

## Clinical Article

# The Prevalence of Undiagnosed Presurgical Cognitive Impairment and Its Postsurgical Clinical Impact in Older Patients Undergoing Lumbar Spine Surgery

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**Objective :** Because elderly patients are undergoing more surgeries, the importance of postoperative cognitive impairment (CI) evaluations is rising, especially for spine surgery, which is related to subjective pain. We investigated the prevalence of undiagnosed CI among elderly patients who underwent spine surgery and the impact of CI on postoperative outcomes.

**Methods :** The preoperative cognitive statuses of 129 patients over 65 who underwent lumbar spine surgery from 2012 to 2014 were determined with the Mini-Mental State Examination, and patients with scores under 24 were diagnosed with CI. The patients were then divided into a CI group (n=49) and non-cognitive impairment (NCI) group (n=80).

**Results :** Among the 129 patients, 49 (38.0%) were diagnosed with CI, and 9 (7.0%) had severe CI. The age of the CI group (72.88±6.20 years) was significantly greater than that of the NCI group (69.96±4.53 years). In contrast, the postoperative visual analog scale scores and performance statuses did not differ significantly. However, postoperative delirium was more frequent and the hospital stay length was longer in the CI group compared with the NCI group ( $p<0.05$ ).

**Conclusion :** A high prevalence of undiagnosed CI was discovered among elderly patients undergoing spine surgery. The existence of CI was associated with higher rates of postoperative delirium and prolonged hospital stays, which affected clinical outcomes. Thus, CI assessments should be included in preoperative evaluations of elderly patients prior to spine surgery.

**Key Words :** Cognitive impairment · Lumbar spine surgery · Postoperative delirium · Elderly patients.

## INTRODUCTION

Postoperative cognitive dysfunction (POCD), which is a common neurological complication that presents after surgery, has been reported in 33–83% of patients undergoing cardiovascular surgeries<sup>16)</sup> and 9.9–12.7% of patients undergoing non-cardiac surgeries<sup>9,10)</sup>. We have previously reported that POCD occurs in 24.3% of patients being treated with spine surgeries<sup>12)</sup>.

In order to assess POCD, cognitive impairment (CI) is assessed before the surgery in order to obtain a baseline. Hogue et al.<sup>5)</sup> have reported that 45% of female patients undergoing coronary artery bypass graft (CABG) surgery show preexisting cognitive impairment (PreCI), while Silbert et al.<sup>14)</sup> reported PreCI in 35% of their patients before elective CABG surgery. Recently, 20% of the patients who were scheduled for total hip joint replacement surgery showed PreCI<sup>11)</sup>.

Although it is important to assess cognitive function before all surgeries, the existence of PreCI before degenerative lumbar spine surgery, which is used to treat subjective pain and functionality, has a particularly large impact on postoperative care and prevention and on the determination of the treatment plan, surgical methods, and extent of surgery.

The aim of our study was to investigate the prevalence of PreCI in patients undergoing degenerative lumbar spine surgery and to explore the effects of PreCI on the surgery and postoperative care.

## MATERIALS AND METHODS

The subjects in this study were selected from among 237 patients who were over 65 years old and who underwent lumbar spine surgery between 2012 and 2014. Of these, we excluded

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patients with preexisting neurological deficits (e.g., stroke) and patients who were expected to have difficulties with the neuropsychological assessment (foreigner, blindness, deafness, etc.). Of the remaining 217 patients, 140 who underwent lumbar surgery for degenerative spine disease were registered for the study. After excluding 11 patients who were not able to perform the Korean Mini-Mental State Examination (K-MMSE), the remaining 129 patients were included in the final study (Fig. 1).

**Cognitive assessment tool**

Cognitive function was measured with the K-MMSE prior to the surgery<sup>4)</sup>. Scores of 24–30 were classified as no CI, 18–23 were mild CI, and under 17 were considered severe CI. The assessment was conducted in a quiet space within a general ward and without external disruption or interference. First, the patient or guardian (caregiver or relative) was interviewed about whether the patient had previously been diagnosed with dementia or if they had discovered any memory problems. Next, it was reconfirmed in a clinical record review whether the patient had any prior diagnosis or medical record that might indicate dementia or CI. All of the cognitive assessments were conducted by trained assessors.

**Data collection**

For data collection, the patients were divided into two groups according to the presence or absence of CI. Baseline demographic data was collected through the review of the clinical records. The pre-operative data included age, sex, marital status, smoking, alcohol, comorbid conditions, education background, and preadmission medication. In addition, surgical type and laboratory abnormalities, such as complete blood count and metabolic panel (e.g., sodium, blood urea nitrogen, creatinine, albumin) were investigated. Prior to the surgery, the Eastern

Cooperative Oncology Group (ECOG) performance status was used as a scale to assess the patients’ mental state and level of physical activity<sup>15)</sup>. Because the presence of pain may affect performance during cognitive testing, this was assessed with a visual analog scale (VAS). Finally, we investigated the length of time from when the patients were admitted to the hospital to the start of the surgery.

