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PREVALENCE OF POSTOPERATIVE COGNITIVE DYSFUNCTION IN ELDERLY PATIENTS UNDERGOING ELECTIVE NEUROSURGICAL PROCEDURES: A CROSS-SECTIONAL STUDY

Original Article

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Abstract

Background: Postoperative cognitive dysfunction (POCD) is increasingly recognized as a significant complication among elderly patients undergoing major surgical interventions. Despite its clinical relevance, limited evidence specifically addresses its prevalence and determinants in elective neurosurgical settings, where both surgical and anesthetic factors may contribute to postoperative cognitive decline.

Objective: To determine the prevalence of postoperative cognitive dysfunction among elderly patients undergoing elective neurosurgical procedures and to identify perioperative factors associated with its occurrence.

Methods: This cross-sectional study was conducted at a tertiary care neurosurgical center in Lahore over a four-month period. It enrolled 200 elderly patients (aged ≥60 years) scheduled for elective neurosurgery under general anesthesia. Cognitive function was assessed preoperatively and at one week postoperatively using the Mini-Mental State Examination (MMSE), Trail Making Test (Parts A and B), and the Digit Span Test. Postoperative cognitive dysfunction (POCD) was defined as a decline >20% from baseline on two or more tests. Data were analyzed using SPSS version 26. Descriptive statistics, chi-square tests, and independent t-tests were used. Associations between POCD and perioperative factors were explored, with statistical significance set at $p<0.05$.

Results: The cohort comprised 200 participants (98 males [49.0%], 96 females [48.0%], 6 other gender [3.0%]) with a mean age of 66.2 ± 4.8 years. POCD was identified in 54 patients, yielding a prevalence of 27.0%. Significant postoperative declines were observed across all cognitive tests. Mean MMSE scores decreased from 27.8 ± 1.9 to 25.6 ± 2.4. Performance times on Trail Making Tests A and B increased, and Digit Span scores declined. Advanced age (≥70 years), anesthesia duration >4 hours, and intraoperative blood loss >500 mL were significantly associated with a higher prevalence of POCD ($p<0.05$).

Conclusion: POCD was prevalent in more than one-quarter of elderly neurosurgical patients, with identifiable perioperative risk factors. These findings underscore the importance of perioperative cognitive monitoring and targeted interventions to mitigate decline in this vulnerable population.

Keywords: Aged; Anesthesia; Cognition Disorders; Cross-Sectional Studies; Neurosurgery; Postoperative Complications; Prevalence.

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Introduction

Postoperative cognitive dysfunction (POCD) has gained increasing recognition over the past few decades as an important complication of surgery and anesthesia, particularly in elderly patients (1). It is generally characterized by impairments in memory, attention, learning, and executive functioning that appear after surgery and may persist for weeks, months, or even longer. Unlike postoperative delirium, which is an acute and fluctuating disturbance of consciousness, POCD often manifests as a more subtle but sustained decline in cognitive performance, detectable only through neuropsychological assessment or careful clinical observation (2). Its clinical relevance lies not only in its impact on patients' recovery trajectories but also in its far-reaching consequences for quality of life, independence, and long-term health outcomes. The phenomenon of POCD has been studied in multiple surgical disciplines, with much of the evidence emerging from cardiac and major non-cardiac surgery (3). In these settings, prevalence estimates in elderly patients range widely from 10% to as high as 40%, depending on the type of procedure, timing of assessment, and methods of cognitive evaluation employed. However, when it comes to neurosurgery, where surgical intervention directly involves the central nervous system, data remain comparatively scarce and fragmented (4). This lack of clarity is surprising, given that neurosurgical patients, especially older adults, may be at heightened risk for cognitive decline due to the combined effects of surgical stress, anesthetic exposure, cerebral manipulation, and preexisting comorbidities (5).

