

ACUTE STROKE IN THE CARDIAC SURGERY PATIENT

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Problem statement:

Patients undergoing cardiac surgeries are exposed to a risk of cerebral injuries due to shared comorbidities. Neurological injuries are the second most common etiology for morbidity next only to heart failure.(1) The incidence of perioperative strokes varies in different types of surgeries. In this talk, subtype of strokes associated with frequent cardiac surgeries such as CABG, Carotid endarterectomy (CEA), aortic valve surgeries and extra-corporeal membrane oxygenation (ECMO) will be discussed.

Ischemic stroke:

Incidence: Ischemic stroke is the most common of stroke subtypes seen across various cardiac surgeries and cause a 6 fold increase in morbidity and mortality.(2) In CABG, the most common procedure performed, the incidence of clinically significant strokes varies from 1.5%(3) to 5.2%(4) in prospective studies. Over the years, there has been a reduction in the rates and averages 1.6% (95% CI: 1.4%-1.7%) in the largest reported study.(5) In addition, multiple studies have demonstrated that the rates of ischemic strokes on and off by-pass pump are not different.(1) In valve replacement procedures, the risk of stroke is higher, with incidence 3-4% after mitral or aortic valve replacement. (6) The risk of strokes associated with CEA or carotid artery stenting (CAS) according to the CREST study is 1.6% and 4.1% respectively within 30 days. However, major strokes, defined as NIHSS > 9 occur in 0.3% and 0.9% in CEA and CAS patients.(7) Strokes in ECMO patients have been reported variedly and is influenced by the etiology for the use of ECMO, age, arterial oxygenation (8) and in the largest case series: was noted to be 3.6%.(9) Combination of CABG with valve or other surgeries have an increased incidence of 7.9% and 7.2% respectively. (10) Timing of stroke: About 40% of all strokes are suspected to occur intra-operatively and 42% are noticed on the first post-operative day while 20% are noted on the second post-operative day. (11) Depending on the nature of the reported study, up to 80% of all strokes after various cardiac surgeries are diagnosed within the first 2 days of surgery. (10) Factors such as the duration of surgical procedure, depth, duration and the type of anesthesia, intra procedural hypoxia/ hypotension are critical determinants of the risk factors of stroke and in turn determine the detection of the symptoms.

Preventive strategies: All preoperative patients undergoing cardiac surgery should receive Aspirin and Statins. Pre-operative beta blocker use can reduce the incidence of atrial fibrillation. Avoiding intra-operative hypotension and hypoxia is beneficial. Limitations in management: Surgical cardiac procedures and the presence of myocardial infarction exclude the patients from thrombolysis unless there has been only PCI performed. Endovascular thrombectomy would be the preferred mode of treatment if the patient falls within the treatment window.(12) Careful selection of patients for endovascular therapy is warranted due to various antiplatelet agents and anticoagulants used in the perioperative phase. Limited data is available for the use of perfusion studies to aid patient selection. Maintenance of adequate perfusion with MAP, euglycemia, eunatremia, euthermia are of utmost importance.

Outcomes: Mortality of stroke patients following aortic valve replacement was 5%,(13) while in patients post CABG, the stroke patients had a higher mortality of 22%. (14) Patients with stroke undergoing CEA or CAS the estimated mortality rate at 4 years was 11.6% in the stroke-free group and 21.2% in the stroke group. In patients receiving ECMO, the mortality is very variable from 40%-95%. (9)

Hemorrhagic Stroke:

Incidence: The information for the overall incidence of hemorrhagic stroke following cardiac surgeries is not as clearly available but is estimated to be around <0.1% in CABG patients and 0.3% in the patients undergoing endarterectomy. ECMO patients are reported to have an increased risk of up to 1.8%, while the aortic valve replacements were associated with 1% incidence of ICH. However, the patients undergoing percutaneous coronary interventions have in increased rates of 8-0,46% of all peri-procedural strokes.(15, 16) This is likely related to the simultaneous use of both antiplatelet agents and anticoagulants.

Etiology: The suspected etiology of the hemorrhagic stroke in CABG patients is likely the hemorrhagic conversion of an ischemic stroke. There is a very high chance of hemorrhagic transformation post reperfusion of ischemic tissue due to blood-brain barrier compromise. In addition, large strokes, use to multiple antiplatelet agents and anticoagulants may precipitate or enhance hemorrhagic stroke. However, spontaneous ICH can also occur due to the use of anticoagulation during the cardiopulmonary bypass. In patients receiving ECMO, ICH is more likely related to anticoagulation with renal failure, low fibrinogen level and thrombocytopenia.(17)

Prevention: Prevention strategies for ischemic stroke and general avoidance of hypo/hypertension, hypoxia, and hyperthermia should be standard practice. In patients receiving anticoagulation, targeted therapy would be best. There appears no clear strategy that has been shown to reduce the incidence of hemorrhagic stroke following cardiac surgeries.

Treatment: Hemorrhagic stroke should be managed according the current AHA recommendations.(18) Standard measures to address airway, breathing, circulation and suspected elevated intracranial pressure as per the emergency neurological life support guidelines (ENLS).(19) Extreme hypertension should be controlled and stat neurosurgical consultation should be obtained. Reversal agents for anticoagulants should be considered cautiously. Activated factor VII containing products can be thrombogenic and need to be used with caution and in discussion with the cardiac intensivists, cardiologists and cardio-thoracic surgeons.

