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Transesophageal Echocardiography Use for Orthotopic Liver Transplant

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Abstract

Transesophageal echocardiography (TEE) is an invaluable tool used in cardiac surgery. So why is it not consistently used in other high-risk surgeries, such as orthotopic liver transplantation (OLT)? Hemorrhage, acute cardiac dysfunction, fluid shifts, and other intraoperative pathologies associated with OLT present many challenges for the anesthesia provider. Therefore, timely identification, evaluation, and intervention of intraoperative pathology are necessary to maintain hemodynamic stability. Traditionally, intra-arterial and pulmonary artery catheters (PACs) were used as hemodynamic monitors. Recently, however, transesophageal echocardiography (TEE) has been used for noncardiac surgery to assess hemodynamic status. This poster discusses perioperative care and current literature surrounding TEE and OLT using a case study approach. Patients undergoing OLT with both TEE and PAC had the lowest hospital length of stay (LOS), 30-day mortality, and infusion of fluids. This suggests that the addition of TEE with traditional monitors may be the safest method of hemodynamic monitoring.

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Introduction/Background

- This scholarly project focuses on a high-risk patient undergoing an orthotopic liver transplant (OLT).
- Hemorrhage, acute cardiac dysfunction, fluid shifts, and other intraoperative pathologies associated with OLT present many challenges for the anesthesia provider.[1]
- Each stage of OLT presents different challenges and varying hemodynamic shifts. (Figure 1).[1]
- Timely identification, evaluation, and intervention of intraoperative pathology are necessary to maintain hemodynamic stability.
- Traditionally, intra-arterial and pulmonary artery catheters (PACs) were used as hemodynamic monitors.[2]
- TEE utilization as a hemodynamic monitor is becoming more popular in OLT, either exclusively or in addition to PAC.[2,7]
- The consideration that the use of TEE may have improved this patient's intraoperative management was the inspiration for this scholarly project.

Purpose

- The first objective of this project is to identify what benefits are gained from the use of TEE in addition to traditional hemodynamic monitoring techniques (CVP/PAOP) during OLT.
- The second objective is to determine how these findings affect fluid and medication administration in the hemodynamically unstable patient.

Case Summary

Pre-Anesthetic Evaluation

- A 50-year-old Caucasian female underwent general endotracheal anesthesia for an OLT.
- Medical history: cirrhosis, refractory ascites, portal hypertension, portal vein thrombosis, hepatitis C, thrombocytopenia, anemia, obesity, and coronary artery disease.
- Surgical history: splenic embolization, coronary artery bypass graft, and cesarean section.
- Current medication: furosemide 100 mg daily, spironolactone 300 mg daily, lactulose 30 mg four times daily, midodrine 5 mg twice a day, rifaximin 550 mg twice a day, montelukast 10 mg daily, gabapentin 600 mg three times a day, trazodone 50 mg daily, vitamin B12 500 mcg daily, and ferrous sulfate 60 mg daily.
- Assessment: abdominal distention, tenderness, jaundice, and +1 edema to bilateral lower extremities.

Intraoperative Course

- Preoperative VS: BP 148/75, HR 89, SpO2 92%, RR 24
- IV induction: 100 mg lidocaine, 100 mg propofol, 5 mcg sufentanil, 50 mg rocuronium.
- Direct laryngoscopy with Miller #2 blade for introduction of 7.0 endotracheal tube (ETT).
- Ventilation mode: SIMV/PS
- Maintenance: Sevoflurane and vecuronium
- Hemodynamic monitors: arterial line and introducer with PA catheter.
- Initial hemodynamic values: CVP 22, PA pressure 33/21, CI 2.4
- Hemodynamic infusions: Epinephrine and norepinephrine.
- Total fluids and blood products: 1.5 L of 5% albumin, 6 units PRBCs, 5 units FFP, and 1 unit of platelets.
- Rapid transfusion and warming device was used for fluid and blood product administration.
- Profound hypotension occurred at various points throughout the case, at times with unknown etiology. The greatest period of hemodynamic instability was during the post-anhepatic stage (donor liver reperfusion).

