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PERIOPERATIVE COGNITIVE DYSFUNCTION IN PATIENTS UNDERGOING ENT SURGERIES: ROLE OF DEPTH OF ANAESTHESIA MONITORING (BIS) AND DEXMEDETOMIDINE INFUSION

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ABSTRACT:

Background: Perioperative cognitive dysfunction (POCD) is a common complication following surgery, particularly in elderly patients, resulting in memory impairment, attention deficits, and decreased executive function. Factors such as anaesthetic depth and intraoperative medication usage are known to contribute to the pathogenesis of POCD. The Bispectral Index (BIS), a measure of anaesthetic depth, and Dexmedetomidine, an alpha-2 adrenergic receptor agonist with neuroprotective effects, have both been suggested as methods to reduce POCD incidence.

Aim of the Study: This study aimed to evaluate the role of BIS-guided anaesthesia and Dexmedetomidine infusion in reducing the incidence and severity of POCD in elderly patients undergoing elective ENT surgeries.

Objectives: To compare the effects of BIS-guided anaesthesia with and without Dexmedetomidine infusion on cognitive function post-surgery and to analyze intraoperative anaesthetic requirements and haemodynamic stability.

Materials and Methods: A total of 120 patients aged 60 years and above, undergoing elective ENT surgeries under general anaesthesia, were randomly assigned to three groups: Group A (standard anaesthesia), Group B (BIS-guided anaesthesia), and Group C (BIS-guided anaesthesia with Dexmedetomidine). Cognitive function was assessed using the Mini-Mental State Examination (MMSE), Digit Symbol Substitution Test (DSST), and Trail Making Test (TMT) at baseline, postoperatively on day 3, and at 1-month follow-up. Statistical analysis was performed using SPSS.

Results: The incidence of POCD was significantly lower in Group C (2.5%) compared to Group A (15%) and Group B (7.5%) at the 1-month follow-up ($p < 0.05$). Group C also showed superior cognitive outcomes in MMSE, DSST, and TMT scores. Intraoperative hemodynamic stability was better in Group C, with fewer hypotensive episodes and reduced anaesthetic consumption compared to the other groups.

Conclusions: The study demonstrates that BIS-guided anaesthesia combined with Dexmedetomidine infusion significantly reduces the incidence and severity of POCD in elderly

patients undergoing ENT surgery. These findings suggest that optimizing anaesthetic depth and incorporating Dexmedetomidine may offer neuroprotective benefits, improving cognitive outcomes in this vulnerable population.

KEY WORDS: POCD, ENT surgeries, Anesthesia, Dexmedetomidine and BIS.

Introduction

Perioperative cognitive dysfunction (POCD) refers to a decline in cognitive performance observed after anaesthesia and surgery, commonly manifesting as memory impairment, difficulties in concentration, and reduced executive function. POCD is particularly relevant in elderly patients due to age-associated neurodegeneration, reduced cognitive reserve, and increased sensitivity to perioperative stressors [1]. With the growing geriatric population and increased surgical interventions in this age group, POCD has emerged as a significant public health issue [2]. Although cardiac surgeries have been extensively studied in the context of POCD, emerging evidence suggests a comparable incidence in elderly patients undergoing ENT surgeries [3]. Factors such as type and depth of anaesthesia, intraoperative hypotension, systemic inflammation, and pre-existing cognitive impairment have been implicated in its pathogenesis [4,5].

The Bispectral Index (BIS), a processed electroencephalogram-based monitor, has been developed to objectively quantify the hypnotic component of anaesthesia. By maintaining BIS values within an optimal range (typically 40–60), the incidence of excessive anaesthetic depth and associated burst suppression can be minimized, thus potentially reducing neuronal injury and POCD [6, 7]. Dexmedetomidine, a highly selective alpha-2 adrenergic receptor agonist, exerts sedative, anxiolytic, and analgesic effects with minimal respiratory depression. It has demonstrated neuroprotective effects in experimental studies by modulating inflammatory responses, enhancing sleep-like sedation, and attenuating oxidative stress [8, 9]. Recent randomized controlled trials have shown that intraoperative infusion of Dexmedetomidine may reduce the incidence of POCD and delirium in elderly patients [10, 11].This study aims to evaluate the effect of BIS-guided anaesthesia with and without Dexmedetomidine infusion on the incidence and severity of POCD in elderly patients undergoing elective ENT surgeries.

