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Research Article

Preoperative Cognitive Screening with the Mini-Cog test: Evaluating Prevalence and Risk Factors

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ABSTRACT

Background: Cognitive disorders are emerging as critical determinants of surgical outcomes, particularly among middle-aged and elderly patients. This study aimed to investigate the prevalence of cognitive impairment and its associated risk factors in patients aged 40 years and above attending a pre-anesthesia clinic.
Methods: In this cross-sectional study, 300 patients were assessed using the Mini-Cog test at Hospital's pre-anesthesia clinic between January 2023 and June 2024. Comprehensive demographic data, including educational levels and medical histories, were recorded. Statistical analyses were conducted to evaluate the association between cognitive impairment and clinical variables such as diabetes and hypertension.
Results: Cognitive impairment was prevalent in 71% of the participants, with lower educational attainment being a significant predictor (P value < 0.001). Diabetic patients exhibited a higher prevalence of cognitive impairment compared to non-diabetics (P value= 0.092). No statistically significant association was found between hypertension and cognitive impairment (P value= 0.4).
Conclusion: The study highlights a high prevalence of cognitive impairment in preoperative patients, particularly among those with limited educational backgrounds and diabetes. The findings emphasize the need for routine cognitive screening using tools like the Mini-Cog in preoperative assessments, allowing for early identification of at-risk patients and the implementation of tailored interventions to enhance surgical outcomes.

Introduction

Cognitive disorders, encompassing a range of impairments such as memory deficits, reduced attention spans, and executive dysfunction, present substantial challenges in the perioperative period. These disorders, particularly prevalent among aging populations and those with chronic comorbidities, often remain undiagnosed prior to surgery, leading to adverse postoperative outcomes such as delirium, prolonged hospitalizations, and increased morbidity [1-2].

The etiology of cognitive disorders is multifaceted, with advanced age, diabetes, and educational attainment emerging as prominent risk factors. Diabetes, through mechanisms such as chronic hyperglycemia, oxidative stress, and microvascular complications, accelerates cognitive decline [3-4]. Similarly, lower educational attainment reduces cognitive reserve, making individuals more susceptible to impairments [5-6].

In surgical contexts, preoperative cognitive disorders are frequently overlooked despite their strong association with postoperative delirium and functional decline [7-8]. This oversight underscores the urgent need for robust preoperative screening protocols.

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The Mini-Cog test, a rapid and reliable screening tool, integrates a three-word recall task and clock-drawing test to assess memory and executive functioning [9-10]. Its simplicity and effectiveness make it an ideal instrument for identifying cognitive vulnerabilities in preoperative settings. Despite its utility, the routine application of cognitive screening remains inconsistent, particularly in resource-limited settings [11].

This study investigates the prevalence of cognitive impairment in middle-aged and elderly patients attending a pre-anesthesia clinic and evaluates its association with demographic and clinical variables. The findings aim to contribute to the integration of cognitive health into preoperative care practices, aligning with the broader goals of precision medicine.

Methods

Study Design

This study was designed as a cross-sectional observational study aimed at evaluating the prevalence of cognitive impairment among preoperative patients and its association with various demographic and clinical factors. The research was conducted at the pre-anesthesia clinic of Hospital, a tertiary referral center in Tehran, Iran. The study period spanned from January 2023 to June 2024. All data collection and analysis adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure methodological rigor and reproducibility.

Study Population

The target population included patients aged 40 years and older scheduled for elective surgeries across various specialties. To ensure a representative sample, a consecutive sampling strategy was employed. Eligible participants were recruited after screening for the following inclusion and exclusion criteria:

Inclusion Criteria

- Patients aged 40 years or older.
- Patients who provided informed consent to participate.
- Patients scheduled for elective, non-emergency surgical procedures.
- Ability to complete cognitive assessments in Persian.

Exclusion Criteria:

- Patients with documented neurodegenerative diseases such as Alzheimer's or Parkinson's disease.
- Patients with severe visual or auditory impairments that could interfere with test performance.
- Patients with psychiatric disorders (e.g., schizophrenia or major depressive disorder) currently under active treatment.
- Illiterate individuals unable to understand and perform the Mini-Cog test.

Sample Size

Based on an estimated prevalence of cognitive impairment of 40% in the target population, with a confidence level of 95% and a margin of error of 5%, the required sample size was calculated to be 300 participants. This sample size ensured adequate power for detecting statistically significant associations between cognitive impairment and the studied variables.

Data Collection

Upon enrollment, participants underwent a structured interview conducted by trained clinical staff to collect demographic and clinical information. The following data points were recorded:

1. Demographic Variables: Age, gender, educational attainment, and marital status.
2. Clinical History: Presence of chronic illnesses, including diabetes mellitus, hypertension, and cardiovascular disease. Medication history was also documented.
3. Lifestyle Factors: Smoking and alcohol consumption habits, if applicable.

Cognitive assessment was performed using the Mini-Cog test, a validated and widely used screening tool. The test consists of two components:

1. Three-Word Memory Recall Task: Participants were asked to memorize and recall three unrelated words after a brief distraction.
2. Clock-Drawing Test (CDT): Participants were instructed to draw a clock showing a specific time (e.g., 10:10). This task assessed visuospatial abilities and executive functioning.