Postoperative Course

- Patient remained intubated and transferred to CVICU.
- 48 hours postoperatively, patient remained intubated and required a furosemide infusion and dialysis to treat acute kidney injury.

	Dissection/Pre-Anhepatic	Anhepatic	Reperfusion
Preload	↓	↓↓	↑
Afterload	↓	↓	↓↓
Cardiac output	↓	↓↓	↑

Figure 1. Hemodynamic Changes During Various Stages of OLT[1]

Reference	Type of Study	Total Patients	Diagnosis
Aniskevich et al. (2007)	Case report	1	LVOTO
Aubuchon et al. (2013)	Case report	1	New diagnosis Stenotic IVC
Boone et al. (2011)	Case series	4	ICT
Chin et al. (2009)	Case report	1	LVOTO
Cywinski et al. (2005)	Case report	1	LVOTO
Dalia et al. (2017)	Case series	2	ICT
de la Morena et al. (1993)	Prospective	18	Hypovolemia
Eagle et al. (2010)	Case report	1	Takotsubo
Eisenberger et al. (2006)	Case report	1	LVOTO
Ellis et al. (1989)	Prospective	16	ICT Heart failure
Essandoh et al. (2016)	Case report	1	LVOTO
Gologorsky et al. (2001)	Case series	7	ICT
Harley et al. (1996)	Case series	2	LVOTO
Hughes et al. (2009)	Case report	1	Heart failure
Kim et al. (2016)	Case report	1	ICT
Lim et al. (1995)	Case report	1	LVOTO
Mandell et al. (2015)	Case control	256	Heart failure
Muttiah et al. (2013)	Case report	1	ICT
Peiris et al. (2015)	Retrospective	2750	ICT
Pissarra et al. (2012)	Prospective	21	Hypovolemia
Planinsic et al. (2004)	Case report	1	ICT
Prah et al. (1996)	Case series	2	ICT
Protin et al. (2016)	Case report	1	ICT
Sanchez et al. (2017)	Case report	1	ICT
Sharma et al. (2006)	Case report	1	Cardiac tamponade
Shillcutt et al. (2016)	Retrospective	100	Intraoperative MACE
Sheltzer et al. (1991)	Prospective	9	ICT Heart failure
Suriani et al. (1996)	Retrospective	100	ICT Heart failure
Tiwari et al. (2008)	Case report	1	Takotsubo
Tüche et al. (1993)	Prospective	26	Hypovolemia
Vannucci et al. (2011)	Case report	1	Liver pathology
Vetrugno et al. (2017)	Case series	4	LVOTO Liver pathology
Vogt et al. (2018)	Case report	1	ICT
Xia et al. (2010)	Retrospective	426	ICT

Table 1. New Diagnoses Made from TEE Assessments in OLT[3]

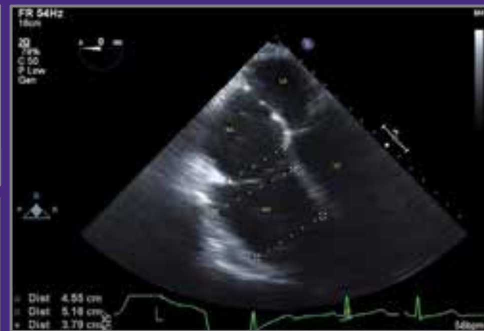

Figure 2. TEE image displaying dilated and dysfunctional right ventricle[1]

