Recovery of Cognitive Function After Coronary Artery Bypass Graft Operations

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Background. **The effect of coronary artery bypass grafting (CABG) operations on cognition was examined after controlling for the operation, emotional state, preexisting cognitive impairment, and repeated experience with cognitive tests.**

Methods. **On-pump CABG patients (n = 16), thoracic surgical patients (n = 15), and a nonsurgical control group (n = 15) were tested preoperatively, and at 1 and 8 weeks postoperatively, using a battery of cognitive tests and an emotional state assessment. Patient groups were similar in age, sex, level of education, and premorbid intelligence quotient score. Surgical group data were normalized against data from the nonsurgical control group before statistical analysis.**

Results. **CABG patients performed worse on every subtest before the operation, and this disadvantage persisted after the operation. Anxiety, depression, and stress were associated with impaired cognitive performance in the surgical groups 1 week after the operation: 44% of CABG patients and 33% of surgical control patients were significantly impaired; yet, by 8 weeks, nearly all patients had recovered to preoperative levels, with 25% of CABG and 13% of surgical control patients improving beyond their preoperative performance.**

Conclusions. **Stress, anxiety, and depression impair cognitive performance in association with CABG and thoracic operations. Most patients recover to, or exceed, preoperative levels of cognition within 8 weeks. Thus, after controlling for nonsurgical factors, the prospects of a tangible improvement in cognition after CABG are high.**

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Improvements in surgical technique have greatly reduced mortality and adverse neurologic outcomes after coronary artery bypass grafting (CABG), and this success has led researchers to focus instead on postoperative cognitive dysfunction (POCD). POCD is associated with decreased quality of life, early withdrawal from the workforce, and loss of independence [1]. After almost 2 decades of improvements in surgical technique and study design, the current incidence of POCD still ranges from 30% to 65% at discharge from the hospital and from 20% to 40% several months later [2].

Although CABG and cardiopulmonary bypass are likely contributors to POCD [3], studies that have included surgical or nonsurgical control groups have shown that other factors can contribute to cognitive impairment [4]. One is general anesthesia [5], which can depress cognitive function beyond the recovery of consciousness [2]. Depression and anxiety also contribute to POCD [6], yet relatively little research has examined whether stress is a factor. This is surprising, because the prospect of undergoing CABG is stressful. Psychologic stress compromises hippocampal function, which is involved in learning and memory [7] and is an important confound in studies of working memory, delayed memory retrieval, and problem-solving [8].

A further consideration is that patients undergoing cardiac operations may have preexisting cognitive impairment. Cardiac patients are likely to have cardiovascular disease and systemic hypertension, which can reduce blood flow to the brain, thereby impairing cognition and increasing the incidence of permanent brain damage via strokes [9]. Consequently, it is important to assess baseline cognitive performance before the operation [10].

In view of the range of factors that can interfere with cognitive function, the extent of POCD directly resulting from CABG may have been overestimated. The present study builds on previous studies to reassess POCD after CABG. The cognitive performance of CABG patients was compared with that of patients undergoing thoracic operations and participants undergoing no operation. The extent of preexisting cognitive impairment was examined, as was the effect of emotional state. The cognitive performance of individual patients was examined using the Reliable Change Index (RCI). The results of the present study provide insights into the extent of cognitive impairment in CABG patients as well as a clearer indication of the prospects for recovery.

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Drs Yelland and Robinson disclose that they are co-inventors of the Subtle Cognitive Impairment Test.

