Article

# The Use of MoCA and Other Cognitive Tests in Evaluation of Cognitive Impairment in Elderly Patients Undergoing Arthroplasty

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## Abstract

**Objective:** To examine the prevalence and effect of cognitive impairment on treatment outcomes in elderly patients undergoing arthroplasty and to describe the feasibility of cognitive tests. **Materials and Methods:** The participants were 52 patients with a mean age of 78 years 11 months (SD: 3.3), waiting for primary arthroplasty. We translated Montreal Cognitive Assessment (MoCA) into Finnish and compared it with Mini-Mental State Examination (MMSE), Mini-Cog, and clock-drawing tests prior to and 3 months after the surgery. The ability to perform activities of daily living, depression, quality of life, and years of education were evaluated. **Results:** The mean MoCA score on the first visit was 20.7 (SD: 4.1). The pre- and postoperative cognitive tests implied there were no changes in cognitive functioning. Unambiguous delirium was detected in 6 patients. Delirium was not systematically assessed and consequently hypoactive delirium cases were possibly missed. Both MMSE and Mini-Cog found 3/6 of those and clock drawing and MoCA 6/6. Low preoperative MoCA, MMSE, and Mini-Cog scores predicted follow-up treatment in health-care center hospitals (P = .02, .011, and .044, respectively). During the 5-year follow-up period, 11/52 patients died. Higher education was the only variable associated with survival. The survivors had attained the median of 8 (range: 4-19) years of education compared with 6 (range: 4-8) years among the deceased. **Conclusion:** The prevalence of cognitive impairment among older patients presenting for arthroplasty is high and mostly undiagnosed. It is feasible to use the MoCA to identify cognitive impairment preoperatively in this group. The clock-drawing test was abnormal in all patients with postoperative delirium, which could be used as a screening test. Higher education predicted survival on a 5-year follow-up period.

## Keywords

delirium, dementia, geriatric medicine, geriatric nursing, adult reconstructive surgery

## Introduction

Surgery and cognitive impairment are linked in many ways. First, cognitive impairment exposes a person to accidents.[1] Second, depending on the level of the cognitive impairment, the patient may have difficulty in understanding the consequences of their operation. Third, there is increased risk for postoperative delirium in patients with cognitive impairment.[2-4] Delirium, in turn, increases the risk for postoperative complications and mortality.[5,6] Cognitive impairment itself is a risk factor for poorer functional outcomes following surgery.[7] In addition, the recovery process may be complicated if the patient is unable to remember the care instructions. An assessment of cognitive functioning is often lacking in nursing and medical records.[8]

Up to now, there is no single ideal screening test for cognitive impairment used in Finland. Mini-Mental State Examination (MMSE) is fast and easy to use and remains the most commonly used cognitive screening test.[9] However, patients with mild cognitive impairment (MCI) often have MMSE scores within the normal range.

The Montreal Cognitive Assessment (MoCA) is a cognitive screening test developed by Nasreddine et al. It has a sensitivity of 90% for detection of MCI, whereas MMSE has a sensitivity of 18%. In the group with mild Alzheimer disease, sensitivity of 100% was reached by MoCA, whereas the MMSE detected 78%.[10] The specificity of MoCA in dementia and MCI is 43.5% to 50% which is significantly lower than 100% of the MMSE.[11,12] The low specificity of MoCA may result in a high rate of false positives. The MoCA has been translated and validated in several languages (www.moca.org) but not in Finnish. The results of validation studies are

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consistent with those of the original study.[11-13] The purpose of this study was to compare the MoCA in the context of pre-hospital screening with other cognitive tests.

## Materials and Methods

### Patients

The regional ethics committee approved the study and all the patients gave written informed consent prior to enrollment. We conducted this study in the outpatient clinic of the Päijät-Häme Central Hospital in Finland between March 17, 2009, and March 26, 2010. The study group consisted of 52 patients over 74 years, mean 79 (range: 74-87) years, and waiting for hip (24 patients) or knee (28 patients) replacement surgery. The mean body mass index (BMI) of these patients was 27.2 (range: 20-38). The patients' educational background was measured by their years of schooling, mean 8.1 (range: 4-19) years. Two patients had been diagnosed with Alzheimer disease, 2 had Parkinson disease, and 3 had previously suffered ischemic stroke. Cognitive assessment had been administered to 3 patients prior to our study. All the patients had advanced osteoarthritis and 93% of the patients required regular pain medication. One patient withdrew from the study before completing the first set of tests and 9 before the second set of tests. Their data were included in the analyses mutatis mutandis. One patient was able to fill the questionnaires on the first visit but not on the second.