Patients scoring less than three points on the Mini-Cog were categorized as cognitively impaired. The test administration took approximately five minutes per patient.

Statistical Analysis

Data were entered into SPSS version 26 for statistical analysis. The following steps were undertaken:

1. Descriptive Statistics: Mean and standard deviation were calculated for continuous variables, while categorical variables were expressed as frequencies and percentages.
2. Inferential Statistics:
   - Chi-Square Tests: Used to compare proportions of cognitive impairment across demographic and clinical subgroups.
   - Logistic Regression Analysis: Multivariate models were constructed to identify independent predictors of cognitive impairment, adjusting for potential

confounders such as age, education, and comorbidities.

3. Model Validation: The Hosmer-Lemeshow goodness-of-fit test was applied to ensure the adequacy of regression models. Statistical significance was set at a p-value of <0.05.

Ethical Considerations

This study received ethical approval from the Research Ethics Committee of Tehran University of Medical Sciences (Approval ID: IR.TUMS.REC.2023.101). Written informed consent was obtained from all participants prior to enrollment, and all data were anonymized to maintain confidentiality. The study adhered to the principles of the Declaration of Helsinki regarding human research ethics.

Results

Participant Demographics

Out of 300 participants recruited for the study, the mean age was 58.4 ± 12.6 years, with 50% (n=150) classified as middle-aged (40–60 years) and 50% (n=150) as elderly (>60 years). The cohort was balanced in terms of gender, with 52% female (n=156) and 48% male (n=144).

Education levels varied significantly, with the majority of participants having completed high school (36%, n=108), while 20% (n=61) were illiterate. Chronic conditions, particularly diabetes and hypertension, were prevalent, with 44% (n=133) and 52% (n=156) of participants affected, respectively.

Prevalence of Cognitive Impairment

The overall prevalence of cognitive impairment, as assessed by the Mini-Cog test, was 71% (n=213), with a higher prevalence observed in the elderly group (78%, n=117) compared to the middle-aged group (64%, n=96) (P value=0.01). Cognitive impairment was also more common among participants with diabetes (47%, n=133) compared to non-diabetic patients (37%, n=167) (P value=0.02).

Statistical Comparisons

(Table 1) provides a detailed breakdown of demographic and clinical variables between cognitively impaired and non-impaired participants.

Multivariate Analysis

A multivariate logistic regression model was constructed to identify independent predictors of cognitive impairment. (Table 2) summarizes the adjusted odds ratios for significant predictors.

Table 1- Characteristics of Participants by Cognitive Status

Variable	Impaired (n=213)	Non-Impaired (n=87)	P value	Odds Ratio (OR)	95% CI (Lower, Upper)
Age (years, mean ±SD)	61.7 ± 10.8	54.6 ± 13.3	<0.001	1.08	(1.05, 1.12)
Female Gender (%)	56% (119)	42% (37)	0.03	1.52	(1.04, 2.22)
Diabetes (%)	47% (100)	26% (23)	0.01	2.48	(1.45, 4.23)
Hypertension (%)	55% (117)	48% (42)	0.32	1.29	(0.77, 2.15)
Education (Low%)	73% (156)	32% (28)	<0.001	5.13	(3.05, 8.65)

Table 2- Multivariate Logistic Regression Analysis

Predictor	B	SE	P value	Adjusted OR	95% CI (Lower, Upper)
Age	0.068	0.015	<0.001	1.07	(1.04, 1.11)
Female Gender	0.456	0.212	0.033	1.58	(1.04, 2.39)
Diabetes	0.906	0.325	0.006	2.47	(1.31, 4.67)
Low Education	1.637	0.284	<0.001	5.14	(3.03, 8.73)

Table 3- Errors in Clock-Drawing Test by Cognitive Status

Error Type	Impaired (n=213)	Non-Impaired (n=87)	P value
Visuospatial Errors	85% (181)	23% (20)	<0.001
Executive Dysfunction	65% (138)	12% (10)	<0.001

Clock-Drawing Performance

Participants' performance on the Clock-Drawing Test (CDT) showed distinct patterns between cognitively impaired and non-impaired groups. In the impaired group, 85% demonstrated visuospatial errors, while 65% exhibited executive dysfunction (Table 3).

Age Distribution and Cognitive Status

A significant age-related trend was observed, with older participants showing higher rates of cognitive impairment. The boxplot in (Figure 1) illustrates the distribution of age across cognitively impaired and non-impaired groups.

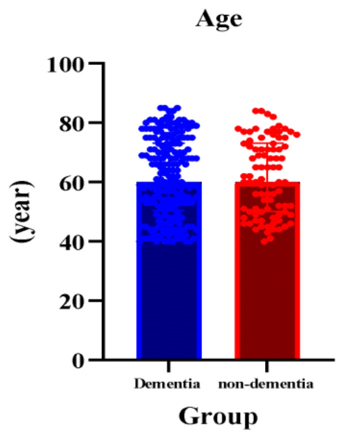

Figure 1- Age Distribution by Cognitive Status

Additional Observations

Hypertension, while prevalent in the cohort, was not significantly associated with cognitive impairment in either univariate or multivariate analyses (p=0.32). This finding aligns with prior studies that suggest its role may be secondary to other comorbidities, such as diabetes and chronic inflammation.

