ORIGINAL ARTICLE

Cognitive Dysfunction after On-Pump Coronary Artery Bypass Grafting (CABG) in a Tertiary University Hospital – A Prevalence Study

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ABSTRAK

Disfungsi kognitif selepas pembedahan (POCD) ialah komplikasi yang biasa berlaku selepas penggunaan mesin pintasan kardiopulmonari semasa pembedahan pintasan koronari arteri (CABG) dan ini boleh mengurangkan kualiti hidup. Oleh itu, kami mengkaji prevalens dan faktor risiko perioperatif berkaitan dengan POCD selepas pembedahan elektif CABG. Di dalam kajian keratan rentas prospektif ini, 38 pesakit telah direkrut dan fungsi kognitif mereka dinilai dengan menggunakan 'Montreal Cognitive Assessment' (MoCA) pada hari sebelum pembedahan, ke-7 dan ke-30 selepas operasi. Empat pesakit meninggal dunia selepas pembedahan dan oleh itu, hanya 34 data pesakit dianalisis. Prevalens POCD pada hari ke-7 dan hari ke-30 adalah setanding pada 41% dan 26.4%. Markah purata MoCA sebelum pembedahan bertambah baik dengan ketaranya pada hari ke-7 dan ke-30 selepas pembedahan CABG (24.68 $\pm$ 3.57 vs 25.06 $\pm$ 3.73 vs 25.88 $\pm$ 4.00, $p = 0.044$). Umur yang lanjut adalah berkaitan dengan pengurangan skor purata MoCA dan meningkatkan risiko POCD pada hari ke-7 dan ke-30 selepas pembedahan (Rs -0.451 dan -0.359, p = 0.007 dan 0.037). Pesakit dengan ujian fungsi paru-paru yang tidak normal mempunyai pengurangan ketara dalam pemarkahan MoCA sebelum pembedahan dan penambahbaikan skor yang rendah selepas operasi, berbanding dengan pesakit yang mempunyai ujian fungsi paru-paru yang normal (p = 0.013). Kesimpulannya, POCD selepas pembedahan CABG berlaku pada satu pertiga daripada pesakit dan bertambah baik dari semasa ke semasa. Peningkatan umur dan ujian fungsi paru-paru praoperasi yang tidak normal dikenal pasti sebagai faktor risiko untuk POCD. Ujian fungsi paru-paru yang tidak normal juga dikaitkan

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dengan peningkatan kognitif yang lebih rendah selama sebulan selepas CABG.

Kata kunci: faktor risiko komplikasi kognitif selepas pembedahan, pintasan koronari arteri, prevalens

ABSTRACT

Postoperative cognitive dysfunction (POCD) was a common complication of on-pump coronary artery bypass grafting (CABG) which could reduce the quality of life. We investigated the prevalence and perioperative risk factors associated with POCD after elective CABG surgery. In this prospective cross-sectional study, 38 patients were recruited and their cognitive function was assessed using Montreal Cognitive Assessment (MoCA) at preoperative, 7th and 30th days, postoperatively. A total of 34 patients completed the study with four dropouts due to post-operative death. Prevalence of POCD on the 7th day and 30th days were comparable at 41% and 26.4%, respectively. The preoperative mean MoCA scoring improved significantly in patients with POCD on the 7th and 30th day after CABG surgery (24.68 $\pm$ 3.57 vs 25.06 $\pm$ 3.73 vs 25.88 $\pm$ 4.00, *p-value* 0.044). Higher age was correlated with a reduction in mean MoCA score and increased risk of POCD detected on the 7th and 30th day postoperatively (Rs -0.451 and -0.359, *p-value* 0.007 and 0.037, respectively). Patients with abnormal lung function tests had a significant reduction of MoCA scoring at preoperative and lower improvement score postoperatively, compared with normal lung function test patients (*p-value* 0.013). In conclusion, POCD after on-pump CABG surgery occured in about one-third of the patient and improved over time. Increasing age and abnormal preoperative lung function tests were identified as the risk factor for POCD. Abnormal lung function test was associated with a lesser one-month cognitive improvement after CABG.

Keywords: coronary artery bypass, postoperative cognitive complications, prevalence, risk factors

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INTRODUCTION

Cognition declines as we age. Cognitive impairment can occur in patients who undergo surgery (Samuel & Kristine 2018). The concept of postoperative cognitive dysfunction (POCD) was introduced in 1955. It refers to the temporary decline in cognitive function associated with surgery and anaesthesia. Unlike delirium and dementia, there was no formal definition of POCD (Audrey & Derek 2013). At best, it was possible to consider POCD as a mild neurocognitive disorder of unspecified aetiology and the clinical suspicion of POCD should be confirmed with a neuropsychological test (Samuel & Kristine 2018). The tests were required to be conducted before surgery as a reference point and reassessed postoperatively in different durations to assess the decline or improvement over time. The Montreal Cognitive Assessment (MoCA) tool was a neuropsychological test developed by Nasreddine et al. (2005) to assess cognitive impairment. It assesses different cognitive domains including attention and concentration, executive functions, memory, language, visuo-constructional skills, conceptual thinking, calculations and orientation (Nasreddine et al. 2005). It was originally in English but it has been validated in other languages including Malay and Mandarin which was suitable for use in our multiracial population (Nasreddine et al. 2005; Cheah et al. 2014; Normah et al. 2016; Yu et al. 2012; Chen et al. 2015). It was selected as the tool in our study as it covered a broad spectrum of cognitive domains and the test can be completed within a short time frame.