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Abbreviations and Acronyms

ANCOVA	= analysis of covariance
ANOVA	= analysis of variance
CABG	= coronary artery bypass grafting
COWAT	= Controlled Oral Word Association Task
GPDOM	= Grooved Pegboard (Dominant Hand)
GPNDOM	= GP (Non-Dominant Hand)
MCG-C	= Medical College of Georgia Complex Figure Task (Copy Trial)
MCG-D	= MCG (Delayed Recall Trial)
MCG-I	= MCG (Immediate Recall Trial)
POCD	= postoperative cognitive dysfunction
RAVLT-D	= Rey Auditory Verbal Learning Task (Delayed Recall Trial)
RAVLT-I	= RAVLT (Immediate Recall Trial)
RAVLT-L	= RAVLT (Learning Trials)
RAVLT-R	= RVLT (Recognition Trial)
RCI	= Reliable Change Index
SCIT-E_H	= Subtle Cognitive Impairment Test Percentage Error in head of curve
SCIT-E_T	= SCIT Percentage Error in tail of curve
SCIT-RT_H	= SCIT Response Time in head of curve
SCIT-RT_T	= SCIT Response Time in tail of curve
SD	= standard deviation
WTAR	= Wechsler Test of Adult Reading

Patients and Methods

All procedures, materials, and methods used in this study had institutional ethics approval. All participants provided written consent.

Enrollment

Patients were recruited when they attended a hospital preadmission clinic before their operation or were contacted by the researcher before their preadmission clinic visit and asked to volunteer. Nonsurgical control participants were recruited from retirement villages in Melbourne.

Forty-six participants completed all testing sessions and were included in the analysis of results. Of these, 31 patients underwent on-pump CABG (n = 16) or a thoracic operation (n = 15), and 15 individuals comprised the nonsurgical control group. The three groups were similar in age, education, sex, and premorbid intelligence quotient (IQ; Table 1). Exclusion criteria were previous cardiac operation, history of psychiatric disorders, previous neurologic complications, or traumatic brain injury, age older than 80 years or younger than 50 years, and inadequate English reading and writing skills to perform the required tasks.

Operative Technique

CABG OPERATION. All surgical procedures were elective. The anesthetic technique consisted of a combination of low-intermediate dose narcotics, inhalational agents, and neuromuscular-blocking drugs. Antibiotics were administered to prevent infection. Administration regimens were at the discretion of the anesthetist. Five surgeons performed the CABG operations using a median sternotomy for all patients. Cardiopulmonary bypass was used for all CABG operations at moderate hypothermia (32° to 34°C), with all anastomoses occurring after application of the aortic cross-clamp. All patients received at least 2 arterial grafts.

SURGICAL CONTROL GROUP. The operation involved a standard thoracotomy approach for lung biopsies or lobectomies, or both. Procedures were performed under stan-

Table 1. Surgical Patient and Control Group Demographic Data

Variable	CABG (n = 16)	Surgical Control (n = 15)	Nonsurgical Control (n = 15)
Age, years			
Mean (SD)	63.6 (9.0)	60.9 (7.1)	65.5 (9.0)
Range	54–80	51–73	52–80
Male sex, %	62.5	40.0	40.0
Education level, years			
Mean (SD)	9.9 (3.1)	10.7 (2.9)	11.8 (3.4)
Range	6–20	6–15	7–20
WTAR, mean (SD)	32.6 (8.0)	35.5 (10.6)	39.6 (6.0)
Stress, mean (SD)	18.9 (12.3)[a]	14.5 (9.8)[b]	5.1 (5.8)
Anxiety, mean (SD)	12.3 (10.2)[a]	10.0 (8.8)[b]	2.7 (3.6)
Depression, mean (SD)	12.4 (9.9)[a]	8.1 (8.8)	4.7 (5.7)
Post-op (# days), mean (SD)			
1 week	5.9 (2.2)[a]	7.2 (2.8)	8.9 (8.6)
8 weeks	57.7 (8.7)	63.8 (21)	51.2 (8.6)
Anaesthesia time, mean (SD) min	306.5 (48.6)[c]	146.2 (74.8)	N/A

[a] Significant difference between CABG and nonsurgical control ($p < 0.05$). [b] Significant difference between surgical and nonsurgical control ($p < 0.05$). [c] Significant difference between CABG and surgical control ($p < 0.05$).

CABG = coronary artery bypass grafting; N/A = not applicable; SD = standard deviation; WTAR = Wechsler Test of Adult Reading.