### Assessment

In this study, cognitive impairment refers to an abnormal result in 1 or more cognitive tests. The tests used in this study are meant as screening tools for cognitive decline and therefore the diagnosis of MCI or dementia cannot be made based solely on these tests. Delirium refers to a common and serious acute neuropsychiatric syndrome with core features of inattention and global cognitive dysfunction.[14] The patients' cognitive status was assessed with the clock-drawing test from the Consortium to Establish a Registry for Alzheimer's Disease cognitive pattern,[15] MMSE,[9] MoCA,[10] and Mini-Cog test.[16] The MoCA test was double and reverse check translated into Finnish for the first time and its effectiveness was compared with other cognitive tests.

The ability to perform daily activities was evaluated by activities of daily living (ADLs)[17] and instrumental ADLs (IADLs) questionnaires.[18] Depression was screened with Geriatric Depression Scale (GDS).[19] The quality of life was assessed by the 15-dimensional (15D) instrument.[20] The tests were performed by a research nurse before and 3 months after the surgery (Figure 1). Both the surgeon's and the patient's own assessments of cognition were discussed prior to the surgery. If the test results arouse the suspicion of a dementing disease or depression, the patient was sent to a local health-care center for administering further assessments.

The surgical operation was carried out in accordance with normal clinical practice. The patients usually arrived at the hospital on the morning of the surgery. On the third or fourth
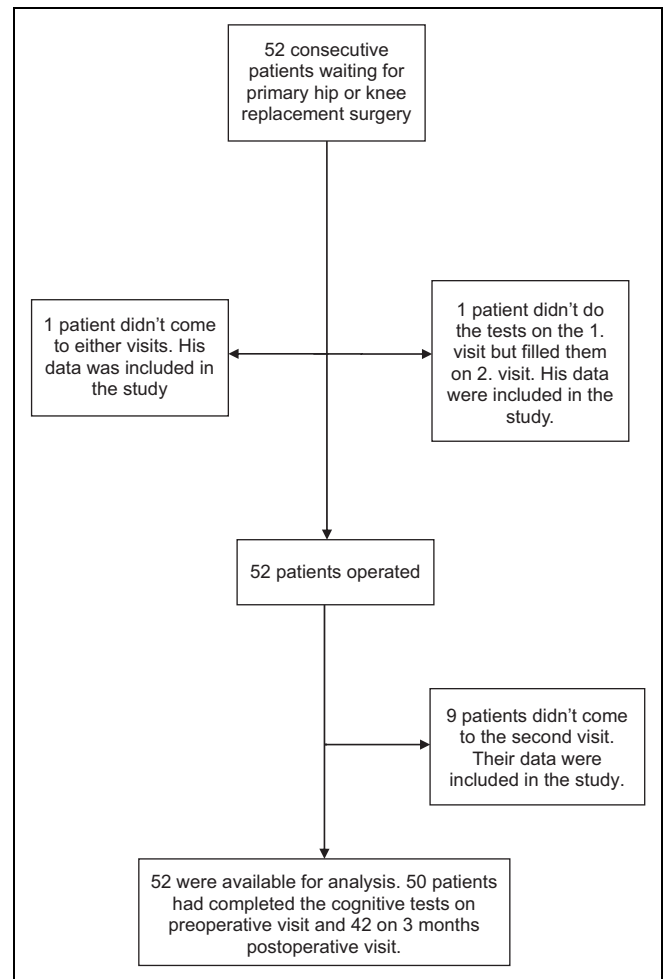


**Figure 1.** Flowchart.

day after the surgery, the patients were discharged or transferred to a health-care center hospital for rehabilitation.

