools and more objective cognitive evaluations (15, 19). A recent study also reported that the SS-Cog was more closely related to daily functioning than to cognitive dysfunction (25), thus stressing the importance of using more objective tools (*e.g.* MoCA) to monitor cognitive dysfunction in FM patients, as suggested here.

Limitations

There are several limitations to this study. The sample size covered a wide age range from 21 to 78, which may constitute a limitation to generalisation to younger and older patients diagnosed or manifesting FM symptoms. Furthermore, the participants were recruited from one specific rheumatology clinic in the central region of Israel, which represents a specific population and not an international span of FM conditions. A study covering a more diverse population, from other rheumatology clinics in Israel or worldwide, could provide better indications for the sensitivity and applicability of the MoCA. Last, the tests were administered in a fixed order across subjects, which could have affected the results, Specifically, the Neurotrax was administered last, when the participants could have been influenced by fatigue. Nevertheless, the TOMM preceded the Neurotrax and all passed the test successfully. Future studies should use a counterbalanced methodology.

Future research

Given these promising results, future research should consider a comparison of the MoCA to other objective and more comprehensive cognitive tests, whether computerised or not, to further validate this screening test. In addition, studies should test the inclusion of younger age ranges, including teenagers and children to determine whether the MoCA as compared to other age-appropriate cognitive tests can adequately detect the cognitive deficits making up juvenile FM. This would expand the test to a larger population in Israel and elsewhere.

Conclusion

FM patients typically suffer from cognitive dysfunction, which is one of the criteria for the diagnosis of fibromyalgia and is typically based on self-report questionnaires and not on objective tests. Here we suggest using the MoCA test in daily clinical practice. Overall, the findings indicated that the MoCA is a valid cognitive screening test for cognitive evaluation of FM patients, which can be easily administered by medical care practitioners and physicians The MoCA test takes no more than 10 minutes to administer, is easy to interpret and gives good indications of the cognitive status of FM patients. The test results can indicate which cognitive domain may be weaker and as a result whether to consider further comprehensive cognitive assessment and/or related therapy such as cognitive rehabilitation.

Take home messages

- The lack of correlations between subjective and lengthy FM evaluations point to the need for a brief and valid evaluation tool for cognitive dysfunction in FM.
- Positive correlations were found between the MoCA and the Neurotrax comprehensive computerised cognitive assessment battery.
- The MoCA emerges as a valid cognitive screening test for the cognitive evaluation of FM patients.

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