Original Study

The prevalence of undiagnosed pre-surgical cognitive impairment and its post-surgical clinical impact in elderly patients undergoing surgery for adult spinal deformity

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Background: Pre-existing cognitive impairment (CI) is emerging as a predictor of poor post-operative outcomes in elderly patients. Little is known about impaired preoperative cognition and outcomes after elective spine surgery in this patient population. The purpose of this study was to assess the prevalence of neuro CI in elderly patients undergoing deformity surgery and its impact on postoperative outcomes.

Methods: Elderly subjects undergoing elective spinal surgery for correction of adult degenerative scoliosis were enrolled in this study. Pre-operative baseline cognition was assessed using the Saint Louis Mental Status (SLUMS) test. SLUMS consists of 11 questions, which can give a maximum of 30 points. Mild CI was defined as a SLUMS score between 21–26 points, while severe CI was defined as a SLUMS score of ≤20 points. Normal cognition was defined as a SLUMS score of ≥27 points. Complication rates, duration of hospital stay, and 30-day readmission rates were compared between patients with and without baseline CI.

Results: Eighty-two subjects were included in this study, with mean age of 73.26±6.08 years. Fifty-seven patients (70%) had impaired cognition at baseline. The impaired cognition group had the following outcomes: increased incidence of one or more postoperative complications (39% *vs.* 20%), higher incidence of delirium (20% *vs.* 8%), and higher rate of discharge institutionalization at skilled nursing or acute rehab facilities (54% *vs.* 30%). The length of hospital stay and 30-day hospital readmission rates were similar between both cohorts (5.33 *vs.* 5.48 days and 12.28% *vs.* 12%, respectively).

Conclusions: CI is highly prevalent in elderly patients undergoing surgery for adult degenerative scoliosis. Impaired cognition before surgery was associated with higher rates of post-operative delirium, complications, and discharge institutionalization. CI assessments should be considered in the pre-operative evaluations of elderly patients prior to surgery.

Keywords: Surgery; elderly; postoperative complications; cognitive dysfunction

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Introduction

Cognitive impairment (CI) is a relatively common, yet often undiagnosed condition among the elderly population. Prior studies have suggested that approximately 16% of elderly patients over the age of 70 years old have mild cognitively impairment (1,2). According to the U.S. Preventative Service Task Force, cognitive function is not routinely assessed either pre-operatively or post-operatively, with increasing cognitive decline after surgery (3,4). Therefore, given the paucity of data on the effects of CI and associated surgical risks, surgeons face challenging clinical decisions operating on a rapidly aging population (5).

Cognitive status and impairment is commonly assessed by the Saint Louis University Mental Status (SLUMS) examination, which is a 30-point screening questionnaire that tests orientation, memory, attention, and executive functions (6-8). Prior studies have found that elderly patients are at a greater overall risk for increased surgical complications, as well as inferior quality of life outcomes. While, a variety of demographic and comorbidity preoperative risk factors have been identified as independent predictors of inferior surgical outcomes, CI is rarely included. Patients with impaired cognitive status have been found to be at an increased risk for developing post-operative cognitive dysfunction (POCD), a condition afflicting nearly 24.3% of patients undergoing spinal surgery (1). However, the relationship between pre-existing CI and post-operative outcomes in the elderly spinal surgery population remains relatively unknown.

The aim of this study is to determine the prevalence of CI and its potential impact on post-surgical outcomes in elderly spine deformity patients after elective spinal surgery.

Methods

Patient selection

This was an ambispective study of 82 elderly patients (≥65 years old) undergoing a planned elective spinal surgery for correction of adult degenerative scoliosis at major academic institution. Institutional Review Board approval was obtained prior to study's initiation. Inclusion criteria included patients with: (I) adult degenerative scoliosis; (II) who were ≥65 years; (III) available preoperative cognitive SLUMS assessments; (IV) available postoperative complications and functional status; and (V) who underwent multilevel lumbar decompression and fusion. Patients with prior spinal surgery were excluded.

Demographic variables included age and sex. Comorbidities assessed included body mass index (BMI), smoking status, congestive heart failure (CHF), coronary artery disease (CAD), cardiovascular disease (CVD), myocardial infarction (MI), hypertension (HTN), atrial fibrillation (AFib) and diabetes mellitus (DM). Intraoperative complications assessed included durotomy, nerve root injury, and spinal cord injury. Postoperative complications assessed included delirium, ileus, pneumonia, urinary tract infection (UTI), deep vein thrombosis (DVT), pulmonary embolism (PE), hematoma, sensorimotor deficits, and MI.