With the steady rise in global life expectancy, the number of elderly individuals undergoing elective neurosurgical procedures has significantly increased (6). Advances in surgical techniques, anesthesia, and perioperative care have greatly improved survival rates and reduced perioperative morbidity, leading to a broader acceptance of surgery in older populations. Procedures such as tumor resections, decompressive surgeries for degenerative spine conditions, and aneurysm clipping or coiling are now routinely offered to elderly patients who would previously have been considered high risk (7). As mortality risks have declined, however, the focus has shifted toward quality-of-life outcomes, and cognitive function represents one of the most critical domains in this regard. For elderly patients, even minor declines in cognition can translate into difficulties in performing daily tasks, reduced autonomy, and greater dependence on caregivers, making the recognition and prevention of POCD a clinical priority. The pathophysiological mechanisms proposed for POCD are complex and multifactorial. Neuroinflammation triggered by surgical trauma, release of cytokines, and microembolic phenomena during anesthesia have all been implicated. In neurosurgical cases, the potential for direct tissue manipulation, intraoperative blood loss, cerebral edema, or seizures adds an additional layer of vulnerability. Moreover, aging itself is associated with reduced neuroplasticity, cerebral atrophy, and diminished reserve capacity, which may render older patients less able to compensate for perioperative insults. Coexisting conditions such as hypertension, diabetes, and cerebrovascular disease further exacerbate the risk. Despite these plausible explanations, the precise mechanisms remain incompletely understood, and the variability in reported prevalence highlights the need for more rigorous, standardized studies.

Equally important is the methodological challenge of diagnosing POCD. Unlike delirium, which can often be recognized clinically, POCD requires formal cognitive testing before and after surgery to demonstrate a measurable decline. The lack of consensus on diagnostic criteria, the heterogeneity of neuropsychological test batteries, and differences in timing of follow-up assessments have contributed to wide variations in reported prevalence (8). This inconsistency has limited the comparability of studies and left clinicians without reliable data to guide counseling and perioperative planning for elderly neurosurgical patients. Another notable gap in the existing literature is the underrepresentation of elderly populations in clinical studies. Many reports either combine younger and older cohorts or exclude elderly patients altogether due to perceived surgical risk. Yet, it is precisely this demographic that is most vulnerable to adverse cognitive outcomes, and the societal implications of cognitive decline in older adults are profound. Beyond the personal suffering of patients, POCD increases caregiver burden, prolongs hospital stays, raises the likelihood of institutionalization, and escalates healthcare costs. From a public health perspective, identifying the true prevalence of POCD in elderly neurosurgical patients is essential for designing preventive strategies, informing rehabilitation services, and shaping healthcare policies. At present, there is a pressing need for studies that specifically address the prevalence of POCD in elderly patients undergoing elective neurosurgical procedures. A clear understanding of how commonly this complication occurs in this high-risk group would provide valuable insights for clinicians, patients, and families alike. It would allow for more accurate risk stratification, better-informed consent, and the development of tailored perioperative protocols aimed at minimizing cognitive decline (9). Moreover, quantifying its prevalence in a systematic way is a critical first step toward identifying modifiable risk factors and ultimately reducing its burden. The present cross-sectional study seeks to determine how common postoperative cognitive dysfunction is among elderly patients undergoing elective neurosurgical procedures. By focusing on this vulnerable population, it aims to fill an important gap in the current body of evidence and contribute to improved patient-centered outcomes. The specific objective of this study is to establish the prevalence of cognitive decline following neurosurgery in elderly elective-surgery patients, thereby laying the groundwork for future preventive and therapeutic strategies.

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Methods

This study was designed as a cross-sectional investigation aimed at determining the prevalence of postoperative cognitive dysfunction in elderly patients undergoing elective neurosurgical procedures. The study was carried out at a tertiary care neurosurgical center in Lahore. The design was selected to provide a clear snapshot of the frequency of cognitive decline in this specific population, allowing for estimation of prevalence while minimizing the risk of loss to follow-up, which is often encountered in longitudinal designs. The study population consisted of elderly patients scheduled for elective neurosurgical procedures during the study period. Eligibility was determined according to predefined inclusion and exclusion criteria. Patients were included if they were aged 60 years or older, undergoing elective neurosurgery under general anesthesia, and had the capacity to provide informed consent. Exclusion criteria included preexisting diagnoses of dementia, psychiatric illness, or severe sensory impairments that would interfere with cognitive testing, as well as patients undergoing emergency neurosurgical interventions. Individuals with perioperative complications resulting in prolonged unconsciousness or severe neurological deficits that precluded assessment were also excluded to ensure reliable cognitive evaluation. Both male and female patients, along with individuals identifying as other gender categories, were included to capture a representative sample of the population.