For the postoperative data, we investigated postoperative complications, including delirium, myocardial infarction, and urinary tract problems. In addition, we collected data on the presence or absence of re-operation, changes in the surgical plan, surgery time, discharge medication, and length of stay. The ECOG performance status was used to assess the patients’ mental states and physical activities after surgeries, and the VAS was used to assess pain. Finally, postoperative delirium was diagnosed with the Confusion Assessment Method<sup>13)</sup>.

**Statistical analysis**

For the three groups, Student’s t-tests, Mann-Whitney U-tests, and chi-square tests were used to test the comparisons. *p* values less than 0.05 were considered statistically significant. The statistical analyses were performed with SPSS software version 18.0 (IBM Corporation, Armonk, NY, USA).

**RESULTS**

The cognitive assessments were performed on each of the 129 patients, and 49 patients (38% of the total) were determined to have CI group. Within the CI group, 40 patients had K-MMSE scores of 18–23, which indicated mild CI, and 9 patients had K-MMSE scores below 17, which indicated severe CI (Table 1).

We compared the patient characteristics between the CI group and the non-cognitive impairment (NCI) group. The mean age of the CI group was 72.88±6.20 years old, and that of the NCI group was 69.96±4.53 years old, which indicated that the CI group was significantly older (*p*=0.005). The sex ratio (M : F) for the CI group was 14 : 35, and that for the NCI group was 37 : 43, with no significant difference between the groups. Marital status, smoking, and alcohol showed no significant differences between the groups (*p*>0.05) (Table 2).

We investigated the comorbid conditions prior to surgery. Although we found a number of conditions, such as hypertension, cardiovascular disease, diabetes mellitus, asthma, renal disease, and cancer, there were no statistically significant differences between the CI group and the NCI group. Preoperative ECOG performance status, presurgical medication, surgical method, and laboratory abnormalities did not differ between

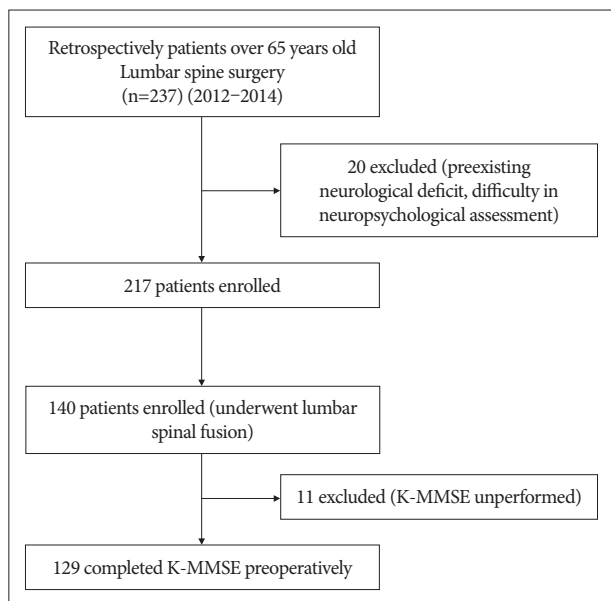


Fig. 1. Flow chart. K-MMSE : Korean Mini-Mental State Examination.

Table 1. Prevalence of cognitive impairment

| Cognitive impairment               | n (total=49) | Prevalence (%) |
|------------------------------------|--------------|----------------|
| Non-diagnosed cognitive impairment | 49           | 38.0           |
| Mild cognitive impairment          | 40           | 31.0           |
| Severe cognitive impairment        | 9            | 7.0            |

the groups ( $p>0.05$ ). The time from hospital admission to the start of surgery was  $4.59\pm 4.59$  days for the CI group and  $3.82\pm 7.01$  days for the NCI group, which again showed no statistically significant difference ( $p>0.05$ ).