Postoperative cognitive dysfunction had a significant impact, leading to a loss of independence, reduction in quality of life and withdrawal from society (Audrey & Derek 2013). Thus, identifying the occurrence of POCD was crucial in reducing the financial burden on the affected individuals and the country. It was also noted to be the most common complication after cardiac surgery. The incidences vary between 30% to 70% upon discharge, reducing to 20% to 30% in 6 months and further dropping to 15% to 20% at 12 months of follow-up (Sandro et al. 2019). Newman et al. (2001) concluded that the prevalence of POCD following coronary artery bypass grafting (CABG) was high with an early improvement but demonstrated a pattern of decline in cognitive function later during the five-years follow-up. The pathophysiology of POCD was multifactorial and associated with a wide range of surgical, anaesthetic and patient factors (Audrey & Derek 2013; Sandro et al. 2019; Steinmetz et al. 2009). It was thought that on-pump CABG patients were more prone to develop POCD due to cerebral microemboli which may occur during cardiopulmonary bypass (CPB) (Audrey & Derek 2013). Therefore, our study aimed to detect the prevalence of cognitive dysfunction after on-pump CABG surgery in our institution. The perioperative risk factors associated with POCD were also identified in this study.

MATERIALS AND METHODS

This prospective cross-sectional study was conducted after approval from the Research Committee of the Department of Anaesthesiology & Intensive Care, Universiti Kebangsaan Malaysia Medical Centre (UKMMC) and the Medical Research & Ethics Committee, UKM (Research code: FF-2020-034). Patients who were undergoing elective on-pump CABG from June 2020 until May 2021 were recruited. Written informed consent was obtained from the patient by a single investigator.

Patients aged from 18 to 80 years old and scheduled for elective on-pump

CABG with CPB and aortic cross-clamp in our centre were included in this study. Exclusion criteria included those unable to participate in the assessment due to hearing disabilities and patients with a previous history of CABG. The patients who could not complete the postoperative assessment, re-open CABG or died were considered dropouts.

A day prior to the surgery, the demographic data including age, gender, race, education level and spoken language were collected and analysed. The education level was considered low if the patient received total duration of formal education less than 12 years. Other parameters documented were body mass index (BMI), comorbidities, smoking, obstructive sleep apnea score (STOPBANG), preoperative ejection fraction (EF) and lung function test. The MoCA test was also performed and taken as a baseline reference point. It was repeated on the 7th day postoperatively and 30th days after surgery, which was the first day of clinic follow up. The repeated assessment was to assess the onset of POCD or its progression. The assessment took place either in the cardiothoracic ward or clinic and a similar assessor carried out the assessment on a one-to-one basis, in a calm, comfortable, pain-free and unstressful environment.

The permission to use MoCA as the tool in this study was granted by the original author. Eight aspects of MoCA as shown in Figure 1, were assessed. Assessment of visuospatial or executive domain consisted of alternative trail making, visuoconstructional skill (cube) and visuoconstructional skill (clock). The estimation of the ability to recognise and name an item were performed by showing three different types of animals and the patients were required to verbalise the name in their preferred language. As for memory assessment, a total of five words were read by the accessor at one-second interval and the patients were required to recall them at the end of the test, which can be repeated twice. The attention span and language of the patients were judged by forward and backward digits span, vigilance, series of seven substractions, sentence repetition and verbal fluency. Abstraction and delayed recall were assessed by looking into the relation of two subjects' similarities and recall of five words, while orientation was performed by asking the date, month, year, day, place and city.

The total maximum score was 30 points and a score of 26 or above was considered normal. An extra point was added for patients who had a low education level. Patients with a score of less than 26 were diagnosed with either mild cognitive impairment (MCI) or POCD, depending upon the timing of the assessment, either during preoperative or postoperative, respectively.

After surgery, patients were admitted to the cardiac-intensive care unit (CICU) for further management and weaning of ventilation as per standard practice. Additional information regarding perioperative management was collected from patients' clinical case notes for analysis. The intraoperative and postoperative data

