Intra-operative Echocardiography: When to Go Back on Pump
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OUTLINE

A. Indications for Intraoperative Echocardiography
B. Role of Intraoperative Echocardiography
C. Criteria for weaning from CPB
D. Indication for going back on pump
E. Summary
WHAT IS CARDIOPULMONARY BYPASS (CPB)?

- System that temporarily takes over the function of the heart and lungs maintaining blood circulation and tissue oxygenation
- Mechanically circulates & oxygenates blood while bypassing the heart and lungs
- CPB machine = heart-lung machine or the “pump”
- Maintains perfusion to other organs while surgeons work in a “bloodless” surgical field

RECOMMENDATIONS FOR INTRAOPERATIVE ECHOCARDIOGRAPHY

CLASS I (With evidence and/or general agreement that TEE is useful and effective)

- Valve repair
- Repair of aortic dissection with AVR
- Surgery for complicated endocarditis
- Congenital heart surgery requiring cardiopulmonary bypass
- Repair of HOCM
- Intracardiac devices (LVAD)
RECOMMENDATIONS FOR INTRAOPERATIVE ECHOCARDIOGRAPHY

CLASS IIa (Conflicting evidence and/or divergence of opinion but weight is in favor of usefulness/efficacy.)

- Valve replacement
- Intracardiac thrombectomy
- Removal of cardiac tumor
- Detection of air emboli (cardiotomy, heart transplant, neurosurgery)
- Cardiac aneurysmectomy
- Patients with increased risk of myocardial ischemia, MI or hemodynamic disturbances (e.g., CABG)

PRACTICE GUIDELINES FOR PERIOPERATIVE TRANSESOPHAGEAL ECHOCARDIOGRAPHY

An updated Report by the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists Task Force on Transesophageal Echocardiography

Appendix 1: Summary of Recommendations

Cardiac and Thoracic Aortic Procedures

- For adult patients without contraindications, TEE should be used in all open heart (e.g., valvular procedures) and thoracic aortic surgical procedures and should be considered in CABG surgeries as well
  - to confirm and refine the preoperative diagnosis,
  - to detect new and unsuspected pathology,
  - to adjust the anesthetic and surgical plan accordingly, and
  - to assess the results of the surgical intervention.
ROLE OF TEE IN SURGERY

• Diagnosis
• Monitoring
• Surgical outcome

DIAGNOSTIC TOOL

Refine assessment of known lesions
DIAGNOSTIC TOOL

Detect unsuspected lesions

Atheromatous disease of the aorta is a strong predictor of **stroke** and **death** after CABG.

TEE determination of **atheroma** grade ➔ critical element during CABG.
ROLE OF TEE IN SURGERY

- Diagnosis
- Monitoring
- Surgical outcome

MONITORING DEVICE

- Wall motion
- Valve function
- Chamber dimension / volume
INTRAOPERATIVE TEE MONITORING

- Cardiac output
- LV diastolic function
- LV filling pressure
- Pressure gradient
- PA pressure

ROLE OF TEE IN SURGERY

- Diagnosis
- Monitoring
- Surgical outcome
**POSTOPERATIVE EVALUATION**

- Immediate result of surgery
- Complications
- Unexplained hypotension

**IMMEDIATE RESULT OF SURGERY**

Adequacy of operation
IMMEDIATE RESULT OF SURGERY

- Residual hypokinesia
- Residual shunt
- Valve regurgitation
- Prosthetic valve dysfunction / paravalvar leak

POST OPERATIVE EVALUATION

COMPLICATIONS

- New wall motion abnormality
- New or worsening regurgitation
- Outflow tract obstruction
- Aortic dissection
- Intracardiac air
POSTOPERATIVE TEE

IMMEDIATE RESULT OF SURGERY

- Adequacy of operation
- Residuals
- Complications

↓

Surgical revision

POSTOPERATIVE EVALUATION

UNEXPLAINED HYPOTENSION

- Contractility
- Volume
- Significant MR
- Systemic vascular resistance
UNEXPLAINED HYPOTENSION
MECHANISM OF HYPOTENSION BASED ON TEE

<table>
<thead>
<tr>
<th>LV SIZE</th>
<th>EF</th>
<th>MR</th>
<th>Mechanism</th>
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<tbody>
<tr>
<td>↓</td>
<td>↑</td>
<td>O</td>
<td>Hypovolemia</td>
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<td>↑</td>
<td>↓</td>
<td>O</td>
<td>Myocardial depression</td>
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<td>N</td>
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<td>Systemic resistance</td>
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<td>↑</td>
<td>O</td>
<td>O</td>
<td>Cardiac arrest</td>
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Weaning from CPB

“The main goal of weaning from cardiopulmonary bypass (CPB) is a smooth transition from mechanical pump-assisted circulation to spontaneous systemic circulation.”

