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Perioperative Mechanical Circulatory Support Symposium

The Transition From Temporary to Durable Mechanical Circulatory Support: Surgical Considerations

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Introduction

The goals of temporary mechanical circulatory support (MCS) are to treat cardiogenic shock, restore sufficient end-organ perfusion, reduce left ventricle end-diastolic pressure, and alleviate pulmonary congestion. In anticipation of durable left ventricular assist device (LVAD) implantation, volume status and right ventricle (RV) function must be optimized. Additional objectives of MCS before LVAD implant include preservation of sternal integrity, minimizing infectious complications, and improving the physical conditioning of the patient.

Candidate Evaluation

Patient considerations include hemodynamic status and the need for additional support, LV or biventricular failure, and the presence of arrythmias. Anatomic considerations include left ventricle size, presence of valvular abnormalities, LV thrombus, peripheral vessel caliber, and presence of peripheral vascular disease.

In many circumstances, an intra-aortic balloon pump and intravenous inotropes are sufficient to optimize hemodynamics. When more complex MCS devices are employed, an increased risk profile is assumed, and complications of MCS support can delay or disqualify candidacy for LVAD. The preoperative presence of an intra-aortic balloon pump is associated with better postoperative LVAD outcomes compared with bridging to LVAD with more complex MCS options (Fig. 1).

In candidates who are marginally qualified for durable LVAD, temporary MCS can be used to assess patient response to LV support. Specific considerations include assessing the RV's functional response to increased LV output and gauging the patient's physical tolerance for surgical intervention. Favorable responses can eliminate some uncertainty in moving forward with durable LVAD.

Device Options

An intra-aortic balloon pump provides diastolic counterpulsation, improving LV output and coronary perfusion. It can be percutaneously inserted at the bedside. The pump is useful when minimal additional support is required above inotropes and in the presence of mitral valve regurgitation, but it is inefficient in the presence of tachyarrhythmias.[1,2]

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The Impella 5.0 and 5.5 (Abiomed) left heart microaxial pumps provide 4 to 5 L per minute of LV support. The device can be inserted through the axillary artery to permit patient ambulation while on support and is helpful in assessing RV response to LV support. Drawbacks include positional instability in a severely dilated left ventricle, risk of hemolysis, and unsuitability in the presence of left ventricle thrombus.[2,3]

The TandemHeart device (Cardiac Assist Inc) can provide 4 to 5 L per minute of support. Insertion is through the femoral vein and requires image-guided transeptal puncture. The device is highly effective at LV unloading and relieving pulmonary congestion from elevated left ventricle end-diastolic pressure. The downside is that the patient remains bedbound and nonambulatory. The TandemHeart is preload dependent; therefore, RV dysfunction and arrhythmias are poorly tolerated. Other contraindications include the presence of intra-atrial thrombus, which increases the risk of embolization and aortic insufficiency, which can be exacerbated by retrograde flow of the TandemHeart device.[2]

Venoarterial extracorporeal membrane oxygenation (VA-ECMO) is a biventricular support system that provides 4 to 6 L per minute of support. Percutaneous insertion can be initiated at the bedside in emergent scenarios. Contraindications include ventricular septal defect, aortic insufficiency, and inability to be on systemic anticoagulation. Support duration on VA-ECMO should be limited and converted to an isolated left heart support device for LVAD candidates.[4]

Abbreviations and Acronyms

LVAD	left ventricular assist device
MCS	mechanical circulatory support
RV	right ventricle
VA-ECMO	venoarterial extracorporeal membrane oxygenation

Temporary MCS Complications

When using temporary MCS to bridge to a durable LVAD, avoiding complications is imperative. Frequently encountered complications should be anticipated and avoided to maintain LVAD candidacy. Ideally, the pa-