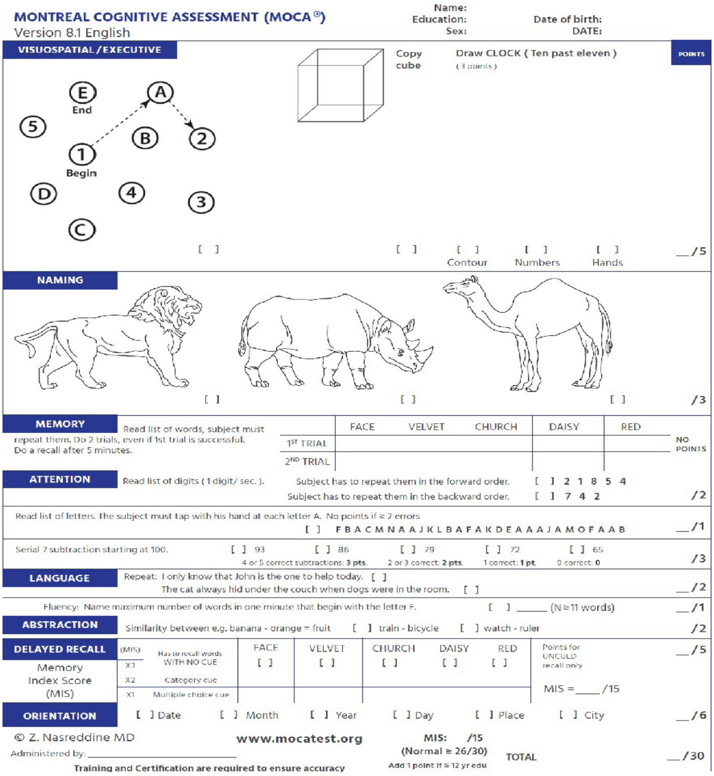

Figure 1: The Montreal Cognitive Assessment test

including anaesthesia, CPB and aortic cross-clamp duration, numbers of grafts, use of intra-aortic balloon pump (IABP), reduction in cerebral oximeter (which was defined as a reduction of cerebral oxygenation by more than 20% from baseline for a duration longer than 10 minutes), total dosage and duration of midazolam, morphine, noradrenaline and adrenaline, duration of mechanical ventilation, use of non-invasive ventilation (NIV) post-extubation, length of CICU and postoperative hospital stay as well as the intraoperative and postoperative complications were charted. The documented intraoperative complications included arrhythmias, disseminated intravascular coagulation (DIVC), ventricular perforation and aortic injury. The postoperative complications were sepsis, bleeding, pleural effusion and arrhythmias.

The minimum number of subjects was 35 patients with study power of 80% with a 95% confidence level and a 10% dropout rate This sample size was calculated using Krejcie & Morgan (1970) formula for a finite population where the population size for CABG patients in our institution from June 2020 till December 2020 was 17 with estimated yearly cases of 34 patients, and quoting the lowest incidence of POCD in one-week post-CABG was 37.6% from Ge et al. (2014).

The collected data were analysed using SPSS for Windows version 26.0

(IBM Corp, Armonk, NY, USA). The results were presented as mean standard deviation, median (interquartile range) or frequency (percentages) when applicable. Paired t-test and Wilcoxon Signed-rank test were performed for continuous parametric and non-parametric intra-group data analysis, respectively. The categorical data analysis involved Chi-square or Fisher exact test. One way ANOVA was used to analyse the MoCA score at baseline and postoperatively.

The relationship analysis of categorical factors includes intraoperative IABP, reduction in cerebral oximeter, postextubation NIV, complications, preoperative education level, comorbidities, smoking and lung function test with MoCA score at baseline and postoperatively were assessed via general linear model. In the results section, the lung function test was reported as a normal or abnormal test, which was defined as either a restrictive or obstructive profile. The Spearman correlation test was performed to assess the association of continuous data which include age, preoperative EF, duration of anaesthesia, CPB, aortic cross-clamp, use and dosage of midazolam, morphine, vasopressors as well as the length of mechanical ventilation, CICU and postoperative hospital stay with MoCA score at one week and one month after CABG. A *p-value* <0.05 was considered statistically significant.

RESULTS

A total of 38 patients were recruited for this study. Four patients drop out as a result of postoperative death. Data collected from 34 patients were analysed. Patients' demographic data and characteristics were shown in Table 1. The prevalence of MCI and POCD on the preoperative, 7^{th} and 30^{th} day postoperative were 50.0%, 41.0% and 26.4%, respectively (*p-value*=0.076). The demographic data and characteristics of patients with and without MCI, and those with and without POCD at 7^{th} and 30^{th} days after surgery were not statistically significant. Preoperative MCI patients demonstrated a higher prevalence of abnormal lung function tests in comparison with patients without MCI (70.6% versus 29.4%, *p-value*=0.01), as shown in Table 2. The comorbidities, BMI, STOPBANG score, the incidence of smoking, preoperative EF and lung function test of the patient with

Table 1: The demographic data and characteristics of patients. Values were expressed as percentage (%), mean $\pm$ SD or median (percentile) wherever appropriate

Characteristics	n = 34
Age	58.9 $\pm$ 9.7
Gender	
Male	29 (85.3)
Female	5 (14.7)
Race	
Malay	18 (52.9)
Chinese	14 (41.2)
Indian	1 (2.9)
Others	1 (2.9)
Education	
Low (<12 years old)	24 (70.6)
None	1 (2.9)
Primary	9 (26.5)
Secondary	14 (41.2)
High	10 (29.4)
Language	
Malay	16 (41.7)
English	5 (14.1)
Mandarin	13 (38.2)

Table 2: The preoperative clinical data. Values expressed as percentages (%), mean ± SD and median (percentile) where appropriate