Outcomes: ICH carries very poor prognosis in cardiac surgery patients overall. Mortality rates are not very well studied in the literature related to CABG. However, with ECMO the rates are as high as 90%.(9)

Conclusions

Perioperative ischemic and hemorrhagic stroke following cardiac surgery carry significant morbidity and mortality. Preventive strategies, early recognition and institution of early treatment are important to impart better patient outcomes.

References

1. Selnes OA, Gottesman RF, Grega MA, Baumgartner WA, Zeger SL, McKhann GM. Cognitive and neurologic outcomes after coronary-artery bypass surgery. *The New England journal of medicine*. 2012;366(3):250-7.
2. Dacey LJ, Likosky DS, Leavitt BJ, Lahey SJ, Quinn RD, Hernandez F, Jr., et al. Perioperative stroke and long-term survival after coronary bypass graft surgery. *The Annals of thoracic surgery*. 2005;79(2):532-6; discussion 7.
3. Breuer AC, Furlan AJ, Hanson MR, Lederman RJ, Loop FD, Cosgrove DM, et al. Central nervous system complications of coronary artery bypass graft surgery: prospective analysis of 421 patients. *Stroke; a journal of cerebral circulation*. 1983;14(5):682-7.
4. McKhann GM, Goldsborough MA, Borowicz LM, Jr., Mellits ED, Brookmeyer R, Quaskey SA, et al. Predictors of stroke risk in coronary artery bypass patients. *The Annals of thoracic surgery*. 1997;63(2):516-21.
5. Tarakji KG, Sabik JF, 3rd, Bhudia SK, Batizy LH, Blackstone EH. Temporal onset, risk factors, and outcomes associated with stroke after coronary artery bypass grafting. *Jama*. 2011;305(4):381-90
6. O'Brien SM, Shahian DM, Filardo G, Ferraris VA, Haan CK, Rich JB, et al. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 2--isolated valve surgery. *The Annals of thoracic surgery*. 2009;88(1 Suppl):S23-42.
7. Hill MD, Brooks W, Mackey A, Clark WM, Meschia JF, Morrish WF, et al. Stroke after carotid stenting and endarterectomy in the Carotid Revascularization Endarterectomy versus Stenting Trial (CREST). *Circulation*. 2012;126(25):3054-61.
8. Mateen FJ, Muralidharan R, Shinohara RT, Parisi JE, Schears GJ, Wijdicks EF. Neurological injury in adults treated with extracorporeal membrane oxygenation. *Archives of neurology*. 2011;68(12):1543-9.
9. Lorusso R, Barili F, Mauro MD, Gelsomino S, Parise O, Rycus PT, et al. In-Hospital Neurologic Complications in Adult Patients Undergoing Venoarterial Extracorporeal Membrane Oxygenation: Results From the Extracorporeal Life Support Organization Registry. *Critical care medicine*. 2016;44(10):e964-72.
10. McKhann GM, Grega MA, Borowicz LM, Jr., Baumgartner WA, Selnes OA. Stroke and encephalopathy after cardiac surgery: an update. *Stroke; a journal of cerebral circulation*. 2006;37(2):562-71.

11. Likosky DS, Marrin CA, Caplan LR, Baribeau YR, Morton JR, Weintraub RM, et al. Determination of etiologic mechanisms of strokes secondary to coronary artery bypass graft surgery. *Stroke; a journal of cerebral circulation*. 2003;34(12):2830-4.
12. Powers WJ, Derdeyn CP, Biller J, Coffey CS, Hoh BL, Jauch EC, et al. 2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke; a journal of cerebral circulation*. 2015;46(10):3020-35.
13. Messe SR, Acker MA, Kasner SE, Fanning M, Giovannetti T, Ratcliffe SJ, et al. Stroke after aortic valve surgery: results from a prospective cohort. *Circulation*. 2014;129(22):2253-61.
14. Bucerius J, Gummert JF, Borger MA, Walther T, Doll N, Onnasch JF, et al. Stroke after cardiac surgery: a risk factor analysis of 16,184 consecutive adult patients. *The Annals of thoracic surgery*. 2003;75(2):472-8.
15. Fuchs S, Stabile E, Kinnaird TD, Mintz GS, Gruberg L, Canos DA, et al. Stroke complicating percutaneous coronary interventions: incidence, predictors, and prognostic implications. *Circulation*. 2002;106(1):86-91.
16. Werner N, Bauer T, Hochadel M, Zahn R, Weidinger F, Marco J, et al. Incidence and clinical impact of stroke complicating percutaneous coronary intervention: results of the Euro heart survey percutaneous coronary interventions registry. *Circulation Cardiovascular interventions*. 2013;6(4):362-9.
17. Kasirajan V, Smedira NG, McCarthy JF, Casselman F, Boparai N, McCarthy PM. Risk factors for intracranial hemorrhage in adults on extracorporeal membrane oxygenation. *European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery*. 1999;15(4):508-14.
18. Hemphill JC, 3rd, Greenberg SM, Anderson CS, Becker K, Bendok BR, Cushman M, et al. Guidelines for the Management of Spontaneous Intracerebral Hemorrhage: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke; a journal of cerebral circulation*. 2015;46(7):2032-60.
19. Miller CM, Pineda J, Corry M, Brophy G, Smith WS. Emergency Neurologic Life Support (ENLS): Evolution of Management in the First Hour of a Neurological Emergency. *Neurocrit Care*. 2015;23 Suppl 2:S1-4.