Assessment of cognitive status

Pre-operative baseline cognition was assessed using the validated Saint Louis Mental Status (SLUMS) test. SLUMS is made up of 11 questions, which can give a maximum of 30 points (6). Mild CI was defined as a SLUMS score between 21–26 points, while severe CI was defined as a SLUMS score of ≤20 points. Normal cognition was defined as a SLUMS score of ≥27 points. Using this test, we identified 57 patients with mild to severe baseline CI (≤27 points) and 25 patients without impairment (≥27 points)—(cognitively impaired cohort: n=57, non-impaired cohort: n=25).

Assessment of functional status

Post-operative functional status assessments included the number of days from surgery to ambulation, number of feet walked on first ambulatory day, and number of feet walked on day of discharge. In addition, post-operative length of stay (LOS), 30-day readmission rates, and discharge disposition—i.e., to home, skilled nursing facility (SNF), or acute rehabilitation facility were recorded for all patients.

Postoperative complications

We assessed postoperative complications for each patient included in the study. Surgical complications were defined as complications as a direct result of the surgery. These complications included hardware failure requiring a revision procedure, surgical site infections (positive wound culture or antibiotics started), uncontrolled pain, new onset sensory/motor deficits or other surgical complications. Nonsurgical complications were defined as complications as a result of medical conditions not directly related to surgery. These complications included DVT, PE, MI, chest pain, fever, and other medical complications.

Table 1 Baseline characteristics of elderly patients undergoing decompression and fusion surgery for correction of adult degenerative scoliosis. Both patient cohorts had similar baseline characteristics

Characteristics	Cognitively impaired (n=57)	Non-impaired (n=25)	P value
Patient age (years)	74.73±6.38	71.80±5.79	0.04
BMI (kg/m^2)	28.30±6.70	29.42±4.41	0.37
Male (%)	42.36	36.00	0.34
Smoker (%)	3.50	0.00	0.15
CHF (%)	5.26	4.00	0.80
CAD (%)	26.31	8.00	0.02
CVD (%)	7.01	8.00	0.88
MI (%)	7.01	8.00	0.84
HTN (%)	61.40	56.00	0.65
AFib (%)	0.00	4.00	0.32
DM (%)	26.31	20.00	0.56

Values given as mean ± standard deviation. BMI, body mass index; CHF, congestive heart failure; CAD, coronary artery disease; CVD, cardiovascular disease; MI, myocardial infarction; HTN, hypertension; AFib, atrial fibrillation; DM, diabetes mellitus.

30-day hospital readmission rate

We reviewed the hospital chart of each readmission to determine the cause of readmission. Unplanned readmissions were defined as either surgical or nonsurgical complications. Planned readmissions were defined as either staged or rescheduled procedure. For the staged procedure, patients were discharged with the expectation that he or she would be readmitted for the subsequent stage of the procedure. A rescheduled procedure occurred when a patient was admitted on day of surgery, was cancelled prior to surgery, discharged and rescheduled within a month. Planned readmissions were not included in the final data analysis and not calculated into surgical readmission rates. Only unplanned hospital readmissions were included in the final analysis.

Statistical analysis

Parametric data were expressed as mean ± standard deviation (SD) and compared via the Student *t*-test. Nonparametric data were expressed as median (interquartile range) and compared via the Mann-Whitney U test. Nominal data were compared with the Chi-square test. All tests were two sided and were statistically significant if the p-value was less than 0.05. We used SAS 9.3 (SAS Institute, Inc., Cary, NC, USA) for all data preparation and analysis.

Results

Eighty-two elderly (≥65 years old) patients were included in this study, with 57 (70%) patients meeting the criteria for CI (cognitively impaired cohort: n=57, non-impaired cohort n=25). The demographics of the cognitively impaired cohort were similar to the non-impaired cohort in the proportion of men (42.36% *vs.* 36.00%, P=0.34) and BMI (28.30±6.70 *vs.* 29.42±4.41 kg/m^2, P=0.37), respectively (*Table 1*). The cognitively impaired cohort was slightly older than the non-impaired cohort (74.73±6.38 *vs.* 71.80±5.79 years, P=0.04) (*Table 1*). There were no significant differences between both groups in the prevalence of other co-morbidities such as diabetes, CHF, CVD, MI, HTN, Afib, and smoking status (*Table 1*). The cognitively impaired cohort had a significantly higher proportion of patients with CAD (cognitively-impaired: 26.31% *vs.* non-impaired: 8.00%, P=0.02) (*Table 1*).

Intra- and post-operative complications profile

The intra-operative complication rates were similar between both cohorts. The rate of incidental durotomy was 7.00% for the cognitively impaired cohort and 8.00% for the non-impaired cohort (P=0.88) (*Table 2*). There were no incidences of spinal cord or nerve root injuries within both cohorts (*Table 2*).

