Identifying postoperative cognitive dysfunction after elective coronary artery bypass graft surgery in a tertiary centre in Malaysia

Siti Hajar Abdull Rahman, MRehabMed[1], Mazlina Mazlan, MRehabMed[1], Anwar Suhaimi, MRehabMed[1], Noorjahan Haneem Md Hashim, MAnaes[2]

[1]Department of Rehabilitation Medicine, Faculty of Medicine, University Malaya, Kuala Lumpur, Malaysia, [2]Department of Anaesthesiology, Faculty of Medicine, University Malaya, Kuala Lumpur, Malaysia

SUMMARY

Postoperative cognitive dysfunction (POCD) is a significant concern, with incidences reported up to 70% following cardiac surgery. Therefore, we aim to evaluate the incidence of POCD after elective coronary artery bypass graft (CABG) surgery at our single centre over a one-year period from August 2021 to July 2022. We included 34 patients in the study and conducted serial cognitive assessments up to three months post-surgery. Interestingly, our findings indicated an absence of POCD among patients who underwent elective CABG. Reasons contributing to this outcome are multifactorial, which may include the patients' younger age, higher educational levels, lack of pre-existing neurological disorders, meticulous intraoperative cerebral saturation monitoring, and the duration of aortic cross-clamp and cardiopulmonary bypass time.

INTRODUCTION

Postoperative cognitive dysfunction (POCD) is a decline in cognitive abilities following surgical procedures. It is particularly prevalent after cardiac surgery, with reported incidences ranging between 50-70%.[1] Identified risk factors for POCD encompass a variety of patient-related elements, intraoperative factors including hypotension, reduced haematocrit levels, and extended surgical duration, as well as anaesthesia-related factors like the depth and duration of anaesthesia, ventilation duration in the intensive care unit, and types of anaesthetic medications, have also been recognized.[2]

Malaysia has a significant prevalence of cardiac disease contributing to 17% of deaths in 2020,[3] and thus, coronary artery bypass graft (CABG) surgery is frequently performed in various centres, including public and private hospitals. Among these, the University Malaya Medical Centre (UMMC) stands out as a public tertiary centre equipped with cardiologists, cardiothoracic surgeons, a dedicated anaesthesia team and a cardiac rehabilitation team.

Despite the known global incidence of POCD, there has been a lack of specific data from Malaysia. Therefore, this study was conducted to investigate the incidence and outcomes of POCD following elective CABG at UMMC. This is also the first report from Malaysia and this paper highlights the utilisation of multiple neurocognitive tools and stringent criteria to ascertain the incidence of POCD.

MATERIALS AND METHODS

We conducted a prospective study of all adults undergoing elective CABG surgery at UMMC from August 2021 to July 2022, with approval from the Medical Research Ethics Committee. Ten age-matched patients with ischemic heart disease were selected as controls from the Cardiac Rehabilitation Clinic. Exclusion criteria for both groups included pre-existing cognitive impairment, visual, hearing, or language disabilities, alcohol or recreational drug dependence and unwillingness to return for postoperative cognitive assessment.

Consenting patients underwent a baseline examination one day before surgery, followed by evaluations at 6 weeks and 3 months post-surgery, utilising a combination of standardised neurocognitive tools. The tools were Montreal Cognitive Assessment test, Trail Making Test (Parts A and B), Digit Symbol Substitution Test and Digit Span Test. The incidence of POCD was determined using the Z-score method, adapted from previous ISPOCD studies as described in the systemic review.[4] POCD was defined if an individual's Z-score in two or more cognitive tests, or a combined Z-score, was >-2. The control group also underwent the assessments at similar timeline.

Data collected for potential POCD risk factors included the patient's demographic data, intraoperative data, postoperative data, and medications used during intraoperative and postoperative periods. This numbers of patients who underwent bispectral index (BIS)guided anaesthesia and patient state index (PSI)-guided anaesthesia were recorded, along with the frequency of intraoperative complications. Numerical data was reported as mean, while categorical data was presented as frequency and percentage.

RESULTS

In this study, 34 patients (94.1% male) with an average age of 57.7±9.6 years completed all cognitive assessments. Demographic details are summarised in Table I, revealing that majority of patients presented with multiple

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Corresponding Author: Prof Dr Mazlina Mazlan
Email: drmazlina@gmail.com; mazlinamazlan@ummc.edu.my

Table I: The demographic characteristics of the patients.

Patient characteristic	Number of patients, n (%)
Age, mean ± SD	57.7±9.6
Gender	
Males	32 (94.1)
Females	2 (5.9)
Race	
Malay	17 (50.0)
Chinese	12 (35.3)
Indian	5 (14.7)
Education Level	
Primary	8 (2.9)
Secondary	26 (61.8)
Tertiary	17 (35.3)
Current comorbidities	
Dyslipidaemia	32 (94.1)
Hypertension	26 (76.5)
Diabetes mellitus	20 (58.8)
Kidney disease	4 (11.8)
Peripheral vascular disease	0 (0)
Liver disease	0 (0)
Smoking status	13 (38.2)
Alcohol consumption	0 (0)

Table II: Intraoperative and postoperative data of the patients.

Parameters	Number of patients, n (%) *mean±SD
Surgical data	
Surgery duration (hours)*	5.5±1.2
Aortic cross clamp time (min)*	96.9±37.1
Cardiopulmonary bypass time (min)*	139.2±50
BIS-guided anaesthesia	14 (42.4)
PSI-guided anaesthesia	19 (57.6)
Intraoperative complications	
Cerebral desaturation	10 (29.4)
Hypotension	13 (38.2)
Homologous blood transfusion	6 (17.6)
Postoperative data	
Mechanical ventilation (days)*	1 ± 0.2
Length of ICU stay (days)*	4.5 ± 2.1
Length of hospital stay (days)*	9.9 ± 4.5

*Values are presented as mean±SD
BIS = Bispectral Index; PSI = Patient State Index

Table III: Mean scores of the individual cognitive tests at baseline (1 day before surgery), 6 weeks and 3 months after surgery for the case (patients underwent CABG surgery) and comparison with the control group.

