Effects on Cognition of Conventional and Robotically Assisted Cardiac Valve Operation

Kathryn M. Bruce, BSc (Hons), Gregory W. Yelland, PhD, Aubrey A. Almeida, MBBS, FRACS, Julian A. Smith, MBBS, FRACS, and Stephen R. Robinson, PhD

Department of Surgery, Monash University, Melbourne; Blood-Brain Interactions Group, School of Psychology and Psychiatry, Monash University, Melbourne; School of Health Sciences and Health Innovations Research Institute, RMIT University, Melbourne; Department of Surgery, Monash University, Melbourne; Cardiothoracic Surgery Unit, Epworth Hospital, Melbourne, Australia

Background. **The effect of valve surgical procedures on cognition was investigated in patients undergoing conventional or robotically assisted techniques. The confounding factors of surgical procedure, mood state, preexisting cognitive impairment, and repeated experience with cognitive tests were controlled for.**

Methods. **Patients undergoing conventional valve procedures (n = 15), robotically assisted valve procedures (n = 15), and thoracic surgical procedures (n = 15), along with a nonsurgical control group (n = 15) were tested preoperatively, 1 week after operation, and 8 weeks after operation by use of a battery of cognitive tests and a mood state assessment. Surgical group data were normalized against data from the nonsurgical control group before statistical analysis.**

Results. **Patients undergoing conventional valve procedures performed worse than those undergoing robotically assisted valve procedures on every subtest before operation, and this disadvantage persisted after operation. Age and premorbid intelligence quotient were significantly associated with performance on several cognitive subtests. Anxiety, depression, and stress were not associated with impaired cognitive performance in the surgical groups after operation. A week after operation, patients undergoing conventional valve procedures performed worse on the cognitive tests that had a motor component, which may reflect discomfort caused by the sternotomy. Patients undergoing robotically assisted valve procedures were significantly less impaired on information processing tasks 1 week after operation when compared with those undergoing conventional valve procedures. The majority of patients who were impaired 1 week after operation recovered to preoperation levels within 8 weeks.**

Conclusions. **The robotically assisted valve surgical procedure results in more rapid recovery of performance on cognitive tests. However, regardless of the type of surgical intervention, the prospect of a recovery of cognitive performance to preoperative levels is high.**

(Ann Thorac Surg 2014;97:48–55)

The introduction of robotically assisted valve surgical procedures has provided the potential for improvement in postoperative outcomes. In comparison with conventional valve procedures, the benefits of robotically assisted valve procedures include a reduction in intensive care unit stay, a reduction in the overall hospital stay after operation, a lower requirement for blood product transfusion, significantly less bodily pain, and a superior cosmetic appearance after operation [1].

Cardiac surgical procedures can expose the brain to potentially harmful complications (eg, microemboli, systemic inflammation, hypoperfusion), and the risk of such complications is significant with conventional valve surgical procedures, which are associated with a high incidence of microembolizations because of the invasiveness of the open chamber procedure. This factor is thought to be responsible for the higher levels of postoperative cognitive decline (POCD) that are associated with conventional valve procedures compared with coronary artery bypass grafting (CABG) procedures [2]. The invasiveness of conventional valve procedures is also related to incisional trauma because of the full median sternotomy required for direct visualization of the operative field [3]. Although both conventional and robotically assisted valve procedures involve cardiopulmonary bypass (CPB) and incisional trauma, robotically assisted valve procedures avoid the complications associated with sternotomy, resulting in less trauma and morbidity [3]. However, it is not yet known whether robotically assisted valve procedures produce better outcomes for POCD when compared with conventional valve procedures.

The aim of the present study was to compare the extent and incidence of POCD after robotically assisted and conventional valve procedures. Care was taken to control

Accepted for publication July 2, 2013.

Address correspondence to Prof Robinson, School of Health Sciences, RMIT University, PO Box 71, Bundoora, Victoria 3083, Australia; e-mail: stephen.robinson@rmit.edu.au.

Drs Yelland and Robinson are co-inventors of the SCIT test.

Published by Elsevier Inc

0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2013.07.018

for methodologic factors that have been shown by previous studies to influence outcomes. For instance, baseline (preoperative) comparisons were performed to address practice effects from repeated assessment sessions [4]. Emotional state, especially anxiety and depression, have been shown to significantly interfere with neuropsychologic performance after other types of cardiac surgical procedures; hence, their impact on valve procedures was assessed [5]. The duration of anesthesia was examined for its capacity to influence outcomes in this study because this factor has been associated with increased cognitive dysfunction [6].