Kim H. Korean J. Anesthesia
June 2013 64 (6) 487-488
During the weaning process, TEE provides a rational basis for diagnostic & therapeutic decision-making, most importantly the need for volume replacement, inotropes and vasopressors, IABP, or the need to go back on pump.

ALGORITHM FOR WEANING FROM CARDIOPULMONARY BYPASS

CHECKLIST

1. Rectal/bladder T° > 35.5°C
2. Hgb ≥8 g/dL, HCT ≥25%, K+ 3.8–5 mEq, pH >7.3, glucose 6-9 mmol/L
3. Surgeon ⇒ Aortic unclamping
   ± de-airing cardiac cavities
   ± defibrillation
4. Lung re-ventilation
5. Spontaneous or paced HR (> 70 b/min)
6. TEE examination under partial CPB
   ⇒ Check for structural defects
   ⇒ Check for functional defects
   ⇒ Adequacy of surgery
ALGORITHM FOR WEANING FROM CARDIOPULMONARY BYPASS

STEP 1

Hemodynamic targets

- HR 70 - 100
- Optimize Preload
- MAP 70 – 90mmHg

Inability to wean from CPB despite preload optimization and adequate surgical repair
(exclude valve dysfunction, coronary graft failure, LV outflow tract obstruction)

Successful CPB Weaning
• TEE & Remove arterial canula
• Protamine IV & ACT control

STEP 2

Ventricular failure

1. INOTROPES ± VASOPRESSORS
2. Stepwise reduction of venous return & pump flow: 100% -75% -50% -25% 0
3. Cardiac pacing : bi-ventricular, atrioventricular
4. Inhaled NO (PGI2) if PH, RV failure

Inability to wean from CPB despite preload & pharmacological optimization
(MAP < 70, CI < 2.0 L/min/m², SvO2 < 70%, lactic acidosis)

Successful CPB Weaning
• TEE & Remove arterial canula
• Protamine IV & ACT control
Weaning from CPB

In case of inability to wean from CPB due to hypotension despite preload optimization,
1. Global cardiac function
2. Completeness of surgery
should be assessed by TEE

Possible causes of weaning difficulty due to hypotension:
1. LV or RV failure
2. Inadequate surgery
3. Inappropriate vasodilation (VASOPEGIC syndrome)

ALGORITHM FOR WEANING FROM CARDIOPULMONARY BYPASS

STEP 3

Successful weaning from CPB
Successful weaning from CPB but with mechanical circulatory support
Unsuccessful weaning

Go BACK on pump

INDICATIONS FOR GOING BACK ON CPB (Philippine Experience)

Survey Question:

“In what instances do you go back on pump right after cardiac surgery?”

A. Adequacy of Surgery

- Failed valve repair
- Acute prosthetic valve dysfunction
- Paravalvar leak
- Acute bypass graft thrombosis
- Acute perioperative MI
- LV or RV failure
- Redo an anastomosis
- Residual shunt post-VSD patching
- Significant residual LVOT gradient (HOCM)
INDICATIONS FOR GOING BACK ON CPB
(Philippine Experience)

B. Prolonged or difficult weaning from CPB
- Heart failure secondary to ignored concomitant moderate valve lesion
- ↓ BP inspite of adequate volume & pharmacologic support

C. Post-operative complications
- Significant bleeding (e.g., cardiac tamponade)
- Bleeders that cannot be sutured in a beating heart
- LV rupture after MVR

- E. De Castro
  - R. Cariño
  - A. Rico
  - D. Estrera
Weaning from CPB

Weaning from CPB requires **MULTIDISCIPLINARY** effort, good teamwork.

There is a strong correlation between technical errors and poor communication.

Important findings/information should be shared and fully communicated among team members

1. Cardiac surgeon
2. Anesthesiologist
3. Cardiologist (Echocardiographer)
4. Perfusionist

**SUMMARY**

**WHEN TO GO BACK ON PUMP?**

A. When a **surgical** procedure needs to be done or redone
B. **Persistent hypotension** despite hemodynamic and pharmacologic intervention
SUMMARY

ROLE OF IOTEE

1. Diagnostic tool
2. Monitoring device
3. Therapeutic decision-making
   - appropriate treatment options

SUMMARY

- Weaning off CPB & going back on pump requires team effort and shared decision-making (surgeon, anesthesiologist, echocardiographer, perfusionist)
- Integration of standardized approach for weaning and going back on pump, TEE assessment, and goal-directed intervention can improve clinical outcomes
- Large trials are warranted to assess management strategies and to validate algorithms for CPB in cardiac surgery

Marc Licker, et. Al
Annals of Cardiac Anesthesia
July 2012
THANK YOU.