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ORIGINAL ARTICLE

Assessment of Neurocognitive Effect in Patients Undergoing Cardiopulmonary Bypass: A Prospective Longitudinal Study

AHMED JAMAL[1], USMAN JAVED IQBAL[2], AROOSA AMJAD[1], RABIA JAVED IQBAL[3], ABRAR HUSSAIN[4], HASSAN ABBAS ABDULLAH[5]
[1]*BSc (Hons) Cardiac Perfusion / ECMO Specialist, Jahra Hospital, MOH Kuwait*
[2]*CCP, LP, CQAP, MSPH, PhD* / Clinical Perfusionist, Gulab Devi Teaching Hospital*
[3]*MSc, MS Clinical Psychology /Consultant (Clinical) Psychologist*
[4]*Senior Registrar Cardiac Surgery, Gulab Devi Teaching Hospital Lahore*
[5]*Assistant Professor Cardiology, Gulab Devi Teaching Hospital Lahore*
Correspondence to: Usman Javed Iqbal, Assistant Professor, Email: sh.usmanjavediqbal@gmail.com, Cell: +92-322-4187357

ABSTRACT
Objective: To assess neurocognitive effects in patients who underwent cardiopulmonary bypass.
Study Design & Setting: Using non probability purposive sampling, a prospective study design was used to collect the data from in tertiary care hospitals with 60 beds in ICU.
Methodology: Patients who underwent CPB having no history of psychological and mental illness was recruited for the said study. We used a short test of global mental status to measure cognitive performance called the "Mini-Mental State Examination (MMSE)".Wilcoxon test was used to analyze the pre- and post-operative changes over MMSE. The Folstein test, often known as the mini-mental state examination (MMSE), is a 30-point survey that has been widely used in clinical and research contexts to evaluate cognitive impairment. Different parameters; temporal, spatial, alternate, recognition, and recall were evaluated. P-value ≤0.05 was considered as significant.
Results: In this study, a significant fall in spatial, temporal, short term recall, long term recall, object recognition, alternate, reading, writing, read and act, and drawing in post-operative MMSE scores was observed as compared to pre-operative. However, there was no significant change in command so there is little or no effect on command parameters in pre-operative and post-operative cardiopulmonary bypass patients. There was a significant difference between pre-operation and post-operation total scores i.e., a fall in the '**total**' score of neurocognition occurred after cardiopulmonary bypass. Practical implication Study finding may be used for practical implications in managing neurocognitive outcome in patients undergoing cardiopulomonary bypass.
Conclusion: This research concludes that neurocognition is affected in patients who underwent CPB, with CPB itself a bigger risk factor in causing postoperative neurocognitive dysfunction.
Keywords: Cardiopulmonary bypass, Mental health, Neurocoagnitive impairment, POCD

INTRODUCTION
Neurocognitive function impairment after cardiac surgery can be tenacious and diminish the quality of life.(1,2) For many years, the consequences of heart surgery on the brain have been thoroughly established, and they constitute a significant cause of postoperative mortality and morbidity.(3) The American College of Cardiology and the American Heart Association classified the neurological complications during cardiac operations into type I and type II. Neurological deficits include coma, fatal cerebral injury, stroke, and transient ischemic attack are known as type I neurological complications. Whereas, neurological deficits include delirium, memory loss, concentration loss, and psychomotor speed deficits are known under type II. Type I is diagnosed by clinical examination whereas type II is diffuse and difficult to examine.(4)

Cognitive and neurological impairments are the most serious outcomes of cardiac surgery and cardiopulmonary bypass (CPB) is a major contributing factor to them. The first survival model of CPB on rats was described by Mackensen and Grocott. A Morris water maze (MWM) test is conducted in the rats' risk groups by De Lange which hypothesized that CPB of 90 min could lead to serious neurological complications.(5) Since the cardiopulmonary bypass (CPB) invention, cerebral impairment during cardiac surgery has been recorded in humans. However, humans have been studying these outcomes for decades. The clinical signs ranged from a stroke to more complicated neurocognitive impairment.(6)