Clinical data	All patients (n = 34)	Without MCI (n = 17)	With MCI (n = 17)	p-value
Comorbidities				
Hypertension	32 (94.1)	15 (88.2)	17 (100.0)	0.48
Diabetes mellitus	11 (32.4)	4 (23.5)	7 (41.2)	0.27
Dyslipidemia	31 (91.2)	15 (88.2)	16 (94.1)	1.00
Renal impairment	3 (8.8)	2 (11.8)	1 (5.9)	1.00
BMI (kg/m^2)	26.4 ± 3.5	25.8 ± 5.6	27 ± 3.5	0.34
STOPBANG score	3 [2 – 5]	3 [2 – 4]	3 [2 – 5]	0.82
Smoking				
Yes	14 (41.2)	8 (47.1)	6 (35.3)	0.48
No	20 (58.8)	9 (52.9)	11 (64.7)	
Ex-smoker	6 (17.6)	3 (17.6)	3 (17.6)	
Non-smoker	14 (41.2)	6 (35.3)	8 (41.7)	
Preoperative EF	56.0 ± 11.3	56.8 ± 10.3	55.3 ± 12.4	0.70
Lung function test				
Normal	17 (50.0)	12 (70.6)	5 (29.4)	0.01*
Abnormal	17 (50.0)	5 (29.4)	12 (70.6)	

BMI=Body Mass Index; STOPBANG=Snoring, Tiredness, Observed breathing, Pressure, Body Mass Index, Age, Neck circumference, Gender; EF=Ejection fraction; *p-value < 0.05

and without POCD on 7th and 30th day postoperatively did not reveal significant results.

Preoperative MCI patients and those without MCI revealed no significant difference with the duration of anaesthesia, CPB, aorta cross-clamp, sedatives, analgesia, vasopressors, mechanical ventilation and length of CICU as well as the hospital stay. The dosage of sedatives, analgesia and vasopressors, number of grafts, reduction in cerebral oximeter, use of IABP and NIV postextubation, as well as operative complications, also showed no significant difference between patients with and without MCI. On the 7th day postoperatively, patients with a longer duration of mechanical ventilation had a lower prevalence of POCD (22 hours versus 19 hours, *p-value*=0.03). However, the mean MoCA score did not significantly correlate with mechanical ventilation at one-week post-surgery, with Rs 0.258 and R^2 0.075 (*p-value*=0.141). A lower prevalence of POCD also was observed in those with postoperative complications one week after CABG surgery (90.0% versus 57.1%, *p-value*=0.04), but it did not significantly correlate with mean MoCA score at preoperative, 7th day and 30th day postoperatively with a *p-value* of 0.236.

The mean MoCA scoring for the patients with MCI was 24.68 ± 3.57, which significantly improved to 25.06 ± 3.73 and 25.88 ± 4.00 at the 7th and 30th day postoperatively (*p-value*=0.044), as shown in Figure 2. The patients with an abnormal lung function test was observed to have a statistically significant lower MoCA score compared to the patients with a normal lung function test

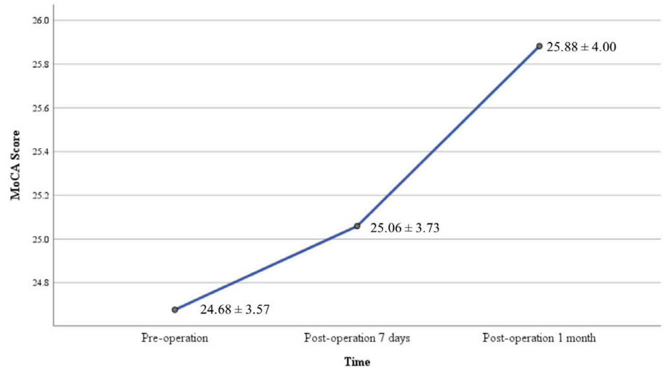

Figure 2: The mean MoCA scoring of MCI and POCD on the preoperative, 7th and 30th days after surgery

at preoperative, 7th and 30th day postoperatively (*p-value*=0.013), as shown in Figure 3. The MoCA score of patients with and without hypertension, diabetes mellitus, dyslipidaemia and renal impairment were statistically no significant difference at preoperative, 7th day and 30th day postoperatively. The MoCA score for the patients with low education was also statistically no significant difference compared to high education levels at these 3 time point assessments. The patient who required intra-operative IABP, cerebral oximeter reduction, had complications and needed NIV postextubation had statistically no significant differences in MoCA score with those who had a normal value of cerebral oximeter, did not require IABP nor had complications or NIV postextubation at preoperative, 7th day and 30th day postoperatively. Preoperative EF, the duration for anaesthesia, CPB and cross-clamp were not statistically correlated with the MoCA score in preoperatively and postoperatively. The dosage and duration of midazolam, morphine,

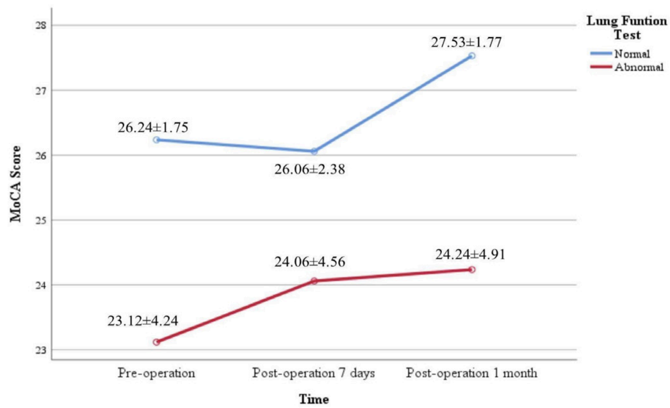

Figure 3: The mean MoCA score between abnormal and normal lung function patients which were assessed on the preoperative, 7th and 30th day postoperatively