**Table 2.** Patient characteristics

| Characteristics                              | CI group (n=49) | NCI group (n=80) | p value |
|--|-----------------|------------------|---------|
| Age (years)                                  | 72.88±6.20      | 69.96±4.53       | 0.005   |
| Sex (M : F)                                  | 14 : 35         | 37 : 43          | 0.063   |
| Marital status                               | 49              | 79               | 1       |
| Smoking                                      | 5/44            | 14/66            | 0.313   |
| Alcohol                                      | 6/43            | 18/62            | 0.169   |
| Comorbid conditions                          |                 |                  |         |
| Hypertension                                 | 31              | 53               | 0.205   |
| Cardiovascular disease                       | 3               | 10               |         |
| Diabetes mellitus                            | 22              | 21               |         |
| Asthma                                       | 9               | 5                |         |
| Renal disease                                | 2               | 3                |         |
| Cancer                                       | 3               | 5                |         |
| Education background (years)                 |                 |                  |         |
| <6   | 30              | 23               | 0.001   |
| 6–9  | 10              | 19               |         |
| 9–12   | 8               | 27               |         |
| >12  | 1               | 11               |         |
| VAS  | 6.82±1.20       | 6.70±0.83        | 0.191   |
| Preoperative ECOG performance (0/I/II/III)   | 1/21/20/7       | 0/45/27/8        | 0.309   |
| Preadmission medication                      |                 |                  |         |
| NSAID  | 34              | 66               | 0.864   |
| Tramadol                                     | 30              | 43               |         |
| Opioid                                       | 4               | 8                |         |
| Gabapentin                                   | 11              | 20               |         |
| Steroid                                      | 1               | 2                |         |
| Surgical type                                |                 |                  |         |
| PHLD   | 1               | 4                | 0.886   |
| PSF  | 6               | 7                |         |
| TLIF   | 24              | 38               |         |
| DLIF   | 17              | 29               |         |
| OLIF   | 3               | 5                |         |
| Laboratory abnormality                       |                 |                  |         |
| Hematocrit <30.0                             | 2               | 0                | 0.142   |
| BUN/Cr >20                                   | 7               | 14               | 0.807   |
| WBC count >12000                             | 3               | 2                | 0.367   |
| Sodium <130                                  | 1               | 0                | 0.380   |
| Albumin <3.5                                 | 15              | 16               | 0.205   |
| Time from admission to initiation of surgery | 4.59±4.59       | 3.82±7.01        | 0.497   |

CI : cognitive impairment, NCI : non-cognitive impairment, ECOD : Eastern Cooperative Oncology Group, NSAID : nonsteroidal anti-inflammatory drugs, PHLD : partial hemilaminectomy and discectomy, PSF : pedicle screw fixation, TLIF : transforaminal lumbar interbody fusion, DLIF : direct lumbar interbody fusion, OLIF : oblique lumbar interbody fusion, BUN : blood urea nitrogen, WBC : white blood cell

We also investigated the patients' educational background. Education level was the duration of education that the patients received, and it was classified as less than 6 years, 6–9 years, 9–12 years, and 12 years or more. With these categories, the CI group showed 30, 10, 8, and 1 patients, respectively, while the NCI group showed 23, 19, 27, and 11 patients, respectively, which confirmed that the NCI group had a significantly higher educational background ( $p=0.001$ ). The presurgical VAS scores were  $6.82\pm 1.20$  for the CI group and  $6.70\pm 0.83$  for the NCI group, which was not a significant difference ( $p>0.05$ ) (Table 2).

For the postoperative outcomes, we investigated the complications that occurred after the surgery. There were cases of delirium, nausea/vomiting, urinary tract symptoms, myocardial infarction, ileus, pulmonary thromboembolism, and deep vein thrombosis, but only delirium showed a significant difference between the two groups. Delirium showed a prevalence of 24% (12 of 49 patients) in the CI group and only 8% (6 out of 80 patients) in the NCI group ( $p=0.009$ ). Four patients each in the CI group and NCI group underwent re-operation, and there was no statistically significant difference. There were 7 patients in the CI group and 13 patients in the NCI group who had changes in their surgical plans, but this was not a statistically significant difference. No significant differences were found between the two groups for surgery duration, pain after surgery, medication on discharge, and preoperative ECOG performance status ( $p>0.05$ ). We investigated the length of stay for the CI group ( $19.59\pm 15.37$  days) and NCI group ( $10.37\pm 8.71$  days) and found a statistically significant difference and ( $p<0.001$ ) (Table 3).

## DISCUSSION

Inouye et al.<sup>6,7</sup> have presented a multifactorial model for delirium, which showed a close association of postoperative delirium with predisposing factors (e.g., dementia and severe illness) and precipitating events (e.g., major surgery, anesthesia, and multiple psychoactive medications). The factor with the biggest impact on postoperative delirium in hip fracture and spine surgery has been reported to be preoperative dementia<sup>8,12</sup>. Although there have been reports about the precise assessment and incidence of preoperative dementia in cardiac surgery, few studies have been performed on the assessment and incidence of preoperative CI for spine surgery, in which subjective symptoms are very important.