Materials and Methods

This prospective, randomized, double-blinded, controlled study was conducted at a tertiary care teaching hospital over a period of 12 months. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants. **Study Population:** Patients aged 60 years and above, scheduled for ENT surgeries under general anaesthesia, were screened for eligibility. Inclusion criteria included American Society of Anesthesiologists (ASA) physical status I–III and expected surgical duration between 1 and 3 hours. **Exclusion criteria** included pre-existing cognitive impairment (Mini-Mental State Examination [MMSE] score <24), history of neurodegenerative disease, psychiatric illness, sensory impairments affecting neuropsychological testing, and concurrent use of sedative or antipsychotic medications. **Sample Size:** Based on prior incidence data and aiming for a power of 80% with α=0.05, a total of 120 patients were enrolled and randomized into three groups (n=40 each): **Group A:** Standard general anaesthesia without BIS monitoring or Dexmedetomidine. - **Group B:** BIS-guided anaesthesia (target BIS 40–60). **Group C:** BIS-guided anaesthesia with Dexmedetomidine infusion. **Anaesthetic Management:** All patients were premedicated with intravenous midazolam (0.02 mg/kg) and fentanyl (2 µg/kg). Induction was carried out using propofol (2 mg/kg) and rocuronium (0.6 mg/kg) to facilitate tracheal intubation. Maintenance was achieved using isoflurane with 50% oxygen in air. In Group B and C, the depth of anaesthesia was titrated to maintain BIS values between 40 and 60. Group C received an intravenous loading dose of Dexmedetomidine (1 µg/kg over 10 minutes) followed by a maintenance infusion at 0.5 µg/kg/h until 30 minutes prior to the

end of surgery. **Monitoring and Intra-operative Parameters:** Standard ASA monitoring was used in all patients. BIS electrodes were applied on the forehead in Groups B and C. Hemodynamic parameters, BIS scores, volatile agent concentration, and infusion rates were recorded at 5-minute intervals. The total dose of isoflurane and intra-operative opioid use were documented. **Cognitive Assessment:** Neurocognitive testing was performed using MMSE, Trail Making Test (Parts A and B), Digit Symbol Substitution Test (DSST), and Montreal Cognitive Assessment (MoCA). Assessments were conducted at three time points: preoperatively (baseline), on postoperative day 3, and at 1-month follow-up. Cognitive decline was defined as a decline of ≥1 standard deviation in ≥2 tests compared to baseline. **Statistical Analysis:** Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean ± standard deviation and compared using one-way ANOVA with post hoc Tukey test. Categorical variables were compared using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results

A total of 120 elderly patients undergoing elective ENT surgeries were enrolled and randomized equally into three groups (n=40 per group). There were no significant differences in demographic variables, ASA physical status, type and duration of surgery, or baseline cognitive test scores across the three groups ($p > 0.05$). The number if ENT surgeired undertaken in this study with their percentages and p value are tabulated in the **Table 1.**

Table 1: Showing the Types of surgeries and the number undertaken in the study. (n- 120)

Nature of Surgeries	Number	Percentage	P value
Ear Surgeries	41	34.1	
Tympanoplasty	18	15	
Myringotomy	06	05	
Mastoidectomy	12	10	0.011
Stapedectomy	01	0.83	
Eustachian Tube Surgery	04	03.33	
Nose Surgeries	22	18.33	
Sinus Surgery (Functional Endoscopic Sinus Surgery (FESS)	13	10.83	0.016
Turbinate reduction	09	07.5	
Throat Surgeries:	29	24.16	
Laryngectomy Thyroidectomy	04	03.33	
Uvulopalatopharyngoplasty (UPPP)	15	12.5	0.010
	10	08.33	
Head and Neck Surgeries:	28	23.33	
Neck Dissection	08	06.66	
Parotidectomy Laryngopharyngeal Surgery Minor	04	03.33	0.021
Salivary Gland Surgery Tracheostomy	03	02.5	
	02	01.66	
	11	09.16	

Incidence of POCD: On postoperative day 3, the incidence of POCD was highest in Group A (30%), followed by Group B (17.5%), and lowest in Group C (10%). At 1-month follow-up, the incidence reduced to 15% in Group A, 7.5% in Group B, and 2.5% in Group C. **(Fig 1)** These differences were statistically significant ($p < 0.05$). **Neurocognitive Test Performance:** Patients in Group C showed better preservation of cognitive function, with minimal decline in MMSE, DSST, and TMT scores compared to Group A. Group B also demonstrated improved cognitive outcomes compared to Group A, but not as markedly as Group C.

Anaesthetic Requirements and Hemodynamic Stability:
Groups B and C had reduced volatile agent usage compared to Group A, with Group C requiring the least isoflurane. Group C also exhibited greater intraoperative hemodynamic stability, with fewer hypotensive episodes and lower vasopressor requirements.