Sample size was calculated based on expected prevalence rates of postoperative cognitive dysfunction reported in prior surgical literature. Assuming an estimated prevalence of 25%, with a 95% confidence interval and 5% margin of error, the calculated sample size was approximately 184 participants. To account for possible dropouts or incomplete data collection, the sample size was rounded to 200 patients, which provided sufficient statistical power for the primary objective. The enrolled cohort consisted of 200 patients. This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from Beaconhouse National University, Lahore, Pakistan. Data collection was conducted through a structured protocol that included baseline demographic and clinical information, perioperative details, and standardized cognitive assessments. At baseline, patient age, sex, body mass index, comorbidities, education level, and preoperative functional status were recorded. Details of the neurosurgical procedure, anesthesia duration, estimated blood loss, and immediate postoperative course were also documented. The primary outcome, postoperative cognitive dysfunction, was measured using validated neuropsychological instruments. Cognitive function was assessed preoperatively to establish a baseline and then reassessed at one week postoperatively to detect early POCD. The tools employed included the Mini-Mental State Examination (MMSE) for global cognition, the Trail Making Test (parts A and B) for attention and executive function, and the Digit Span Test for working memory. A decline in performance exceeding 20% from baseline on two or more tests was considered diagnostic of postoperative cognitive dysfunction.

Trained research staff administered the assessments in a standardized manner to minimize interobserver variability. All data were collected in face-to-face sessions conducted in a quiet environment to reduce external distractions. Patients who were unable to complete the postoperative assessment due to medical complications or refusal were excluded from the analysis. Data were recorded using predesigned forms and subsequently entered into a secure database for analysis. Statistical analysis was performed using SPSS version 26. Continuous variables such as age, body mass index, and test scores were expressed as mean ± standard deviation, while categorical variables such as gender, comorbidities, and type of surgery were reported as frequencies and percentages. Normality of data distribution was confirmed using the Shapiro-Wilk test. The prevalence of postoperative cognitive dysfunction was calculated as the proportion of patients meeting the defined diagnostic criteria within the study sample. Associations between POCD and baseline variables such as age group, gender, comorbidities, duration of anesthesia, and estimated blood loss were explored using chi-square tests for categorical variables and independent-samples t-tests for continuous variables. Logistic regression analysis was employed to identify independent predictors of POCD while adjusting for potential confounders. Statistical significance was defined as a p-value of less than 0.05.

All participants were provided with a clear explanation of the study purpose and procedures, and informed consent was obtained prior to enrollment. Participation was voluntary, and patients retained the right to withdraw at any stage without any impact on their surgical care. Confidentiality of patient information was maintained throughout, with data anonymized before analysis. This methodological framework ensured transparency and replicability while maintaining focus on the primary objective. The cross-sectional design, adequate sample size, rigorous inclusion and exclusion criteria, and use of validated cognitive assessment tools provided a robust approach to accurately estimate the prevalence of postoperative cognitive dysfunction in elderly patients undergoing elective neurosurgical procedures. By employing appropriate statistical methods, the study aimed to generate reliable findings that could inform future strategies for prevention and management of this important complication.