The occurrence of complications was based on medical record entries and nurses' notes. Delirium was not systematically assessed (eg, by using confusion assessment method). The clinical outcome of the surgery was assessed by the information entered in the Harris Hip Score and Modified Knee Society Score register. The operation was considered successful if postoperative increase in the Harris Hip Score was over 20 points. A postoperative Harris Hip Score under 70 was considered poor, 70 to 79 fair, 80 to 89 good, and 90 to 100 excellent. Modified Knee Society Score is modified from the original so that instead of 200 the maximum score is 100. Both original and Modified Knee Society Scoring systems comprise a knee score and a functional score. The knee score of 80 to 100 is rated as excellent, 70 to 79 good, 60 to 69 fair, and less than 60 poor.[21] After a 5-year follow-up period the patients' medical records were checked to see which of the patients were deceased.

### Statistics

Data from the questionnaires were entered manually into Microsoft Excel 2010 (Microsoft Excel version

**Table 1.** Findings of Cognitive Tests of 50 Patients.

| Test | Definition of Abnormal | Amount of Abnormal (%) |
|---|---|---|
| Montreal Cognitive Assessment | 25/30 or below | 46 (92%) |
| Clock-drawing test | 4/6 or below | 28 (56%) |
| Mini-Cog | 0 recalled words or 1-2 recalled words and abnormal clock-drawing test | 16 (32%) |
| Mini-Mental State Examination | 24/30 or below | 11 (22%) |

**Table 2.** Association Between Operative Results and Preoperative MoCA—Test Results.

| | MoCA Normal (>25), n = 4 | MoCA Abnormal (≤25), n = 46 | Total, N = 50 |
|---|---|---|---|
| 5-Year mortality (%) | 1 | 9 | 10 (20) |
| Complication[a] (%) | 1 | 2 | 3 (6) |
| Postoperative delirium (%) | 0 | 6 | 6 (12) |
| Postoperative hip or knee score mean (range) | 82 (71-81) | 78 (3-98) | 78 (3-98) |
| Discharged home (%) | 1 | 17 | 18 (36) |
| Length of stay in central hospital median (range) | 3 (3-4) | 4 (3-8) | 3 (3-8) |
| Length of stay in health-care center hospital median (range, n) | 3 (3-3)[1] | 7 (1-25)[20] | 6 (1-25)[21] |

Abbreviation: MoCA, Montreal Cognitive Assessment.
[a]Periprosthetic fracture 1, hypertensive crisis 1, and ileus 1.

14.0.7172.5000 © 2010 Microsoft Corporation). Statistical analyses were performed using SPSS version 21. No imputation of missing values was done. $t$ Test was used for continuous variables and $\chi^2$ test was applied to categorical data. Binary regression analyses were used for estimating the relationships. We assessed whether MoCA, MMSE, Mini-Cog, clock-drawing test, ADLs, IADLs, 15D, or GDS results would explain this setback for treatment. A $P$ value of less than .05 was considered statistically significant. The receiver–operating characteristic (ROC) curve and Youden index were used to evaluate MoCA's and MMSE's ability for classifying disease status in terms of postoperative setbacks. Postoperative delirium and follow-up treatment in a health-care center hospital were considered as setbacks.

## Results

The preoperative MoCA showed cognitive decline in 46 of 50 patients (Table 1). The MoCA was the most laborious of the tests, taking about 20 minutes to complete. Completing and scoring clock-drawing test took only a few minutes, Mini-Cog about 5 minutes, and MMSE 10 minutes. The clock-drawing test was easy to execute and it detected 64% of those with abnormal results in MoCA, 36% in Mini-Cog, and 24% in MMSE.

Only 2 of the patients had a statement about their cognition in medical files made by the surgeon. The statements were "decent" and "memory impaired." When asked for further information on the patients' cognition, the surgeon estimated that 9 of 37 patients had slightly impaired cognition. All of these patients had abnormal MoCA score. The surgeon considered 28 patients as cognitively normal although they had an abnormal MoCA score. The surgeon recognized 2 of 11 patients who had an abnormal (<25/30) MMSE score. Two of the patients had an assessment made by an anesthetist before the surgery; neither included a statement about cognition. Of 11 patients, 8 had a good understanding of their cognitive dysfunction according to MMSE and 27 of 45 according to MoCA. The problem with the self-evaluation was that the patients thought that their cognition was impaired although it was normal according to MMSE in 76%, clock drawing in 52%, and MoCA in 10% of the cases. The postoperative cognitive tests at 3 months after the surgery showed no significant changes in cognitive functioning. There was no immediate

postoperative mortality. Three of the 50 patients had complications following the surgery. The surgical outcome was good (Table 2). The Harris Hip Score and Modified Knee Society Score improved significantly (mean improvement 35.3, $P = .001$). At the follow-up visit 3 months after the surgery, the quality of life (15D) and the ADLs remained unchanged, but the IADLs had declined significantly (Table 3).