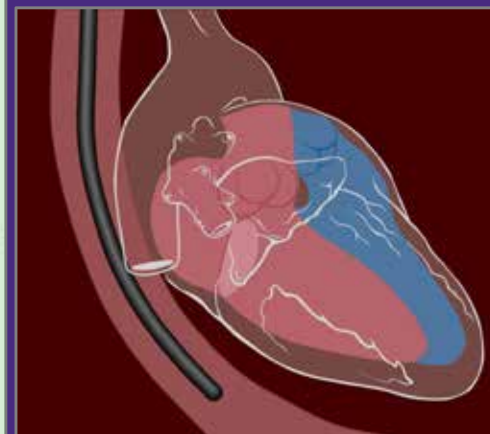

Figure 3. Positioning of TEE probe in Relation to Heart.[8]

Supporting Evidence

TEE as a Hemodynamic Monitor

- One systematic review (SR) qualitatively assessed 39 articles that included 3,193 participants addressing new diagnoses.[3] Table 1 details the main diagnoses from each.[3]
- One prospective database analysis including 99 participants undergoing noncardiac surgery (7 undergoing OLT) observed 165 new findings with the additional use of TEE to PAC monitoring.[6]
- A retrospective cohort study included 100 participants undergoing TEE assessment for OLT; 88% of patients had at least 1 abnormal intraoperative TEE finding during OLT.[4] The most common finding included microemboli (44%), right ventricular dysfunction (31%), and thromboemboli (27%).[4] TEE was also found to accurately distinguish hemodynamic instability caused by RV dysfunction and hypovolemia.[4]

Influence of TEE on Fluid and Medication Administration

- One SR included 7 noncomparative studies involving a change in management attributed to TEE use. Change in management ranged from 17 to 81%.[5]
- One prospective database analysis including 99 participants undergoing noncardiac surgery performed a subgroup analysis of 17 liver and lung transplant patients.[6] TEE-guided interventions occurred as follows[6] ($p < 0.05$):
  - Vasodilator therapy in 63% of patients
  - Vasopressor therapy in 56% of patients
  - Fluid management in 50% of patients
- One observational cohort study including 318 participants compared TEE, PAC, and TEE+PAC.[2] The TEE+PAC group had the shortest median hospital length of stay (LOS) and had the lowest 30-day mortality rate.[2] TEE+PAC group received the lowest volume of crystalloid and the lowest perioperative infusions.[2] The TEE group had the least perioperative time with MAP < 60 mmHg.[2]

Discussion

- The literature review found evidence that intraoperative TEE use for OLT was proficient at rapidly identifying multiple pathologies and guiding fluid and vasoactive agent administration.
- However, there was not a high quality of evidence supporting new TEE findings with better patient outcomes. Both SRs were unable to perform a metanalysis because of limited analytical data and variance in study methodology.[3,5]
- Additionally, sample sizes for the 3 reviewed observational cohort studies were relatively small.[2,4,6]
- The subjective nature of the anesthesia provider's interpretation of data and decision to implement a treatment was a common limitation found in the reviewed literature.
- Anesthesia providers' level of experience or certification with TEE was also variable throughout the studies. However, this may reflect a realistic view of clinical practice.
- The best outcome-based evidence retrieved suggests that TEE combined with PAC produces optimal patient outcomes.[2] The authors found that the patients undergoing OLT with both TEE and PAC had the lowest hospital LOS, 30-day mortality, and infusion of fluids.[2] This suggests that the addition of TEE with traditional monitors may be the safest method of hemodynamic monitoring.

Conclusions and Recommendations for Practice

- TEE can be used to promptly identify pathology associated with hemodynamic instability and provide information on valvular morphology and cardiac function.
- While the research displays an influence of TEE findings on fluid, vasopressor, and vasodilator usage during OLT, more research needs to be taken to verify the positive impact of this influence.
- Until beneficial outcomes have been validated, the use of TEE cannot be recommended as a comprehensive intervention for every OLT.
- TEE should be used based on the anesthesia provider's judgment along with other monitoring tools.

Recommendation for Future Research

- Higher-quality research should be performed to validate the outcome-based benefits of TEE findings and subsequent intraoperative interventions.
- Future research with more rigorous study designs that include greater control and randomization should be performed.
- Data acquisition via creation of large database analyses would control for confounding factors and selection bias.[5]

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