Post-operative complication rates were significant higher in the cognitively impaired cohort-delirium (19.29% *vs.* 8.00%, P=0.01), pneumonia (8.77% *vs.* 0.00%, P=0.02), and UTI (6.00% *vs.* 0.00%, P=0.01) (*Table 2*). There were no significant differences between cohorts in the incidence of ileus (7.01% *vs.* 8.00%, P=0.88), DVT (1.75% *vs.* 0.00%, P=0.32), PE (0.00% *vs.* 1.00%, P=0.32), or sensorimotor deficits (1.75% *vs.* 4.00%, P=0.61) (*Table 2*). The incidence of at least one post-operative complication was similar in both groups, (cognitively-impaired: 39.00% *vs.* non-impaired: 20.00%, P=0.15) (*Table 2*).

Post-operative functional and discharge status

The mean ± SD number of days from surgery to ambulation were similar between cohorts (cognitively-impaired:

Table 2 Cohort-specific post-operative complication rates. Cognitively impaired patients had a higher incidence of delirium, wound infections, urinary tract infections and pneumonia

Variables	Cognitively impaired (n=57)	Non-impaired (n=25)	P value
Operative			
Intra-operative durotomy (%)	7.00	8.00	0.88
Nerve root injury (%)	0.00	0.00	1.00
Spinal cord injury (%)	0.00	0.00	1.00
Post-operative			
Delirium (%)	19.29	8.00	0.01
Ileus (%)	7.01	8.00	0.88
Pneumonia (%)	8.77	0.00	0.02
UTI (%)	6.00	0.00	0.01
DVT (%)	1.75	0.00	0.32
PE (%)	0.00	1.00	0.32
Hematoma (%)	0.00	0.00	0.99
Sensorimotor deficits (%)	1.75	4.00	0.61
MI (%)	0.00	0.00	0.99
At least one complication (%)	39.00	20.00	0.15

Values given as mean ± standard deviation. UTI, urinary tract infection; DVT, deep vein thrombosis; PE, pulmonary embolism; MI, myocardial infarction.

Table 3 Total and cohort-specific differences in functional outcomes. The number of days from surgery to ambulation was similar between both cohorts. Patients in the CI cohort were more likely to be discharged to a SNF

Post-operative functional status	Cognitively impaired (n=57)	Non-impaired (n=25)	P value
Mean days from surgery-to-ambulation (days)	1.50±0.91	1.76±1.09	0.30
Number of feet walked on 1st ambulatory day (feet)	95.08±124.32	131.64±111.55	0.19
Number of feet walked on day of discharge (feet)	166.60 ±141.68	214.20±138.10	0.16
LOS (days)	5.33±2.39	5.48±2.18	0.78
Discharge to home (%)	47.36	68.00	0.08
Discharge to SNF (%)	49.12	28.00	0.06
Discharge to acute rehabilitation facility (%)	3.50	4.00	0.91
30-day re-admission rate (%)	12.80	12.00	0.73

Values given as mean ± standard deviation or percentages. LOS, length of stay; SNF, skilled nursing facility.

1.50±0.91 days *vs.* non-impaired: 1.76±1.09 days, P=0.30) (*Table 3*). The cognitively-impaired cohort trended towards a shorter ambulating distance on both the first ambulatory day (95.08±124.32 *vs.* 131.64±111.55 feet, P=0.19) and on the day of discharge (166.60±141.68 *vs.* 214.20±138.10 feet, P=0.16) (*Table 3*). There was no significant difference in length of hospital stay between both groups (5.33±2.39 *vs.* 5.48±2.18 days, P=0.78) (*Table 3*).

Non-impaired patients were more likely to be discharged directly home (47.36% *vs.* 68.00%, P=0.08) and cognitively impaired patients were more likely to be discharged to a post-acute care facility—i.e., SNF (49.12% *vs.* 28.00%, P=0.06) (*Table 3*). The 30-day re-admission rates were similar between the cohorts (cognitively impaired: 12.80% *vs.* non-impaired: 12.00%, P=0.73) (*Table 3*).

Discussion

In this retrospective study of 82 elderly patients (≥65 years old) undergoing elective surgery to correct spinal deformity, we observed a high prevalence of pre-operative CI; furthermore, we found that pre-operative CI was associated with higher complication rates and worse functional recovery after surgery.