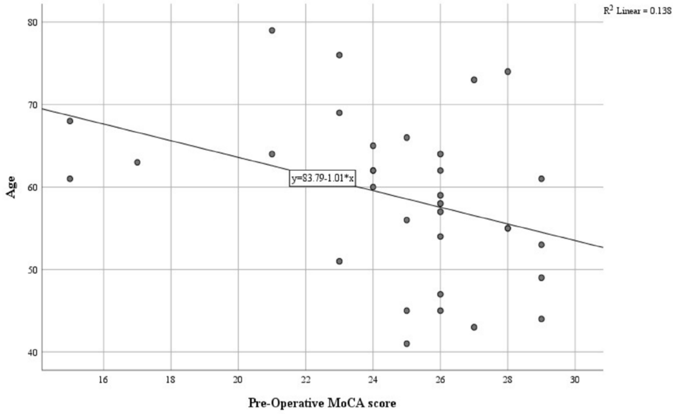

Figure 4: The correlation of mean MoCA score with age at baseline

adrenaline and noradrenaline also demonstrated no correlation with the MoCA score. Duration of mechanical ventilation, length of CICU and hospital stay were statistically not correlated with the MoCA score.

A significant negative association of MoCA score with age was demonstrated, with Rs values of -0.451 and -0.359 (*p-value*=0.007 and 0.037, respectively). Figures 4 and 5 showed a strong correlation of mean MoCA score with age at baseline and 30th day postoperatively, which indicates a significant reduction in MoCA score when age increases (R_2=0.138 and 0.122, respectively).

DISCUSSION

Preoperative MCI occurs in 50% of our patients with a mean age of 61. Robinson et al. (2012) demonstrated similar results, with 44% of elderly patients undergoing surgery had a baseline cognitive impairment at 65 and above. It was highlighted that the basic executive function of cognitive performance was mainly affected by anxiety, as demonstrated by Eysenck

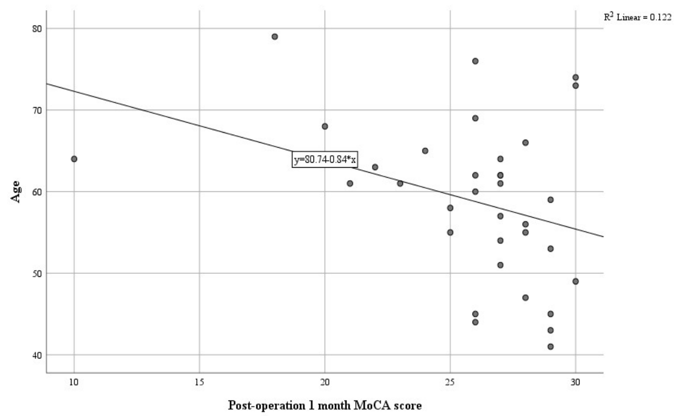

Figure 5: The correlation of mean MoCA score with age on the 30th day postoperatively

et al. (2007). Preoperative anxiety, stress and depression were observed as factors associated with preoperative MCI affecting the elderly (Eysenck et al. 2007; Gan et al. 2020). This finding was also consistent with a study by Goebel et al. (2012), which the effect of preoperative anxiety, extreme levels of stress and depression affected the patient's cognitive performance.

In general, 41% of our CABG patients had POCD on the 7th day postoperatively, similar to Ge et al. (2014), who demonstrated that the incidence of POCD was 37.6%. In contrast, studies conducted by Liu et al. (2009) and Mu et al. (2011) quoted a higher POCD incidence at 55.2% after one week of CABG surgery. However, different neuropsychological assessment tools were used in these studies. We found that the prevalence of POCD on the 30th day postoperatively was comparable with Ge et al. (2014), 26.4% versus 20.8%, respectively, even though the cognitive assessment in their study was performed later, at 12 weeks post-CABG surgery. The cognitive function also was observed to improve over time postoperatively, resembling the studies by Ge et al. (2014), Liu et al. (2009) and Mu et al. (2011), which demonstrated a reduction of POCD prevalence over time. However, the authors did not focus on the difference of POCD score at the assessment point, unlike our research. Our study demonstrated improved cognitive function with a rising value of MoCA score, even though the overall reduction of POCD incidence in our patients was insignificant.

We observed that patients with higher education levels had a lower percentage of POCD however, our analysis revealed no significant findings. The level of education was one of the factors that affected cognitive function. A meta-analysis by Feinkohl et al. (2017) had concluded that patients with higher education levels had a reduced risk of POCD. In relation to cardiac surgery, patients with lower education levels were associated with a higher risk of immediate postoperative delirium, which was one of the predisposing factors of POCD, as described by Oliveira et al. (2018) and Mu et al. (2011).

As for the association of comorbidities with POCD, Kadoi et al. (2005) demonstrated significant cognitive impairment in patients with diabetes mellitus group compared to the control group. The author also noted that hypertension, reduced jugular oxygenation to less than 50% and ascending aorta atherosclerosis were associated with short-term cognitive impairment, whereas those who received insulin therapy, diabetic retinopathy and high glycated haemoglobin were associated with POCD six months post-CABG. Oliveira et al. (2018) also showed that hypertension was one of the risk factors for delirium in postcardiac surgery that led to POCD. Concerning kidney function, patients with a high preoperative serum creatinine level significantly affected their cognitive function after cardiac surgery (Ghaffary et al. 2014). In our study, we were unable to demonstrate that hypertension, diabetes mellitus, dyslipidemia or renal impairment were associated with POCD which probably due to current study did not look into the severity of each comorbidity.