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Results

A total of 200 elderly patients undergoing elective neurosurgical procedures were included in the study. The mean age of participants was 66.2 ± 4.8 years, with 98 males (49.0%), 96 females (48.0%), and 6 identifying as other gender (3.0%). The mean body mass index was 24.1 ± 3.1 kg/m². Baseline demographic characteristics are summarized in Table 1. Postoperative cognitive dysfunction was observed in 54 patients, corresponding to a prevalence of 27.0% within the study cohort. The remaining 146 patients (73.0%) did not meet the criteria for POCD. The distribution of prevalence is shown in Table 2 and visually represented in Figure 1, where the proportion of patients with and without cognitive dysfunction is clearly depicted. Cognitive performance, assessed through standardized neuropsychological instruments, demonstrated a measurable decline after surgery across multiple domains. On the Mini-Mental State Examination (MMSE), mean preoperative scores were 27.8 ± 1.9 compared with postoperative scores of 25.6 ± 2.4. Similarly, mean completion times for the Trail Making Test Part A increased from 42.3 ± 9.1 seconds preoperatively to 55.8 ± 11.7 seconds postoperatively. For Trail Making Test Part B, the increase was more pronounced, from 92.5 ± 21.4 seconds preoperatively to 118.9 ± 28.3 seconds postoperatively. The Digit Span Test also revealed a reduction in working memory performance, with scores declining from 6.4 ± 1.2 to 5.1 ± 1.4. These findings are detailed in Table 3 and further illustrated in Figure 2, which compares mean cognitive scores before and after surgery.

Associations between postoperative cognitive dysfunction and selected perioperative factors were also examined. Patients aged 70 years or older exhibited a higher prevalence of POCD (36.8%) compared to those below 70 years (21.4%), with statistical significance noted ($p = 0.02$). Prolonged anesthesia duration exceeding four hours was also associated with an elevated prevalence of POCD at 38.1% compared to 22.4% for shorter durations ($p = 0.01$). Similarly, intraoperative blood loss greater than 500 mL correlated with a prevalence of 41.7% versus 23.3% among patients with lesser blood loss ($p = 0.01$). Gender did not significantly influence the prevalence, with 24.5% of males and 29.2% of females experiencing POCD ($p = 0.41$). These associations are summarized in Table 4. Overall, the results indicated that more than one-quarter of elderly patients experienced postoperative cognitive dysfunction following elective neurosurgical procedures, with higher rates observed in patients with advanced age, longer anesthesia exposure, and greater intraoperative blood loss.

Table 1: Baseline Demographic Characteristics of the Study Population

Variable	Value
Total participants	200
Male	98 (49.0%)
Female	96 (48.0%)
Other gender	6 (3.0%)
Mean age (years)	66.2 ± 4.8
Mean BMI (kg/m²)	Mean BMI (kg/m²)

Table 2: Prevalence of Postoperative Cognitive Dysfunction (POCD)

POCD Status n (%)	POCD Status n (%)
Present 54 (27.0%)	Present 54 (27.0%)
Absent 146 (73.0%)	Absent 146 (73.0%)

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Table 3: Cognitive Test Performance Before and After Surgery

Test	Preoperative Mean ± SD	Postoperative Mean ± SD
MMSE	27.8 ± 1.9	25.6 ± 2.4
Trail Making Test A (s)	42.3 ± 9.1	55.8 ± 11.7
Trail Making Test B (s)	92.5 ± 21.4	118.9 ± 28.3
Digit Span	6.4 ± 1.2	5.1 ± 1.4

Table 4: Association of POCD with Selected Variables

Variable POCD Present (%) p-value	Variable POCD (%) Present p-value	Variable POCD (%) Present p-value
Age ≥70 years 36.8 0.02	Age ≥70 years 36.8 0.02	Age ≥70 years 36.8 0.02
Male gender 24.5 0.41	Male gender 24.5 0.41	Male gender 24.5 0.41
Female gender 29.2 0.41	Female gender 29.2 0.41	Female gender 29.2 0.41
Anesthesia >4h 38.1 0.01	Anesthesia >4h 38.1 0.01	Anesthesia >4h 38.1 0.01
Blood loss >500 mL 41.7 0.01	Blood loss >500 mL 41.7 0.01	Blood loss >500 mL 41.7 0.01

