

New Cerebral Ischemic Events after Cardiac Surgery by Diffusion-Weighted Imaging: Their Incidence, Regional Vascular Occurrence, and Procedural Dependence

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Introduction: Clinical stroke occurs in 3-5% of all subjects after cardiac surgery and may approach 40-70% in high risk groups[1]. The additional mortality and long-term morbidity associated with perioperative stroke is staggering. Postoperative cognitive dysfunction(POCD) occurs much more frequently than stroke, is much more subtle, goes largely undiagnosed, and may linger for considerable time after surgery. While emboli are most commonly identified as the cause of stroke after cardiac surgery, the etiology of POCD remains in question. Silent cerebral infarction occurs in up to 40% of subjects after aortic valve replacement(2). These “silent” cerebral infarcts may be subtle, but not really silent at all, and may contribute to POCD in the short and long terms.

Methods: We recruited 34 unselected subjects undergoing cardiac surgery with cardiopulmonary bypass. These individuals underwent Diffusion-Weighted MRI(DWI) before after surgery on either 1.5 Tesla GE(21/34), 3.0T Siemens(10/34) systems, or both(3/34). Standard DWI sequences supplied by the magnet manufacturers were used. Preoperatively, patient histories were reviewed for the presence of the following risk factors: Age ≥ 65 , previous stroke or transient ischemic attack(TIA), hypertension(HTN), diabetes mellitus(DM), atrial fibrillation(AF), smoking, and peripheral vascular disease(PVD). Medical records were reviewed for discharge diagnosis of stroke, duration of CPB, occurrence of postoperative atrial fibrillation, and surgical procedure performed. MRI studies were reviewed by a trained neuroradiologist blinded to pre and postoperative state. Images were evaluated for number, size of lesions, and vascular region of occurrence.

Results: Subjects mean age was 67 ± 15 years, and included 28 men and 6 women. The average number of risk factors was 3 ± 1 , and the relative frequency of each was as follows: age ≥ 65 -25/34(74%), previous stroke/TIA-8/34(24%), HTN-27/34(79%), DM 6/34(18%), smoking 15/34(44%), PVD 5/34(15%), and AF-9/34(26%). Surgical procedures conducted were as follows: coronary artery bypass grafting(CABG)-12/34, aortic valve replacement(AVR)-6/34, mitral valve repair or replacement(MVR)-2/34, combined CABG/AVR-9/34, combined CABG/MVR-4/34, and AVR with ascending aortic root replacement-1/34. In other words, 22/34 or 65% of these subjects underwent open cardiac procedures, thought to elevate risk of stroke over “closed” procedures(CABG alone).

Subjects were imaged postoperatively at 6 ± 2 days. Clinical stroke occurred in 3/34 subjects(9%). New ischemic lesions were evident on DWI in 6/34 subjects(18%). New ischemic lesions were clinically “silent” in 4/6 or 67% of subjects. In a single subject who underwent CABG, clinical signs of stroke occurred without the presence of a lesion on DWI.

The largest lesion measured 3.5 cm but the average lesion was < 1 cm. The number of new lesions was 3 ± 3 . Lesions had a prevalence for the right hemisphere with a ratio of 2:1, R:L. Vascular distributions are listed in Table-1.

All of the new ischemic lesions occurred in subjects undergoing surgery on the aortic valve: AVR(2/6), CABG/AVR(3/6), or AVR-Root(1/6), for a total of 6/16(38%). Cardiopulmonary bypass time was not different in those without(122 ± 33 min) and without new lesions(122 ± 29 min), $p=.84$; nor was the number of clinical risk factors(3 ± 1) different. Fifty percent(50%) of those suffering new ischemic lesions had a history of stroke or TIA. Postoperative AF occurred in 3/6 subjects(50%) with and in 17/28(61%) without new ischemic lesions and therefore did not predict stroke risk.

Conclusions: While it has been thought that open-cardiac procedures presented an especially high risk for postoperative stroke, DWI reveals that new infarction occurs in nearly 40% of subjects after AVR, yet other types of open-heart procedures appear relatively immune. The fact that clinical manifestations of these lesions, either gross neurologic deficit or more subtle but potentially important cognitive dysfunction, are not diagnosed may be due to inadequate surveillance.

Table-1

Vascular Region	Right	Left
ACA	2	1
MCA	1	0
PCA	0	1
Watershed	7	4
PICA	1	1

References:

1. McKhann, G.M., et al., *Predictors of stroke risk in coronary artery bypass patients*. Ann Thorac Surg, 1997. **63**(2): p. 516-21.
2. Stolz, E., et al., *Diffusion-weighted magnetic resonance imaging and neurobiochemical markers after aortic valve replacement: implications for future neuroprotective trials?* Stroke, 2004. **35**(4): p. 888-92.