CI in elderly patients before and after surgery have mostly been studied for cardiac surgery. In coronary artery bypass surgery, PreCI prevalence has been reported as 35–45%<sup>5,14</sup>. Moreover, PreCI has been reported to be present in 20% of patients undergoing total hip joint replacements<sup>1</sup>. In our case, even after excluding the patients who had been diagnosed with dementia, 38% of the patients showed non-diagnosed CI, and, of these, 18% showed severe CI. These figures were similar to those reported for the cardiac surgery patients, which we suggest is probably because, like cardiac surgery, spine surgery patients

**Table 3.** Postoperative complications and outcomes

| Complications and outcomes                  | CI group (n=49) | NCI group (n=80) | p value |
|---|-----------------|------------------|---------|
| <b>Complication</b>                         |                 |                  |         |
| Delirium*                                   | 12              | 6                | 0.009   |
| Nausea/vomiting                             | 3               | 3                | 0.673   |
| Urinary tract symptom                       | 9               | 10               | 0.444   |
| Myocardial infarction                       | 1               | 0                | 0.38    |
| Ileus                                       | 5               | 5                | 0.503   |
| Pulmonary thromboembolism                   | 1               | 0                | 0.38    |
| Deep vein thrombosis                        | 1               | 0                | 0.38    |
| Re-operation                                | 4               | 4                | 0.436   |
| Change of surgical plan                     | 7               | 13               | 0.808   |
| Surgery time                                | 224.69±95.68    | 206.75±89.14     | 0.283   |
| VAS   | 2.18±0.75       | 2.19±0.92        | 0.754   |
| Postoperative ECOG performance (0/I/II/III) | 15/28/6/0       | 32/41/7/0        | 0.522   |
| <b>Discharge medication</b>                 |                 |                  |         |
| NSAID                                       | 33              | 49               |         |
| Tramadol                                    | 37              | 66               |         |
| Opioid                                      | 12              | 15               |         |
| Gabapentin                                  | 20              | 25               |         |
| Steroid                                     | 2               | 5                |         |
| Length of stay*                             | 19.59±15.37     | 10.37±8.71       | <0.001  |

\*p<0.001. CI : cognitive impairment, NCI : non-cognitive impairment, VAS : visual analog scale, ECOG : Eastern Cooperative Oncology Group, NSAID : nonsteroidal anti-inflammatory drugs

are mostly elderly. Moreover, given that this level of prevalence before surgery is lower than that for hypertension but higher than those for diabetes mellitus or smoking, we suggest that there needs to be a preoperative assessment of CI. In addition, in order to investigate postoperative cognitive changes, baseline cognitive function needs to be accurately evaluated prior to surgery.

Partridge et al.<sup>11)</sup> have researched undiagnosed CI in older vascular surgical patients. In that study, CI or dementia was found in 68% of the patients (77 of 114), and it was previously unrecognized in 88.3% of the patients (68 of 77), which indicated that 60.5% of the patients (68 of 114) who were aged 60 years or older and who were presenting for vascular surgery had previously undiagnosed CI. Although these figures are higher than those of our study, a high number of patients with undiagnosed CI has been reported in several studies for vascular surgery and spine surgery.

Several studies have reported that postoperative delirium increases hospitalization, in-hospital cost, and mortality, and the reported risk factors include advanced age and a personal history of alcohol/drug abuse, depression, psychotic disorders, neurological disorders, anemia, fluid/electrolyte disorders, and weight loss. Moreover, postoperative delirium occurs more frequently in the PreCI group, and their duration of stay is longer<sup>2,3,12)</sup>. Therefore, interventions that increase the early detection of delirium have the potential to decrease the severity and duration of delirium and prevent unnecessary suffering and

costs from the complications of delirium and unnecessary readmissions to the hospital<sup>2)</sup>.

One limitation of this study was that only the MMSE was used to assess CI. Because there was a difference in educational background between the groups before surgery, additional assessments of CI are required, including a neurocognitive battery, a memory clinic diagnosis of vascular CI, and radiological study. Although the preoperative cognitive assessment was performed without interruption prior to the surgery, the physical environment or the patient's education level is likely to have affected the CI test results. Although we tried to select a homogeneous group of patients who were undergoing lumbar spinal fusion at 65 years or older, the number of patients who were examined in this study was small, and there was no assessment of the surgery duration or anesthesia methods for lumbar spinal fusion. In the future, a large-scale assessment of preoperative CI and postoperative delirium in spinal surgery will be required.

**CONCLUSION**

A high prevalence of undiagnosed CI was discovered among elderly patients undergoing spine surgery. The existence of CI is associated with higher rates of postoperative delirium and prolonged hospital stays, which appears to affect clinical outcomes. Therefore, these results suggest that CI should be included in the preoperative evaluations that are performed prior to spine surgery on elderly patients.

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