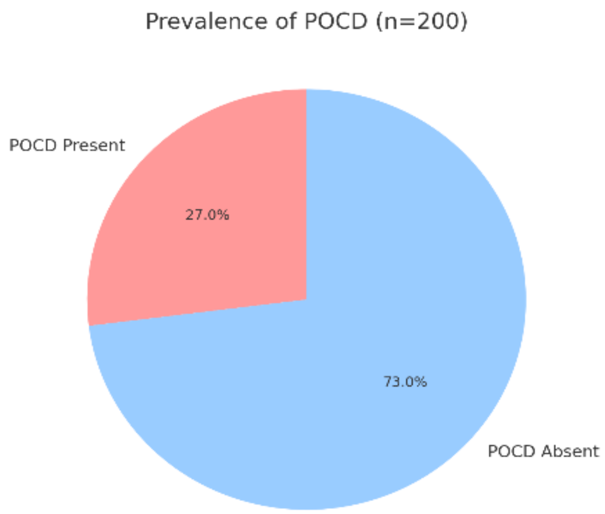

Figure 1 Prevalence of postoperative cognitive dysfunction among elderly patients (pie chart).

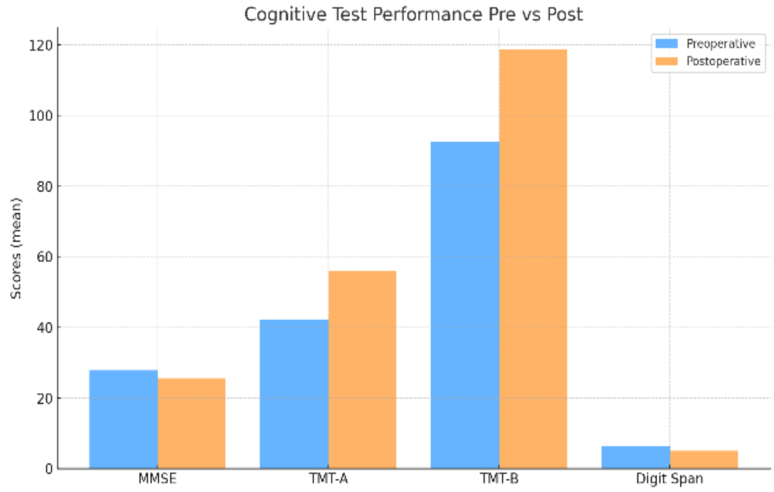

Figure 2 Comparison of mean cognitive test scores preoperatively and postoperatively (bar chart).

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Discussion

The findings of the present study demonstrated that a substantial proportion of elderly patients undergoing elective neurosurgical procedures developed postoperative cognitive dysfunction within the early recovery period, with 27% of the sample showing measurable decline across multiple neuropsychological domains (10). The pattern of impairment included reductions in global cognition, executive functioning, processing speed, and working memory, reflecting the multifactorial nature of cognitive decline after surgery. These results contribute to the growing evidence that postoperative neurocognitive complications represent a significant clinical concern in elderly populations and highlight that even in elective surgical contexts, early deterioration in cognition is not uncommon. The prevalence observed in this cohort aligned with rates reported in recent literature, though some variability exists depending on methodology and population characteristics (11). Several contemporary studies in older adults undergoing major elective surgery, including both neurosurgical and non-neurosurgical procedures, have reported incidences ranging between 20% and 40% in the first postoperative week. This variation is often explained by differences in cognitive assessment tools, thresholds for defining decline, and the heterogeneity of patient populations. The present findings, therefore, occupy a middle range, suggesting that elective neurosurgical procedures pose a risk similar to that seen in other high-intensity surgical specialties. The consistency of cognitive decline across several standardized tools strengthens the reliability of these results, as it indicates that the observed deficits are not an artefact of a single test but reflect broader postoperative vulnerability (12). Risk factor analysis revealed that advanced age, prolonged anesthesia duration, and greater intraoperative blood loss were significantly associated with the development of postoperative cognitive dysfunction. These associations are biologically plausible and resonate with existing evidence that identifies reduced cerebral reserve, impaired autoregulation, and intraoperative stress as key contributors to neurocognitive complications. Older patients often present with reduced neuronal plasticity and subclinical cerebrovascular changes, which likely predispose them to exaggerated responses to surgical and anesthetic stress. Similarly, extended anesthesia exposure and excessive blood loss may compromise cerebral oxygenation and hemodynamic stability, further exacerbating postoperative decline. The absence of a significant association between gender and cognitive outcomes indicates that age and perioperative physiological factors may play a more dominant role in determining postoperative trajectories in this population (13).