In roughly 3% of patients following coronary artery bypass grafting, severe cerebral problems such as nonfatal stroke, complete cerebral infarction, and transient ischemic attack occur after heart surgery (CABG). Furthermore, after CABG, 40-80% experience a reduction in cognitive capacities such as short-term memory, attention, concentration, and cognitive processing speed. Many of these cognitive deficits are temporary and improve within months, but they can last up to a year in about 35% of patients.(7)

After heart surgery, the cognitive change appears to follow a biphasic pattern. Patients' cognitive function at discharge improved after an early postoperative decline in 53% of patients, while 36% had cognitive impairment at 6 weeks and 24% still had cognitive impairment at 6 months. However, after five years, 42% of the individuals had deteriorated from their starting performance.(7) The objective of this study was to assess neurocognitive effects in patients following coronary artery bypass surgery (CABG). We used a short test of global mental status to measure cognitive performance called the "Mini-Mental State Examination (MMSE)".

MATERIAL AND METHODS
Study design& setting: A Prospective study design was used to collect the data from a tertiary care hospitals with 60 beds in ICU.
Sampling Technique: Using non probability (purposive) sampling technique a sample size of 102 patients who underwent cardiopulmonary bypass, having sound psychology and no mental illness irrespective of the gender were included for this study. Considering the objective of this study, patients with any mental paralysis and neurocognitive disease were excluded. Similarly patients who were unable to perform the neurocognitive test were also dropped.
Data collection: After obtaining informed consent from every patient data was collected on a structured questionnaire; that was made using Mini-Mental State Examination (MMSE) to determine the neurocognitive efficiency of patients and has scored on the appropriate response to a particular question. The Folstein test, often known as the mini-mental state examination (MMSE), is a 30-point survey that has been widely used in clinical and research contexts to evaluate cognitive impairment. Different parameters; temporal, spatial, alternate, recognition, and recall were evaluated. The questions were asked before and after the cardiopulmonary bypass procedure, to compare the preoperative neurocognitive functions with the postoperative neurocognitive functions. History was also taken from the patients if they have had any mental or neuronal Illnesses.
Statistical analysis: Statistical Package for Social Sciences (SPSS) version 23.00 was used for both inferential and descriptive statistics. EndNoteX7 was used to cite all of the references. Quantitative data were presented as descriptive and frequency

distribution, whereas categorical data were given as percentages and graphs. After confirming the normality of data non parametric test (Wilcoxon signed rank Test) was applied to see if there is any statistical difference before and after CPB. P-value ≤0.05 was considered as significant

RESULTS

The mean age was 49±1.43 years and the main comorbidities were hypertension (77.4%) and diabetes (79.4%).

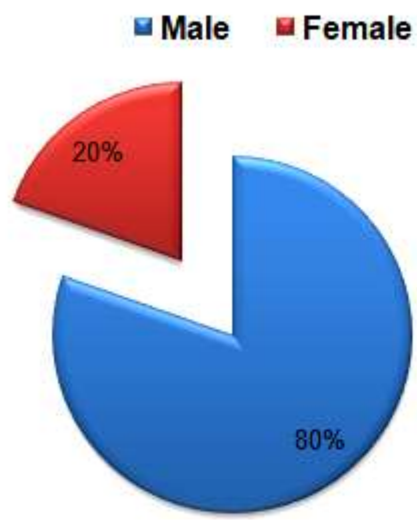

Table 01. Comparison of Pre and Postoperative MMSE

Parameters	Pre-Operative (Mean+S.D.)	Post Operative (Mean+S.D.)	Z-Test	P-Value
Spatial	4.72+0.52	4.48+0.71	-4.26	0.000
Temporal	4.48+0.76	3.93+.11	-5.72	0.000
Short term recall	2.99+0.09	2.96+0.19	-1.73	0.083
Alternate	4.01+1.99	3.60+2.11	-3.37	0.001
Long term recall	2.70+0.47	2.22+0.81	-5.73	0.000
Object Recognition	1.92+0.27	1.79+0.43	-3.35	0.001
Commands	3.00+0.00	3.00+0.00	0.00	1.000
Reading	0.84+0.36	0.76+0.42	-2.82	0.005
React and Act	0.84+0.36	0.74+0.43	-3.16	0.002
Writing	0.91+0.28	0.77+0.41	-3.74	0.000
Drawing	0.86+0.34	0.52+ 0.50	-5.83	0.000
Total	27.3+3.30	24.8+3.98	-7.75	0.000