Six patients were clinically diagnosed with delirium. All 6 patients with delirium had cognitive deficits according to preoperative MoCA. Preoperative MMSE and Mini-Cog found 3/6 of delirium patients and clock drawing 6/6. Patients with delirium had an abnormal score of <25 on the MoCA. The median hospital stay was 3 (range: 3-8) days; 18 patients were discharged home and 32 were transferred to health-care center hospitals. Treatment in a health-care center hospital was received by 23 of 32 patients, the mean period being 8 (range: 1-25) days. Low preoperative MoCA, MMSE, and Mini-Cog scores predicted the need for treatment in health-care centers ($P = .02$, .011, and .044, respectively). The mean MoCA score of those discharged home was 22.35 (SD: 2.473) and of those transferred to health-care centers was 19.15 (SD: 4.647) The mean MMSE score of those discharged home was 27.41 (SD: 1.839) and 25.11 (SD: 3.055), and the mean Mini-Cog score of those discharged home was 3.53 (SD: 1.125) and 2.68 (SD: 1.249). The ADLs, IADLs, or clock-drawing test did not predict the need for follow-up care. None of the variables predicted the duration of hospitalization. However, there was a trend toward a higher baseline ADLs score predicting shorter hospitalization ($P = .051$). Two of 6 patients who had delirium were discharged home.

An abnormal preoperative MoCA score (≤25) predicted decreased IADLs after the surgery ($P = .019$, mean score decreased 0.48 points), while there was no significant change in ADLs or 15D in patients with either normal or abnormal MoCA scores. The IADLs did not change significantly in patients with normal MoCA scores. The patients with a very

**Table 3.** Changes in the Scores of Quality of Life and Daily Performance Before and After Surgery.

|  | Mean | Standard Deviation | 95% Confidence Interval of the Difference, Lower | 95% Confidence Interval of the Difference, Upper | Significance, P |
|---|---|---|---|---|---|
| ADLs-ADLs2 | 0.19 | 1.04 | −0.134 | 515 | .25 |
| IADLs-IADLs2 | 0.43 | 1.06 | 0.097 | 0.760 | .012 |
| 15D-15D2 | 0.27 | 3.5 | −0.841 | 1.378 | .63 |

Abbreviations: ADL, preoperative activities of daily living; ADLs2, postoperative activities of daily living; IADLs, preoperative instrumental activities of daily living; IADLs2, postoperative instrumental activities of daily living; 15D, preoperative quality of life; 15D2, postoperative quality of life.

low (<19) preoperative MoCA score did not show a less favorable outcome in terms of ADLs, IADLs, or 15D than those patients whose MoCA score was higher.

A low preoperative MoCA or MMSE score predicted either delirium or follow-up care in a health-care center hospital ($P = .038$, odds ratio [OR] = 0.814 and $P = .043$, OR = 0.721, respectively). If the goal is to predict whether a patient will have 1 of these setbacks, according to MoCA, the Youden index would be highest (1.415) at 19 points. For MMSE, the Youden index is highest (1.296) at 24.5 points, which is close to the general cutoff score of 25.

The length of the total duration of hospital care, including treatment periods both in central hospital and in health-care center hospital was associated with low preoperative ADLs ($P = .011$) but not with any other variable including postoperative delirium.

Increasing age predicted lower Mini-Cog and MoCA scores ($P = .001$ and .02, respectively). The ADLs, IADLs, 15D, GDS, and BMI did not correlate with increasing age. Mean preoperative pain scores were similar in patients with high and low MoCA scores. There was no association between MoCA and 15D scores. There was no statistically significant association with preoperative cognitive test results and postoperative ADLs, IADLs, Harris, or Knee society scores.