Patients and Methods

Enrollment

All procedures, materials, and methods had human ethics approval from three institutions: Monash University, Southern Health and Epworth Hospital. All patients were required to give informed consent before inclusion in the study. Patients were recruited when they attended a preadmission clinic before operation or were contacted by the researcher before their preadmission clinic and asked to volunteer. Nonsurgical control participants were recruited from retirement villages in Melbourne. All participants gave written consent.

A total of 60 participants completed all testing sessions and were included in the analysis of results. A total of 45 patients underwent conventional valve procedures, robotically assisted valve procedures, or thoracic surgical procedures, with 15 patients in each group. The conventional valve group underwent aortic valve replacement (n = 8), aortic valve and mitral valve replacement (n = 1), mitral valve replacement (n = 3), and mitral valve repair (n = 3). The robotically assisted valve group all underwent mitral valve repair. Valve pathologic conditions consisted of stenosis (n = 10) and regurgitation (n = 8) in the conventional valve group and stenosis (n = 1) and regurgitation (n = 14) in the robotically assisted valve group. A further 15 participants constituted the nonsurgical control group. Table 1 provides a list of participant characteristics. Exclusion criteria for all participant groups were previous cardiac operations, history of psychiatric disorders, previous neurologic complications or traumatic brain injury, age over 80 and under 50 years, and inadequate English reading and writing skills to perform the required tasks.

Operative Technique

All surgical procedures were elective. The anesthetic technique was standardized, and conventional general anesthesia was administered to all surgical groups. Administration regimens were left to the discretion of the individual anesthetist.

Conventional Valve Procedure

Five experienced surgeons performed the conventional valve operations, using a median sternotomy for all patients. Central CPB was established for all patients at moderate hypothermia (32° to 34°C), with all valve repairs

Table 1. Demographic Data of Patients in Surgical Groups and Control Group

Variable	Conventional Valve Group	Robotically Assisted Valve Group	Surgical Control Group	Nonsurgical Control Group
No.	15	15	15	15
Age, mean (SD)	65.3 (9.2)	60.0 (5.8)	60.9 (7.1)	65.5 (9.0)
Age range, y	50-77	54-71	51-73	52-80
Sex, % male	60.0	80.0	40.0	46.7
Education level, mean (SD)	9.4 (2.1)[a]	12.2 (2.7)	10.7 (2.9)	11.8 (3.4)
Education range, y	5-12	8-15	6-15	7-20
WTAR score, mean (SD)	37.9 (9.9)	40.8 (7.3)	35.5 (10.6)	39.6 (6.0)
Hypertension, n	9	1	5	1
Cerebrovascular disease, n	1	0	0	0
Diabetes, n	4	0	2	1
Stress, mean (SD)	8.1 (5.6)	9.5 (7.2)	14.5 (9.8)[b]	6.7 (5.1)
Anxiety, mean (SD)	6.9 (4.7)	6.8 (7.0)	10.0 (8.8)	2.7 (3.6)
Depression, mean (SD)	7.1 (9.6)	3.7 (3.6)	8.1 (8.8)[b]	4.7 (5.7)
1 wk postop, no. days, mean (SD)	10 (2.2)[a]	6.6 (3.6)	7.2 (2.8)	8.9 (8.6)
8 wks postop, no. days, mean (SD)	64 (18)[c]	58.7 (14.4)	63.8 (21)	51.2 (8.6)
Anesthesia time, min, mean (SD)	288.6 (54.5)[d]	280.7 (72.7)[e]	146.2 (74.8)	n/a
CPB time, min, mean (SD)	115.2 (37.7)	133.4 (42.8)	n/a	n/a
Cross-clamp time, min, mean (SD)	90.7 (36.7)	97.5 (26.9)	n/a	n/a

[a] Significant difference between conventional valve and robotically assisted valve groups ($p < 0.05$). [b] Significant difference between surgical control and nonsurgical control groups ($p < 0.05$). [c] Significant difference between conventional valve and nonsurgical control groups ($p < 0.05$). [d] Significant difference between conventional valve and surgical control groups ($p < 0.05$). [e] Significant difference between robotically assisted valve and surgical control groups ($p < 0.05$).

CPB = cardiopulmonary bypass; n = number of participants; SD = standard deviation; WTAR = Weschler Test of Adult Reading.