As for the perioperative factors associated with POCD, we demonstrated that age was one of the predisposing factors. It was observed that those with higher age had an increased risk of POCD postoperatively. This finding was similar to studies by Ge et al. (2014), Liu et al. (2009) and Mu et al. (2011), which established age as one of the independent risk factors for POCD after CABG surgery. We also observed that patients with abnormal lung function tests had a higher risk of developing preoperative MCI and a lower cognitive scoring at baseline and one-month post-operation, which was similar to findings by Ghaffary et al. (2014), who reported that patients with preexisting chronic obstructive pulmonary disease (COAD) that undergone cardiac surgery had a lower cognitive function postoperatively. It was found that those with a higher forced-expiratory volume were associated with a greater walking speed, reasoning, memory and self-reported physical functioning (Singh-Manoux et al. 2011). However, those with a history of smoking alone and without COAD were not predisposed to cognitive dysfunction after CABG, which corresponded with our study, supporting smoking as not-related factor for POCD (Liu et al. 2009).

The duration of CPB had been identified as one of the independent predictors of POCD by Perez-Belmonte et al. (2018) when cardiopulmonary bypass time was greater than 160 minutes. However, we found no association between the duration of CPB with POCD both on the 7th and 30th day post-CABG, even though the median duration of CPB was 192 minutes. Dijk et al. (2007) studied the 5 years cognitive status of 281 patients who either received off-pump or on-pump CABG surgery and revealed no difference in cognitive decline. It was concluded that neither the presence nor duration of CPB was the factor contributing to the cognitive impairment, and factors such as anaesthesia and generalised inflammatory response following a major surgical procedure were more related to POCD.

Interestingly, the postoperative usage of sedation and analgesia were not associated with POCD after cardiac surgery in our study, which were identical to Mu et al. (2011). In contrast, Silbert et al. (2006) showed that intraoperative low dose fentanyl was associated with a greater incidence of POCD at one-week post-CABG in elderly patients than high dose fentanyl. The author concluded that high dose fentanyl might obtund the stress response during surgery and thus lessen the risk of POCD in CABG patients.

The cerebral oxygen saturation (rSO_2) has been debating for many years and there was no standardised formula or data in determining the cut-off point of reduction in rSO_2 percentage associated with postoperative morbidities, especially in cardiac surgery. As early as 1994, Croughwell et al. (1994) observed that central venous desaturation was associated with POCD post-cardiac surgery. Yao et al. (2004) had shown that intraoperative reduction of rSO_2 less than 40% which length more than 10 minutes was associated with postoperative neurocognitive decline. This finding was also similar to Slater et al. (2009), who showed that patients who underwent cardiac surgery had an increased risk of postoperative cognitive decline and prolonged hospital stay when cerebral oxygen saturation dropped 50% from baseline. Whereas Tournay-Jetté et al. (2011) demonstrated that the patient with rSO_2 less than 50% during the surgery experienced POCD 4 to 7 days after surgery and a decrease of more than 30% from the patient's rSO_2 baseline was associated with POCD one month after CABG. The present study did not show a significant relationship of POCD in the patients who have a reduction in rSO_2 intraoperatively. However, our methodology could confound this finding as we included those who had rSO_2 of less than 20% rather than 30% from the baseline parameter, and neither of our patients has more than 30% decline to yield a significant result.

The use of IABP as part of intra-operative cardiac intervention did not affect cerebral hemodynamics and was not associated with a higher incidence of neurological complications, and these results were consistent with our observations (Caldas et al. 2019). Our study also did not support the prescription of vasopressor or inotropic medication as risk factors for POCD after CABG surgery. As of date, there have been no studies examining the direct effect of vasopressor use toward POCD however, Jannati et al. (2014) established that the use of inotropic support within the first to third-day postcardiac surgery increased the delirium risk, which could indirectly affect the incidence of POCD.

Although we observed that the risk of POCD was higher in patients with a shorter duration of mechanical ventilation on the 7th day postoperatively, it did not show a correlation between the two variables. This finding was in concordance with the study by Dumas et al. (1999), whereby patients who were extubated 3 hours versus 10 hours after CABG surgery did not affect their cognitive function at 3, 8 days and up to 8 weeks postoperatively. Research by Liu et al. (2009) also demonstrated that the duration of mechanical ventilation up to 12 hours post-surgery was not associated with POCD. In relation to the period of hospitalisation, the duration of ICU stay observed by Mu et al. (2011) was not significantly predisposed to POCD, which was similar to findings in our study even though the average CICU stay was three days and much longer than Mu et al. (2011). Our patients' median day of hospital stay was 9 days and it was found that the duration of hospital stay less than 7 days was identified as an independent risk factor for POCD, as demonstrated by Liu et al. (2009). Patients with postoperative complications had a lower risk for POCD one week after surgery however, no correlation was observed between POCD and complications after surgery, similar to Mu et al. (2011). Our study has limitations. The preoperative psychological states such as anxiety, depression and stress could predispose to MCI were not addressed in this study. Due to the limited study population, we were unable to proceed with multivariate analysis to identify the independent risk factors associated with POCD.