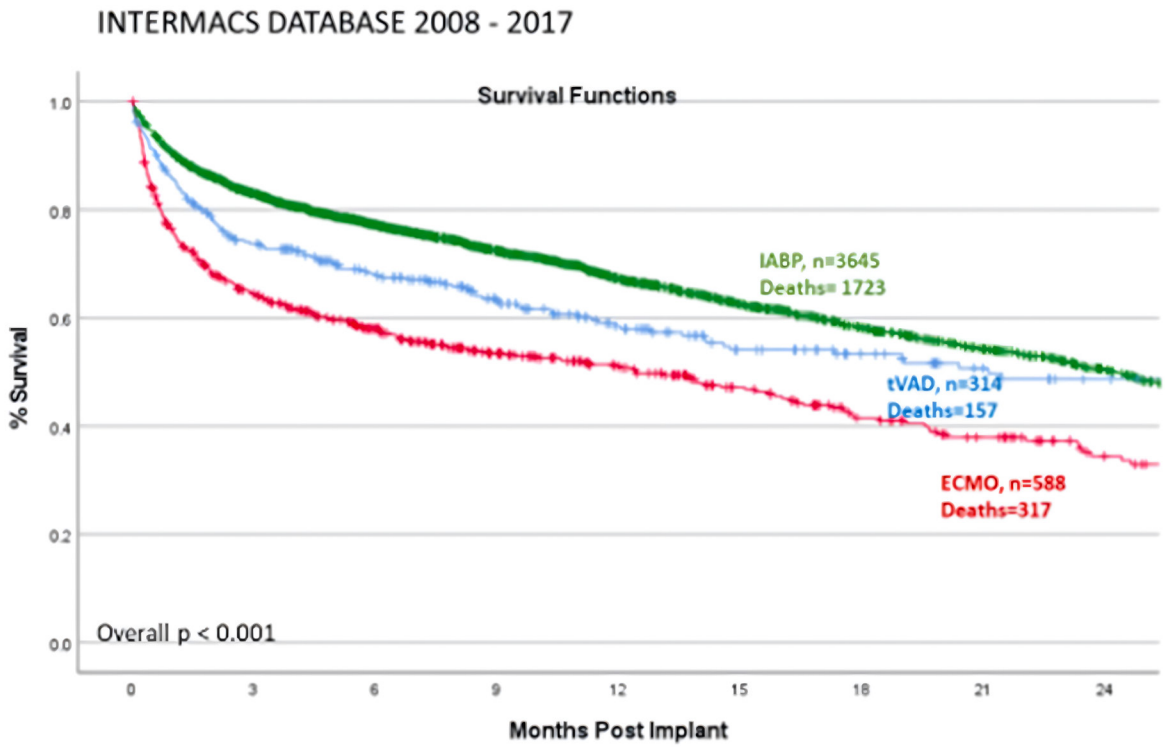

Fig. 1 Preoperative mechanical support device and associated outcomes after left ventricular assist device implant.

ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; INTERMACS, Interagency Registry for Mechanically Assisted Circulatory Support; tVAD, temporary ventricular assist device.

tient should be optimized quickly and transitioned to a durable device before complications ensue.

Temporary MCS devices have many associated complications. Patients on VA-ECMO can develop significant pulmonary edema because of the lack of LV ejection and elevated pulmonary pressures. Cerebral and coronary hypoxia can develop in patients on VA-ECMO as a result of retrograde ECMO perfusion. Early intervention with left heart venting is necessary when there is minimal cardiac ejection to prevent these complications.

Stroke prevention is imperative to maintain LVAD candidacy. Important measures for preventing thromboembolic complications and stroke include providing appropriate anticoagulation, preventing intraventricular blood stasis, and avoiding cannulation of diseased vessels.

Limb ischemia is a major complication and can necessitate amputation or fasciotomy. When cannulation of a peripheral arterial vessel is necessary, a distal perfusion catheter should be placed to maintain distal blood flow (Fig. 2).

Pigment-induced nephropathy and resulting kidney failure is associated with blood pump–induced hemolysis. An overwhelming burden of heme pigment released from lysed red blood cells injures the kidney through direct tubular obstruction and vasoconstriction that leads to reduced medullary blood flow.

Conclusion

When bridging patients to durable LVADs, temporary MCS devices should be tailored to each patient. Intraaortic balloon pumps and inotropes are often sufficient. Avoiding complications is imperative. Ideally, patients can be quickly transitioned to a durable LVAD when organ function has been restored and volume status optimized.

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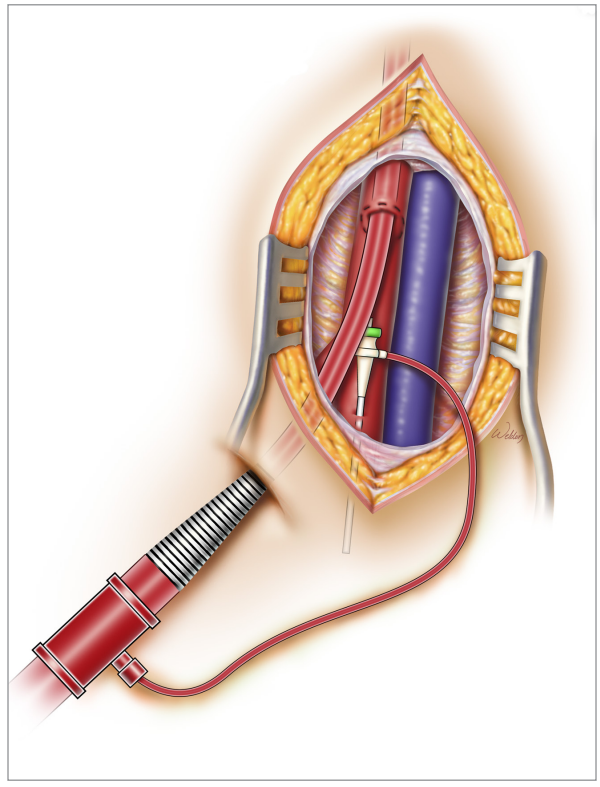

Fig. 2 Common femoral artery cannula with a distal perfusion catheter in the distal superficial femoral artery.

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