	Baseline		6 weeks after surgery		3 months after surgery	
	Case n=34	Control n=10	Case n=34	Control n=10	Case n=34	Control n=10
MoCA	25.6	24.9	26.5	26.1	26.9	26.4
TMT-A (seconds)	45	60.8	41.8	48.2	37.1	41.3
TMT-B (seconds)	82.1	104.4	74.5	99.4	71	79.4
DST-forward	6.8	6.2	6.5	6.5	7.1	7.1
DST-reverse	3.4	3.4	3.3	2.8	3.6	3.4
DSST	28.3	31.9	31.5	32.7	34.0	35.1

MoCA = Montreal cognitive test, TMT-A = Trail making test-A, TMT-B = Trail making Test-B, DST = Digit span test, DSST = Digit symbol substitution test

Table IV: Cumulative Z-score of the 25 patients who completed the assessment at 6 weeks and 3 months after surgery.

Patient	Cumulative Z-score		Patient	Cumulative Z-score	
	6 weeks	3 months		6 weeks	3 months
1	0.045	-0.092	13	0.055	0.125
2	-0.070	-0.066	14	0.011	0.035
3	-0.061	0.035	15	-0.029	-0.045
4	-0.053	-0.048	16	0.081	0.089
5	0.095	0.029	17	0.011	-0.009
6	-0.099	-0.028	18	-0.045	0.021
7	0.049	-0.021	19	-0.113	-0.066
8	0.089	-0.031	20	0.069	0.009
9	0.006	-0.034	21	0.024	0.015
10	0.054	0.029	22	0.004	0.029
11	-0.076	-0.035	23	-0.037	-0.026
12	-0.062	-0.049	24	-0.058	-0.065
			25	0.050	-0.063

comorbidities. There was no statistically significant difference when compared with the control group.

Table II detailed the intraoperative and postoperative data, including the mean surgery duration, aortic cross-clamp (ACC) time, and cardiopulmonary bypass (CPB) time. All complications were resolved immediately during the surgery.

Cognitive test scores post-surgery showed no significant decline from baseline levels, as detailed in Table III. Among the participants, none met the POCD criteria, therefore, no incidence of POCD was observed at 6 weeks and 3 months post-surgery, including in the patients who experienced cerebral desaturation during surgery.

In this study, remifentanil, sevoflurane, midazolam and morphine were the most frequently used medications during CABG surgery, while dexmedetomidine, fentanyl and tramadol were commonly administered postoperatively in the ICU.

DISCUSSION

In the current study, we found no incidence of POCD among patients undergoing elective CABG surgery at UMMC. This result could be attributed to multiple factors. The patients in our centre were comparatively younger, and free from neurological diseases or alcohol abuse, contrasting with previous literature which identified old age (above 60 years), pre-existing neurological disease and alcohol abuse as risk factors for POCD.

Notwithstanding, there are limitations in our sample size representing the local population. The small sample size was inevitable due to the reduction in CABG procedures performed during the COVID-19 pandemic, coupled with a high dropout rate for follow-up appointments. While the mean age in our study aligns with the younger demographic reported in the acute coronary syndrome registry,[5] a larger sample size would provide more generalisability and confirm the broader applicability of our findings.

The other mechanism attributed for POCD development is cerebral hypoperfusion and micro emboli caused by cardiopulmonary bypass. Although it remains under debate, studies suggest that CPB exceeding 180 minutes and ACC exceeding 150 minutes are associated with adverse outcomes.[6,7] Click or tap here to enter text.In our study, both CPB and ACC times remained below these thresholds. In our practice, NIRS is also utilised to monitor intraoperative cerebral regional saturation of all the patients, with a standardised protocol in place for addressing desaturation, as suggested in the literature.[8]

The selection of medications could also influence POCD outcomes. Remifentanil, an ultrashort-acting drug, has minimal impact on cognition. Postoperatively, dexmedetomidine was used for sedation and analgesia in the ICU, which, according to recent studies, may reduce POCD incidence and offers neuroprotective effects.[9] Despite the use of long-acting medications (morphine and midazolam) and sevoflurane, the use of processed EEG (BIS and PSI) to monitor depth of anaesthesia to guide drug titration may contribute to the reduction of POCD.

The challenge in POCD studies lies in the lack of universally accepted definitions and criteria. Our study adhered to the recommendations by the Perioperative Cognition Nomenclature Working Group[10] to avoid cognitive assessments within the initial 30 days post-surgery, allowing sufficient time for the dissipation of acute effects from drugs, anaesthesia, pain, and emotional stress. The neurocognitive tests employed and the diagnostic criteria for POCD were adapted from large scale ISPOCD studies.[4] All the tests are effective in detecting domains affected by POCD, such as executive function, processing speed, memory, and attention. Additionally, the use of a standard anaesthesia technique in a single centre helped reduce variability in the approaches examined.

CONCLUSION

Elective coronary artery bypass graft (CABG) surgery is not significantly associated with cognitive dysfunction, given the detailed preoperative preparation and the controlled setting of the planned procedure. Further studies with larger sample sizes and multi-centre recruitment are recommended. Assessing patients at longer follow-up intervals may provide additional insights into the potential delayed onset of cognitive decline.

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