CONCLUSION

The prevalence of POCD after on-pump CABG surgery occurred in about one-third of patients and the cognitive dysfunction improved over time. Increasing age and abnormal preoperative lung function were identified as the risk factor for POCD. Abnormal lung function test was associated with a lesser one-month cognitive improvement after CABG.

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REFERENCES

Audrey, M.Y.T., Derek, A. 2013. Postoperative cognitive dysfunction after cardiac surgery. *CEACCP* **13**(6): 218-23.

Caldas, J.R., Penerai, R.B., Bor-Sheng-Shu, E., Ferreira, G.S.R., Camara, L., Passos, R.H., Salinet, A.M., Azevedo, A.S., de-Lima-Oliveira, M., Galas, F.R.B.G., Fukushima, J.T., Nogueira, R., Taccone, F.S., Landoni, G., Almeida, J.P., Robinson, T.G., Hajjar, L.A. 2019. Intra-aortic balloon pump does not infuence cerebral hemodynamics and neurological outcomes in high-risk cardiac patients undergoing cardiac surgery: an analysis of the IABCS trial. *Ann Intensive Care* **9**(1): 130

Cheah, W.K., Teh, H.L., Huang, D.X.H., Ch'ng, A.S.H., Choy, M.P., Teh, E.E., Looi, I. 2014. Validation of Malay version of Montreal cognitive assessment in patients with cognitive impairment. *Clin Med Res* **3**(3): 56-60.

Chen, X.L., Wong, A., Ye, R.D., Xiao, L., Wang, Z.J., Lin, Y., Yang, F., Li, H., Feng, T., Duan, L.H., Han, Y.F., Dai, Q.L., Du, J., Xu, G.L., Mok, V., Xiong, Y.Y., Liu, X.F. 2015. Validation of NINDS-CSN neuropsychological battery for vascular cognitive impairment in Chinese stroke patients. *BMC Neurol* 15: 20.

Croughwell, N.D., Newman, M.F., Blumenthal, J.A., White, W.D., Lewis, J.B., Frasco, P.E., Smith, L.R., Thyrum, E.A., Hurwitz, B.J., Leone, B.J., Schell, R.M., Reves, J.G. 1994. Jugular Bulb Saturation and Cognitive Dysfunction After Cardiopulmonary Bypass. *Ann Thorac Surg* **58**(6): 1702-8.

Dijk, D.V., Spoor, M., Hijman, R., Nathoe, H. M., Borst, C., Jansen, E.W.L, Grobbee, D.E, De Jaegere, P.P.T., Kalkman, C.J. 2007. Cognitive and cardiac outcomes 5 years after off-pump vs on-pump coronary artery bypass graft surgery. *JAMA* **297**(7): 701-8.

Dumas, A., Dupuis, G.H., Searle, N., Cartier, R. 1999. Early versus late extubation after coronary artery bypass grafting: effects on cognitive function. *J Cardiothorac Vasc Anesth* **13(2):** 130-5.

Eysenck, M.W., Derakshan, N., Santos, R., Calvo, M.G. 2007. Anxiety and cognitive performance: attentional control theory. *Emotion* **7**: 336-53

Feinkohl, I., Winterer, G., Spies, C.D., Pischon, T. 2017. Cognitive reserve and the risk of postoperative cognitive dysfunction - a systematic review and meta-analysis. *Dtsch Arztebl Int* **114**(7): 110-7.

Gan, S.Y., Wu, J.T., Tang, X.D., Zheng, Y.Y., Wang, M.C., Zhu, S.M. 2020. Preoperative assessment of cognitive function and risk assessment of cognitive impairment in elderly patients with orthopedics: a cross-sectional study. *BMC Anesthesiol* **20**: 189.

Ge, Y.L., Ma, Z.L., Shi, H.W., Zhao, Y.M., Gu, X.P., Wei, H.Y. 2014. Incidence and risk factors of postoperative cognitive dysfunction in patients underwent coronary artery bypass grafting surgery. *Zhong Nan Da Xue Xue Bao Yi Xue Ban* **39**(10): 1049-55.

Ghaffary, S., Talasaz, A.H., Ghaeli, P., Karimi, A., Salehiomran, A., Hajighasemi, A., Bina, P., Darabi, S., Jalali, A., Dianatkhah, M., Noroozian, M., Shahmansouri, N. 2014. Association between perioperative parameters and cognitive impairment in post-cardiac surgery patients. *J Tehran Heart Cent* **10**(2): 85-92.

Goebel, S., Kaup, L., Wiesner, S.D., Mehdorn, H.M. 2012. Affective state and cognitive functioning in patients with intracranial tumors: validity of the neuropsychological baseline assessment. *Psychooncology* **22**(6): 1319-27.