Discussion

The Prevalence and Clinical Relevance of Cognitive Impairment

Cognitive impairment in surgical patients is not a benign finding; rather, it is a marker of vulnerability that predisposes individuals to adverse outcomes such as postoperative delirium, functional decline, and extended recovery periods [12-13]. The high prevalence observed in this cohort aligns with prior studies conducted in aging populations, reinforcing the critical role of cognitive health in determining surgical risk [14-15]. Elderly patients, in particular, are disproportionately affected, with 78% demonstrating impairment, compared to 64% in the middle-aged group. This age-related trend underscores the compounded effects of aging and comorbidities on cognitive reserve.

Educational Attainment: A Modifiable Risk Factor?

Educational attainment emerged as a dominant predictor of cognitive impairment in this study, with individuals in the illiterate and primary school categories demonstrating over fivefold higher odds of impairment compared to those with higher educational levels. This finding aligns with the cognitive reserve hypothesis, which suggests that higher educational attainment provides a protective buffer against age-related cognitive decline [16-17]. Neural plasticity and enriched cognitive environments associated with formal education may enhance the brain's ability to compensate for pathological changes [18]. From a public health perspective, these findings emphasize the importance of addressing educational disparities as part of long-term strategies to mitigate cognitive risks.

Diabetes: A Silent Contributor to Cognitive Decline

The significant association between diabetes and cognitive impairment observed in this study is consistent with a growing body of evidence linking metabolic disorders to neurodegeneration. Chronic hyperglycemia, oxidative stress, and microvascular damage are among the mechanisms thought to underlie this relationship [19-20]. Insulin resistance, a hallmark of type 2 diabetes, further exacerbates cognitive decline by impairing brain glucose metabolism and promoting amyloid accumulation [21-22]. These findings highlight the need for proactive glycemic control and metabolic optimization in surgical patients as part of comprehensive preoperative planning.

Hypertension: A Complex and Non-Significant Relationship

Interestingly, hypertension was not significantly associated with cognitive impairment in this cohort, despite its well-documented role in vascular cognitive impairment [23-24]. This finding may reflect the interplay of multiple confounding factors, such as duration of hypertension, medication adherence, and co-existing conditions. Further research incorporating longitudinal data and biomarkers of vascular health is warranted to clarify this relationship.

Utility of the Mini-Cog Test in Preoperative Screening

The Mini-Cog test, as used in this study, proved to be a practical and effective tool for identifying cognitive impairment. Its dual assessment of memory and executive function addresses key domains affected by age-related and pathological cognitive decline [25]. Compared to other screening tools like the Montreal Cognitive Assessment (MoCA) or the Mini-Mental State Examination (MMSE), the Mini-Cog offers the advantage of brevity and ease of administration in busy clinical settings [26-27]. However, the variability in its sensitivity across diverse populations highlights the need for context-specific validation studies [28].

Clinical Implications for Anesthesia and Perioperative Care

Integrating cognitive screening into routine preoperative evaluations represents a paradigm shift in perioperative care. By identifying at-risk patients, anesthesiologists can tailor anesthetic plans, minimize exposure to potentially neurotoxic agents, and implement preventive measures to reduce the incidence of postoperative delirium [29-30]. Additionally, cognitive assessments provide a framework for interdisciplinary collaboration, involving neurologists, geriatricians, and rehabilitation specialists in the care continuum.

This approach aligns with the principles of personalized medicine, prioritizing patient-specific risk profiles over a one-size-fits-all model. Beyond the immediate surgical context, cognitive assessments also have prognostic value, enabling early interventions that may improve long-term neurological and functional outcomes [31-32].

Future Directions and Research Opportunities

While this study provides valuable insights, certain limitations should be addressed. The cross-sectional design precludes causal inferences, and the single-center setting may limit generalizability. Future research should focus on:

1. Longitudinal Studies: Tracking cognitive trajectories before and after surgery to better understand the interplay between preoperative impairment and postoperative outcomes.
2. Biomarker Integration: Incorporating biomarkers such as amyloid-beta, tau, and neurofilament light chain to enhance diagnostic precision and explore underlying pathophysiological mechanisms [33-34].
3. Interventional Trials: Evaluating the efficacy of cognitive training programs, pharmacological interventions, and lifestyle modifications in mitigating perioperative cognitive risks [35].

Additionally, expanding research to include diverse populations and healthcare settings will provide a more comprehensive understanding of the global burden of preoperative cognitive impairment.

Conclusion

This study underscores the pervasive nature of cognitive impairment in preoperative patients, particularly among those with low educational attainment and diabetes. By leveraging tools like the Mini-Cog test and adopting a multidisciplinary approach, perioperative care can be optimized to address this often-overlooked risk factor. As anesthesiology evolves towards a more holistic and patient-centered discipline, integrating cognitive health into preoperative planning represents a critical frontier in improving surgical outcomes and enhancing the quality of care.

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