In this study, there is a significant fall in spatial, temporal, short term recall, long term recall, object recognition, alternate, reading, writing, read and act, and drawing in post-operative MMSE scores as compared to pre-operative. However, there was no significant change in command so there is little or no effect on command parameters in pre-operative and post-operative Cardiopulmonary bypass patients. There was a significant difference between pre-operation and post-operation total scores i.e., a fall in the '**total**' score of neurocognition occurred after Cardiopulmonary bypass.

DISCUSSION

According to Liu et al., 2009 postoperative cognitive dysfunction (POCD) refers to cognitive impairment including attention, short-term memory, concentration, motor dexterity, and psychomotor speed, and these are known neurologic outcomes of cardiac surgery affecting almost 50% to 70% of patients.[12]

In a study conducted by Newman, almost 50% of patients who undergo CABG and show an immediate decline in cognitive function are at a high risk of long term POCD. These findings examine the longitudinal effects of cardiac surgery on cognitive functioning and then Sotaniemi and Murkin further work on it by using a larger sample with a longer period of follow-up. The change in cognitive function in patients in this research who had cognitive impairment at discharge between baseline and five years after surgery was more than two to three times that seen in a five-year longitudinal evaluation of cognitive function in 5888 Medicare patients.[7,13-15]

In our study, we concluded that the patient's cognition function declined after cardiopulmonary bypass, the neurocognitive aspects i.e., spatial, temporal, alternate, long-term recall, object recognition, reading, read and act, writing, and drawing have significant statistical differences in pre-operation and post-operation values. However, the short-term memory recall remains the same i.e., there is no statistical difference between the pre-operation and post operation values.

Another study conducted by Saczynski on 112 patients assessed post cognitive function of patients. Delirium is developed in 21% of patients after cardiac surgery. He showed that concentration and memory problems were more prevalent among patients with postoperative delirium after 1 to 1.5 years.[16]

This study conducted by van Dijk has extensively reviewed reports on POCD after CABG. After the six studies considered for the pooled analysis, 10-30% of patients exhibit a significant reduction in neurocognitive function within two months of CABG, and van Dijk concluded in his analysis that 22.5 % showed neurocognitive deterioration two months following CABG.[17]

The main findings of Ahlgren's study were that 20 patients with CABG showed a greater degree of cognitive decline after intervention than 27 patients with PCI, and those with a cognitive decline had significantly worse driving performance than patients without a cognitive decline.[18]

Compare with our study findings of 102 patients showed that there was a variation in the incidence of cognitive decline. We analyzed patients with cardiopulmonary bypass pre-operation and post-operation for cognitive dysfunction. There was a positive association between neurocognitive decline after the operation compared to before the operation. In our study memory and concentration decline are more prevalent as compared to other cognitive factors. Our results are compatible with van Dijk's study as well but we neither follow up for a long time nor recorded cognitive decline after PCI (percutaneous coronary intervention).

CONCLUSION

This research concludes that neurocognition is affected in patients who underwent CPB, with CPB itself a bigger risk factor in causing postoperative neurocognitive dysfunction. We concluded that POCD is a significant complication after heart surgery that causes a reduction in the patient's quality of life, as well as financial and social impacts. Use of minimally invasive surgery, cell saver technology, Intra-operative external head cooling, use of Lidocaine, and volatile anesthetics offer considerable protection against POCD. We believe that using this method to conduct a systematic study of post-surgical brain damage would allow for more fruitful research into the incidence, predictors, and persistence of neurocognitive impairment, as well as its prevention.
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REFERENCES