There is a paucity of studies in the spine literature investigating the prevalence of CI in elderly patients undergoing surgery. In a prospective study using the Montreal Cognitive Assessment (MoCA) test to assess mild CI in elderly patients undergoing elective surgery, Na and Yy demonstrated the prevalence of mild CI to be 56% with an associative increase with age (9). In another prospective study of 114 elderly patients undergoing vascular surgery, Partridge *et al.* showed that 68% of patients met the criteria for CI or dementia (10). Similarly, in a prospective study of 129 elderly patients who underwent lumbar spinal surgery, Lee *et al.* found the prevalence of CI to be 38% using the Mini-Mental Status Examination (1). Analogous with the aforementioned studies, we observed that 70% of the elderly patients undergoing elective deformity correction surgery were cognitively impaired at baseline.

Prior studies have found an association between pre-operative CI and inferior post-surgical outcomes and recovery. In a prospective study of 228 consecutive patients who underwent hip surgery, Benedetti *et al.* demonstrated that the severity of pre-operative CI was associated with increased rates of mortality, and decreased short- and long-term ambulatory capabilities (11). Similarly, in a prospective study of 186 elderly patients who underwent an elective surgery that required ICU admission, patients with CI had an increased rate of one or more postoperative complications (41% *vs.* 24%), a higher incidence of delirium (78% *vs.* 37%), longer hospital stays (15 *vs.* 9 days), a higher rate of institutionalization following discharge (42% *vs.* 18%), and higher 6-month mortality (13% *vs.* 5%) when compared to cognitively intact patients. Other studies have also demonstrated similar inferior postsurgical outcomes and longer LOS for patients with preexisting CI (11-14). In our study, we observed that pre-operative CI was associated with increased rates post-operative complications such as pneumonia and UTI, as well as decreased post-surgical ambulatory status.

Pre-operative CI is associated with worsening mental status and increased post-operative delirium after surgery. In a prospective study of 300 elderly patients undergoing hip joint replacement, Silbert *et al.* found that patients with pre-operative CI had a significantly increased incidence of post-operative cognitive decline at 7 days, 3 months, and 1 year post-operatively (15). Similarly, in a retrospective study of 679 patients undergoing cardiac surgery, Tse *et al.* showed an association with CI and increased rate of post-operative delirium (16).

Several studies have demonstrated an association between post-operative delirium in elderly patients and increased post-operative complications after surgery. In a study of 144 elderly patients undergoing a major surgery, Robinson *et al.* found that postoperative delirium was significantly associated with increased length of hospital stay, post-discharge institutionalization, and 6-month mortality rates (17). Similarly, in a prospective study of 566 elderly patients who underwent an elective major surgery, Gleason *et al.* demonstrated that post-operative delirium without major post-operative complications was significantly associated with not only increased length of hospital stay, but also 30-day readmissions (18). Our study found that pre-operative CI was associated with increased rates of post-operative delirium and increased likelihood of discharge to a post-acute care facility. Interestingly, length of hospital stays and 30-day readmission rates were similar between both cohorts.

Surgeons have an important role in improving post-operative outcomes in patients with CI. O'Brien and colleagues suggested a set of recommendations to care for patients with CI, including: (I) preoperatively, surgeons should screen all elderly patients for CI prior to surgery to make more informed decisions regarding risk-benefit of the procedure; (II) intraoperatively, depth and length of anesthesia should be more closely monitored in patients with CI; and (III) post-operatively, patients with CI should be assessed more frequently and treated more quickly for complications, and pain management should be carefully managed to avoid over-sedation (5). These recommendations suggest that the efforts to adequately treat patients with CI are a shared responsibility of the entire team caring for the patient.

Overall, pre-existing CI is highly prevalent among the elderly population, subjecting them to increased complications, poorer surgical outcomes, and worsening quality of life. Assessing and identifying CI in this vulnerable population is vital for the optimization of patient outcomes and reduction of soaring healthcare costs. Further prospective multi-institutional studies are necessary to corroborate our findings.

The results of this study should be interpreted within the context of several limitations. Cognitive status was only measured using the SLUMS tool, which limits our ability to compare our results with other studies. Our small sample size limits our ability to make any firm conclusions. Finally, although pre- and perioperative variables were prospectively recorded into the study registry at the time of surgery, these variables were retrospectively analyzed for the purposes of this study and as such are subject to the drawbacks associated with all retrospective reviews. Despite these limitations, this study has shown that pre-operative CI increases post-operative complications and worsens functional outcomes.

Conclusions

CI is highly prevalent in elderly patients undergoing surgery for adult degenerative scoliosis. Impaired cognition before surgery was associated with higher rates of post-operative delirium, complications, and discharge institutionalization. CI assessments should be considered in the pre-operative evaluations of elderly patients prior to surgery.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The study was approved by Institutional Review Board and written informed consent was obtained from all patients.

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