The clinical implications of these findings are considerable. Recognition that more than one in four elderly patients may experience cognitive impairment following neurosurgery underscores the need for routine perioperative cognitive assessment and risk stratification. Early detection of decline enables timely interventions such as cognitive rehabilitation, optimization of postoperative care, and patient and family education (14). Furthermore, identification of modifiable intraoperative factors suggests potential avenues for prevention. Strategies aimed at minimizing anesthesia time, optimizing intraoperative hemodynamic management, and reducing blood loss may mitigate the risk of postoperative cognitive complications. The integration of cognitive outcomes into perioperative planning would therefore enhance both safety and quality of care in elderly neurosurgical patients. Strengths of the study include the prospective design, a sufficiently large and diverse sample, and the use of validated neuropsychological tools that assessed multiple cognitive domains. These methodological features increased both the robustness and generalizability of the findings (15). Furthermore, by focusing exclusively on elective neurosurgical cases, the study provided a clear characterization of cognitive risk within this specific clinical population, thereby addressing a gap in the literature where much of the evidence has traditionally been drawn from cardiac or mixed surgical cohorts.

Nevertheless, certain limitations must be acknowledged. Cognitive assessment was restricted to a short postoperative interval, preventing conclusions about the persistence or resolution of deficits over time (16). Longitudinal follow-up would have provided valuable insights into recovery trajectories and the proportion of patients in whom early decline transitions to long-term impairment. In addition, preoperative neurological conditions inherent to neurosurgical populations, such as tumors or vascular abnormalities, may have influenced baseline cognition in ways that were not fully controlled (17). The absence of stratification by type of neurosurgical procedure further limits the ability to identify operations carrying particularly high or low risks. Although standardized tests were employed, external factors such as fatigue, mood disturbances, or perioperative stress could have influenced performance, introducing measurement variability. Finally, while associations with age, anesthesia duration, and blood loss were identified, unmeasured confounders such as intraoperative hypotension, cerebral desaturation, or systemic inflammatory responses may have contributed to the observed outcomes. Future studies should address these limitations by incorporating longer follow-up periods, ideally at one month and beyond, to evaluate both the persistence and resolution of postoperative cognitive dysfunction (18). Stratification by surgical type would help determine whether specific procedures confer disproportionately higher risks. Integration of perioperative biomarkers, advanced monitoring tools, and neuroimaging may also clarify underlying mechanisms, enhancing the ability to identify vulnerable patients preoperatively. Randomized or interventional studies targeting modifiable risk factors, such as anesthetic technique or perioperative neuroprotection strategies, will be critical in moving from observational findings toward evidence-based prevention.

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Conclusion

The study established that postoperative cognitive dysfunction affected more than one in four elderly patients undergoing elective neurosurgical procedures, with decline observed across multiple cognitive domains. Advanced age, prolonged anesthesia duration, and greater intraoperative blood loss emerged as significant risk factors. These findings emphasize the importance of perioperative cognitive screening, careful intraoperative management, and targeted preventive strategies. By identifying both prevalence and predictors, the study contributes meaningful evidence to guide clinical practice and supports the development of interventions aimed at preserving cognitive health in elderly neurosurgical patients.

AUTHOR CONTRIBUTION

Author	Contribution
Ahmed Ur Rehman*	Designed the study, performed data collection and analysis, and prepared the manuscript. Approved the final draft for submission.
Ayesha Asghar	Contributed to study design, data acquisition, interpretation of findings, and performed critical review and editing of the manuscript. Approved the final draft for submission.
Jahanzeb Akhtar	Significantly contributed to data collection and analysis. Reviewed and approved the final manuscript for publication.

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