1. Steinmetz J, Christensen KB, Lund T, Lohse N, Rasmussen LS, Group I. Long-term consequences of postoperative cognitive dysfunction. The Journal of the American Society of Anesthesiologists. 2009;110(3):548-55.
2. Van Harten A, Scheeren T, Absalom A. A review of postoperative cognitive dysfunction and neuroinflammation associated with cardiac surgery and anaesthesia. Anaesthesia. 2012;67(3):280-93.
3. Tan AMY, Amoako D. Postoperative cognitive dysfunction after cardiac surgery. Continuing Education in Anaesthesia, Critical Care & Pain. 2013;13(6):218-23.
4. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R, et al. Adverse cerebral outcomes after coronary bypass surgery. New England Journal of Medicine. 1996;335(25):1857-64.

5. De Lange F, Dieleman J, Jungwirth B, Kalkman C. Effects of cardiopulmonary bypass on neurocognitive performance and cytokine release in old and diabetic rats. British journal of anaesthesia. 2007;99(2):177-83.
6. Mackensen GB, Sato Y, Nellgård B, Pineda J, Newman MF, Warner DS, et al. Cardiopulmonary bypass induces neurologic and neurocognitive dysfunction in the rat. The Journal of the American Society of Anesthesiologists. 2001;95(6):1485-91.
7. Newman MF, Kirchner JL, Phillips-Bute B, Gaver V, Grocott H, Jones RH, et al. Longitudinal assessment of neurocognitive function after coronary-artery bypass surgery. New England Journal of Medicine. 2001;344(6):395-402.
8. Eagle KA, Guyton RA, Davidoff R, Ewy GA, Fonger J, Gardner TJ, et al. ACC/AHA guidelines for coronary artery bypass graft surgery: executive summary and recommendations: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to revise the 1991 guidelines for coronary artery bypass graft surgery). Circulation. 1999;100(13):1464-80.
9. Grocott HP, Mackensen GB, Newman MF, Warner DS. Neurological injury during cardiopulmonary bypass in the rat. Perfusion. 2001;16(1):75-81.
10. Shaw PJ, Bates D, Cartlidge NE, French JM, Heaviside D, Julian DG, et al. Early intellectual dysfunction following coronary bypass surgery. QJM: An International Journal of Medicine. 1986;58(1):59-68.
11. M Dieleman J. Corticosteroids for the inflammatory response to cardiopulmonary bypass: an update. Current pharmaceutical design. 2013;19(22):3979-91.
12. Liu Y-H, Wang D-X, Li L-H, Wu X-M, Shan G-J, Su Y, et al. The effects of cardiopulmonary bypass on the number of cerebral microemboli and the incidence of cognitive dysfunction after coronary artery bypass graft surgery. Anesthesia & Analgesia. 2009;109(4):1013-22.
13. Murkin J, Baird D, Martzke J, Adams S, Lok P. Long-term neurological and neuropsychological outcome 3 years after coronary artery bypass surgery. Anesth Analg. 1996;82(Suppl):S328.
14. Sotaniemi K, Mononen H, Hokkanen T. Long-term cerebral outcome after open-heart surgery. A five-year neuropsychological follow-up study. Stroke. 1986;17(3):410-6.
15. Haan MN, Shemanski L, Jagust WJ, Manolio TA, Kuller L. The role of apoe∊ 4 in modulating effects of other risk factors for cognitive decline in elderly persons. Jama. 1999;282(1):40-6.
16. Saczynski JS, Marcantonio ER, Quach L, Fong TG, Gross A, Inouye SK, et al. Cognitive trajectories after postoperative delirium. New England Journal of Medicine. 2012;367(1):30-9.
17. van Dijk D, Keizer AM, Diephuis JC, Durand C, Vos LJ, Hijman R. Neurocognitive dysfunction after coronary artery bypass surgery: a systematic review. The Journal of Thoracic and Cardiovascular Surgery. 2000;120(4):632-9.
18. Ahlgren E, Lundqvist A, Nordlund A, Aren C, Rutberg H. Neurocognitive impairment and driving performance after coronary artery bypass surgery. European Journal of Cardio-thoracic Surgery. 2003;23(3):334-40.