Jannati, Y., Bagheri-Nesami, M., Sohrabi, M., Yazdani-Cherati, J., Mazdarani, S. 2014. Factors associated with post-surgical delirium in patients undergoing open heart surgery. *Oman*

Med J **29**(5): 340-5.
Kadoi, Y., Saito, S., Fujita, N., Goto, F. 2005. Risk factors for cognitive dysfunction after coronary artery bypass graft surgery in patients with type 2 diabetes. *J Thorac Cardiovasc Surg* **129**(3): 576-83.
Krejcie, R.V., Morgan, D.W. 1970. Determining sample size for research activities. *Educ Psychol Meas* **30**(3): 607-10.
Liu, Y.H., Wang, D.X., Li, L.H., Wu, X.M., Shan, G.J., Yu, S., Li, J., Yu, Q.J., Shi, C.X., Huang, Y.N., Sun, W. 2009. The effects of cardiopulmonary bypass on the number of cerebral microemboli and the incidence of cognitive dysfunction after coronary artery bypass graft surgery. *Anesth Analg* **109**(4): 1013-22.
Mu, D.L., Wang, D.X., Li, L.H., Shan, G.J., Su, Y., Yu, Q.J., Shi, Q.X. 2011. Postoperative delirium is associated with cognitive dysfunction one week after coronary bypass grafting surgery. *J Peking Univ Health Sci* **43**(2): 242-9.
Nasreddine, Z.S., Phillips, N.A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J.L.C., Chertkow, H. 2005. The montreal cognitive assessment, MoCA: A Brief screening tool for mild cognitive impairment. *J Am Geriatr Soc* **53**: 695-99.
Newman, M.F., Kirchner, J.L., Phillips-Bute, B., Gaver, V., Grocott, H., Jones, R.H., Mark, D.B., Reves, J.G., Blumenthal, J.A. 2001. Longitudinal assessment of neurocognitive function after coronary artery bypass surgery. *N Eng J Med* **344**: 395-402
Normah, C.D., Suzana, S., Baitil, H.Z., Rosdinom, R., Chyn, A.V., Azhadi, O. 2016. Validation and optimal cut-off scores of the Bahasa Malaysia version of the Montreal Cognitive Assessment (MoCA-BM) for mild cognitive impairment among community dwelling older adults in Malaysia. *Sains Malays* **45**: 1337-43
Oliveira, F.R., Oliveira, V.H., Oliveira, I.M., Lima, J.W., Calderaro, D., Gualandro, D.M., Caramelli, B. 2018. Hypertension, mitral valve disease, atrial fibrillation and low education level predict delirium and worst outcome after cardiac surgery in older adults. *BMC Anesthesiology* **18**(1): 15.
Perez-Belmonte, L.M., Florido-Santiago, M., Milan-Gomez, M., Barbancho, M.A., Gomez-Huelgas, R., Lara J.P. 2018. Research long-term cognitive impairment after off-pump versus on-pump cardiac surgery: involved risk factors. *J Am Med Dir Assoc* **19**(7): 639-40.
Robinson, T., Wu, D.S., Pointer, L.F., Dunn, C.L., Moss, M. 2012. Preoperative cognitive dysfunction is related to adverse postoperative outcomes in the elderly. *J Am Coll Surg* **215**(1): 12-7.
Samuel, F., Kristine, O. 2018. Postoperative Cognitive Disorders: Postoperative Delirium and Postoperative Cognitive Dysfunction. *ATOTW* 385. https://resources.wfsahq.org/atotw/postoperative-cognitive-disorders-postoperative-delirium-and-postoperative-cognitive-dysfunction/ [7 August 2018]
Sandro, G., Goran, K., Nenad, K. 2019. Postoperative cognitive decline after cardiac surgery: a narrative review of current knowledge in 2019. *Medic Sci Monit* **25**: 3262-70.
Silbert, B.S., Scott, D.A., Evered, L.A., Lewis, M.S., Kalpokas, M., Maruff, P., Myles, P.S., Phil, K.J.D. 2006. A comparison of the effect of high- and low-dose fentanyl on the incidence of postoperative cognitive dysfunction after coronary artery bypass surgery in the elderly. *Anesthesiology* **104**(6): 1137-45.
Singh-Manoux, A., Dugravot, A., Kauffmann, F., Elbaz, A., Ankri, J., Nabi, H., Kivimaki, M., Sabia, S. 2011. Association of lung function with physical, mental and cognitive function in early old age. *Age (Dordr)* **33**(3): 385-92.
Slater, J.P., Guarino, T., Stack, J., Vinod, K., Bustami, R.T., Brown III, J.M., Rodriguez, A.L., Mangovern, C.J., Zaubler, T., Freundlich, K., Parr, G.V.S. 2009. Cerebral oxygen desaturation predicts cognitive decline and longer hospital stay after cardiac surgery. *Ann Thorac Surg* **87**(1): 36-45.
Steinmetz, J., Christensen, K.B., Lund, T., Lohse, N., Rasmussen, L.S. 2009. Long-term consequences of postoperative cognitive dysfunction. *Anesthesiology* **110**(3): 548-55.
Tournay-Jetté, E., Bherer, L., Deschamps, A., Cartier, R., Denault, A. 2011. The relationship between cerebral oxygen saturation changes and postoperative cognitive dysfunction in elderly patients after coronary artery bypass graft surgery. *J Cardiothorac Vasc Anesth* **25**(1): 95-104.
Yao, F.S., Tseng, C.C.A., Ho, C.Y.A., Levin, S.K., Illner, P. 2004. Cerebral oxygen desaturation is associated with early postoperative neuropsychological dysfunction in patients undergoing cardiac surgery. *J Cardiothorac Vasc Anesth* **18**(5): 552-8.
Yu, J., Li, J., Huang, X. 2012. The Beijing version of the Montreal cognitive assessment as a brief screening tool for mild cognitive impairment: a community-based study. *BMC Psychiatry* **12**: 156.

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