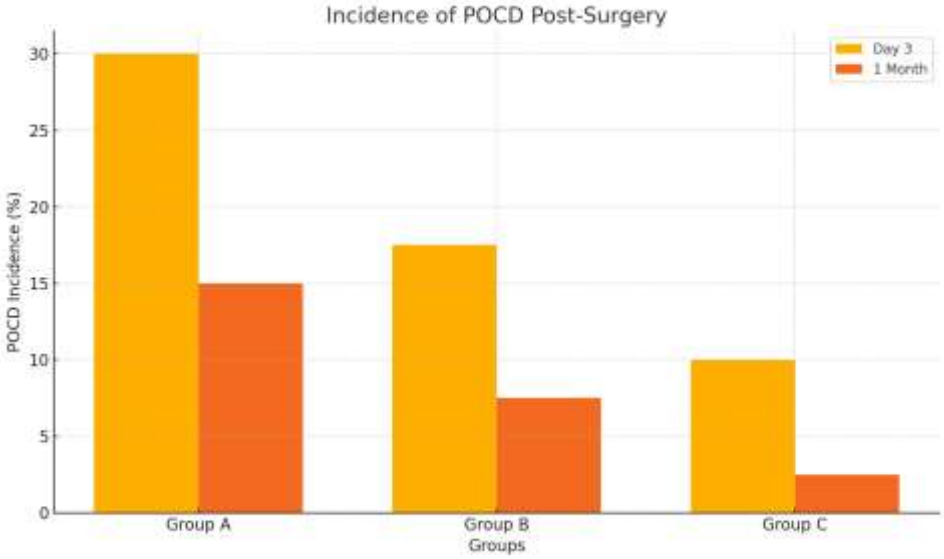

Figure 2: Incidence of POCD on Postoperative Day 3 and at 1 Month Follow-up.

Table 1: Postoperative Neurocognitive Scores (Mean ± SD)

Cognitive Test	Group A	Group B	Group C
MMSE (Day 3)	26.3 ± 2.1	28.1 ± 1.5	29.2 ± 0.8
MMSE (1 Month)	27.8 ± 1.9	29.0 ± 1.2	29.6 ± 0.6
DSST (Day 3)	41.2 ± 3.5	45.3 ± 3.0	49.1 ± 2.4
TMT-B (sec)	140 ± 20	120 ± 18	105 ± 12

Discussion
This study evaluated the impact of BIS-guided anaesthesia and intraoperative Dexmedetomidine infusion on the incidence of POCD in elderly patients undergoing ENT surgeries. The findings demonstrated that both BIS monitoring and Dexmedetomidine significantly reduced the incidence and severity of POCD, with the combination of the two strategies (Group C) yielding the most favourable outcomes. The role of BIS monitoring in optimizing anaesthetic depth is well-established. In this study, patients in the BIS-monitored groups (B and C) had significantly lower POCD rates compared to those receiving standard care (Group A). Excessive anaesthetic depth has been associated with burst suppression patterns, which may contribute to neurocognitive decline postoperatively [1]. BIS allows for titration of anaesthetic agents to maintain optimal depth, thereby preventing cortical over-suppression and ensuring patient safety [2, 3]. Dexmedetomidine, a selective alpha-2 adrenergic receptor agonist, provides sedation that mimics natural sleep architecture and has shown anti-inflammatory and neuroprotective effects [4, 5]. Our findings corroborate previous studies, where Dexmedetomidine was associated with reduced neuroinflammation, attenuated oxidative stress, and decreased incidence of delirium and POCD [6, 7]. Patients in Group C also demonstrated better intraoperative haemodynamic stability, reduced anaesthetic and opioid requirements, and shorter emergence times, which may have further contributed to improved postoperative cognitive outcomes. This study supports the findings of Su et al. and Deiner et al., who also reported the protective effects of Dexmedetomidine against cognitive decline in elderly surgical patients [8, 9]. Furthermore, our results are in agreement with Wildes et al., who highlighted the benefits of EEG-guided anaesthesia in reducing postoperative

neurocognitive complications [10, 11]. Limitations of this study include its single-centre design and relatively short follow-up period of one month. Additionally, cognitive assessments were limited to standardized tests and did not include biomarkers of neuroinflammation or neuroimaging studies. Future research with multicentric cohorts, longer follow-up, and integration of objective biological markers is warranted to validate and expand upon these findings.

CONCLUSION

Perioperative cognitive dysfunction remains a significant concern in elderly patients undergoing surgery. This study demonstrates that the combined use of BIS-guided anaesthesia and Dexmedetomidine infusion significantly reduces the incidence and severity of POCD in elderly patients undergoing elective non-cardiac surgery. Tailoring anaesthetic depth with BIS monitoring, alongside pharmacological neuroprotection through Dexmedetomidine, provides a promising strategy to enhance cognitive recovery and overall postoperative outcomes. Incorporating these evidence-based practices into routine anaesthetic protocols may contribute to safer, more patients.

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