Anesthetic Management of the Post-Cardiac Transplant Patient for Non-Cardiac Surgery

Alexis Boutchie, S-AA, Nova Southeastern University

Abstract

About 2500 orthotopic heart transplants (OHT) occur annually in the United States, with current surgical techniques and post-operative management increasing survival rates to 75-80% after 1 year, 50% after 10 years, and a median life expectancy of 10.7-11.9 years post OHT(2021). As these continue to improve, the likelihood of anesthesia care providers encountering these patients for non-cardiac surgery increases and we must understand how to direct their care. The pathophysiology of the transplanted heart is altered which impacts the physiological response to sympathetic stimulation, the pharmacological agents that can be used, and the way in which anesthetic depth is monitored. These patients are on immunosuppressant therapy which must be perioperatively monitored to prevent graft rejection.

Pathophysiology of the transplanted heart

Cardiac transplantation results in the denervation of paraysympathetic vagal fibers and sympathetic nerve fibers from the stellate ganglion which eliminates the baroceptor reflex, blunts chronotropic response to sympathetic stimulation, and eliminates the hearts response to drugs that mediate their effects via the autonomic nervous system. As the heart can no longer mediate its rate in response to stimuli, cardiac output becomes primarily dependent on frank-starling mechanisms and is entirely preload dependent (Choudhury, 2017). Monitoring of anesthetic depth will also become entirely dependent upon blood pressure and accessory monitors such as BIS rather than heart rate(Brusich & Acan, 2018). The heart rate is consistently 90-110 regardless of physiologic stress and conducts normal sinus rhythm with an increased sinus refractory period. This combined with a loss of vagal input results in a high rate of arrythmias including AV node block, bradyarrhythmia's, and right bundle branch block which may require the placement of a pacemaker. The atria is also often enlarged due to biatrial anastomosis which predisposes patients to a fib, a flutter, and tricuspid regurgitation. (Blanco & Modak, 2021)

Physiologic Changes

Changes in Atrial Geometry
- Larger right and left atrial end-diastolic and end-systolic volumes
- Larger right atrial pressure
- Functional atrio-ventricular valve regurgitation (tricuspid valve most commonly affected)

Changes in Pacemaker function and Electrophysiology
- Resting heart rate 90-110 beats per minute
- Blunted tachycardia response to physiologic stress
- Presence of "*two p-waves*" in electrocardiogram
- Lack of functional efferent systemic vaso-motor input

Changes in Cardiac Function
- Preserved Frank-Starling Mechanism (normal contractile response to preload)
- Heart rate responsive to increased circulating catecholamines
- Accentuated orthostatic hypotension
- Greater left ventricular mass
- Diastolic compliance and relaxation abnormal
- Lower maximal heart rate and cardiac index during exercise

Changes derived from Cardiac Denervation
- Heart Rate unresponsive to Systemic Blood Pressure changes (Absent Baroreceptor Reflex)
- Heart Rate unresponsive to Carotid Massage
- Lack of Heart Rate change to Valsalva Maneuvers and Respiratory Changes
- Slower Heart Rate response to postural changes
- Lack of Angina Pectoris during myocardial ischemia ("*silent ischemia*")

(Blanco & Modak, 2021)

Pharmacological effects on the heart

Action	Drug	Effect on Heart Rate	Effect on Systemic Blood Pressure
Indirect	Ephedrine	Increase	Increase
	Atropine	None	None
	Glycopyrrolate	None	None
	Opioids	None	Decrease
	Glucagon	Increase	None
	Neostigmine	None	Decrease
Direct	Epinephrine	Increase	Increase
	Phenylephrine	None	Increase
	Esmolol	None	Decrease
	Metoprolol	None	Decrease
	Propranolol	Decrease	Decrease
	Isoproterenol	Increase	Decrease
	Dobutamine	Increase	Decrease
	Dopamine	Increase	None
	Norepinephrine	Increase	Increase

(Blanco & Modak, 2021)

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Side Effects of Immunosuppressive Therapies

Anesthetic agent	Effect with immunosuppressive drugs
Isoflurane	↓ Clearance of oral CyA
Thiopental	Nil
Benzodiazepines	↑ Blood level of benzodiazepines
Propofol	Nil
Etomidate	Nil
Opioids	CyA ↑ analgesic effect produced by fentanyl
Muscle relaxants	Prolonged neuromuscular blockade
Neostigmine	Caution in heart transplant patients
Local anesthetics	Bupivacaine and ropivacaine can be safely used

(Brusich & Acan, 2018)

Immunosuppressants are utilized to prevent graft failure, the leading cause of death in 1st 12 months after transplant(Blanco & Modak, 2021). Patients are typically on a combination of corticosteroids, calcineurin inhibitors, and antiproliferative agents to inhibit helper-T and B-cell proliferation and to suppress the production of Il-2. Therapeutic serum levels of calcineurin inhibitors should be measured throughout the perioperative period. A pre-operative stress dose of steroid should be given to steroid dependent patients and their glucose monitored. Care must also be taken to avoid infection, the cause of death in 32% of cases 1 month-1 year after OHT(Brusich & Acan, 2018)

Pharmacologic management

Medications that indirectly mediate their effects via the vagus nerve are ineffective due to denervation while direct-acting myocardial drugs are effective due to intact beta and alpha receptors. Those that work on the phases of cardiac tropism are also effective at slowing AV node conduction (verapamil, quinidine, amiodarone, and procainamide) (Brusich & Acan, 2018). Anticholinesterase and anticholinergic drugs have led to extreme bradycardia and cardiac arrest in post-OHT patients and are generally avoided. Neuromuscular blockers that are not eliminated by the liver or kidneys such as cisatracurium are recommended although rocuronium and sugammadex combined have been successfully utilized. (Choudhury, 2017, Blanco & Modak, 2021)

Conclusions

The likelihood of anesthesia care providers encountering an OHT patient presenting for non-cardiac surgery increases with parallel increases in surgical techniques and post-operative guidelines. It is crucial for providers to be knowledgeable about the altered pathophysiology and appropriate pharmacological interventions to take as well as their immunosuppressant regimen and how these will impact our anesthetic.

References

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