The mean follow-up time was 5 years 1 month (range: 4 years 11 months-5 years 8 months). During the follow-up, 11/52 patients died. Higher education was the only variable associated with survival ($P = .017$). The median education time was 8 (range: 4-19) years among the survivors and 6 (range: 4-8) years among the deceased. Cognitive status was not associated with survival, but almost all our patients had impaired cognition according to MoCA.

## Discussion

This observational study demonstrated a significant burden of undiagnosed cognitive impairment in elderly (mean age 79 years) patients undergoing arthroplasty. Our findings show it is difficult for the surgeons to recognize cognitive decline. The 2 patients who scored worst on each of the tests were considered cognitively normal by the surgeon. Cognitive impairment and the risk for postoperative delirium are not routinely addressed in current preoperative services. The prevalence of cognitive impairment detected using the MoCA in our study was high. The cutoff value (92% with a cutoff value of 26/30 and 78% with 24/30) also played a major role. In a study by Hewitt et al of acute general surgery patients over 65 years (mean age 76.9), the prevalence of cognitive impairment detected using the MoCA was 66.9%.[22] Only 2 of our participants had a previously diagnosed Alzheimer disease. The high percentage of patients with undiagnosed cognitive impairment may be caused by the low specificity of MoCA. The lack of a clear cutoff score for abnormal MoCA resulted in unclear statistics and outcomes. There is an ongoing validation study to define the accurate cutoff score for MoCA in the Finnish population.

When the MoCA was described, the authors used a cutoff value of <26/30 to define MCI as validated by a neuropsychological battery.[10] More recent studies propose a cutoff score of 24/30 in patients with cardiovascular disease and diabetes, with preserved sensitivity and specificity compared with the Neuropsychological Assessment Battery Screening Module.[23] A cutoff score of 23/30 has also been used in a recent study.[24]

We present here the first estimate of the prevalence of cognitive impairment with Finnish surgical patients assessed by the MoCA translated into Finnish and compare it to the established cognitive tests. The MoCA proved to find significantly more patients with impaired cognition compared to other tests. The ROC curve used suggests a cutoff value of 19/30 for the Finnish population to determine patients susceptible to setbacks (either delirium or follow-up care in a health-care center) after surgery.

The results of our study suggest that MoCA is a feasible screening instrument to assess mild to moderate cognitive decline. The MoCA is more sensitive than MMSE, and it takes only 20 minutes to complete and is easy to interpret. In the surgical setting, it is important to obtain a valid informed consent. These findings show that many older people admitted to elective surgery may lack the capacity to make informed decisions. The MoCA score range of 18 to 26 is graded MCI[10] and with these individuals a valid consent can probably still be obtained.

In a study by Daniels et al, the mean preoperative pain scores were significantly higher for patients whose MoCA score was <23 than for those with higher MoCA scores.[24] In our study, low MoCA scores were not associated with higher preoperative pain scores. Increasing age predicted lower MoCA scores in this population. The results of previous studies have been conflicting regarding the association of abnormal MoCA scores and older age.[22,25]

In our study, the clock-drawing test was abnormal in all the patients with postoperative delirium. The preoperative clock-drawing test was abnormal in 28/50 patients. If there is not enough time to screen aged surgical patients with MoCA, the

clock-drawing test can be considered a feasible method to screen patients at risk of postoperative delirium and for further cognitive assessment. Further studies are needed to confirm this.

According to some reports, clinicians fail to recognize delirium in up to 66% of cases.[26] Delirium may have also gone unnoticed in our study as postoperative delirium was not systematically assessed but was determined retrospectively based on physicians' medical record entries and nurses' notes.

Our study shows that patients with cognitive decline have a need for longer institutional care. Cognitive decline proved to be a reliable risk factor in predicting delirium. Higher education predicted survival in a 5-year follow-up period. This is in line with previous research results.[27] In our study, postoperative delirium, sex, age, BMI, operated joint, follow-up care in a health-care center hospital, performance (ADLs, IADLs), or any of the questionnaires or cognitive tests used did not predict death.

## Declaration of Conflicting Interests

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## Funding

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