TRAUMA

ImaCor hTEE™ in Trauma Patients – A Miniseries of Case Reports

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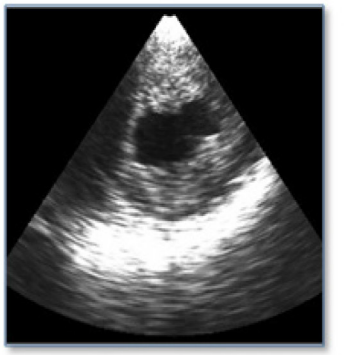
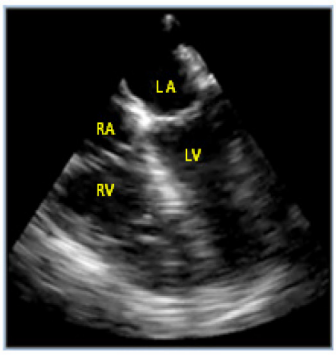
Introduction

The FAST (**F**ocused **A**ssessment with **S**onography in **T**rauma) exam (Rozycki and Shackford, J Trauma 1996) has become standard practice in the assessment of patients presenting with severe trauma. "Considering the pace of the trauma setting, ultrasound is an ideal modality for assessment of these patients. It should be the initial diagnostic test for the evaluation of patients with precordial wounds and blunt truncal injuries because it is rapid and accurate, and it augments the surgeon's diagnostic capabilities." (Rozycki and Newman, Adv Surg. 1999) The ImaCor hTEE system is designed for ongoing management of hemodynamic instability in intensive care and is enabled through the ClariTEE® probe, which is cleared by the FDA to remain indwelling up to 72 hours. hTEE offers the trauma surgeon and intensivist another similarly focused assessment tool, aimed at ongoing assessment of cardiac function and volume status. hTEE is based upon the focused exam by Vieillard-Baron et al. (Intensive Care Med 2004): "a *long-axis view* permits examination of the four cardiac cavities … we measure left ventricular (LV) and right ventricular (RV) end-diastolic and end-systolic size and calculate the LV ejection fraction. . . . A *short-axis view* of both ventricles by a transgastric . . . approach also permits measurement of LV size, calculation of LV fractional area contraction, and examination of septal shape and kinetics. (Thirdly), a long-axis view of the *superior vena cava*, anastomosing with the right atrium, allows us to examine variation in its diameter during the respiratory cycle." Here are static pictures of the hTEE views using the ImaCor system analogue of the Vieillard-Baron exam views with one change; the superior vena cava is shown in a short-axis view:



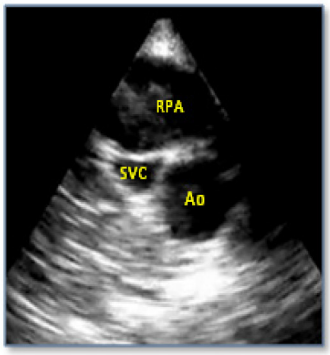
Trans-Gastric Short Axis

•*LV Filling & Function*



Four Chamber

•*Biventricular Function*



Superior Vena Cava

•*Fluid Responsiveness*

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The following case summaries illustrate a broad range of applications of hTEE in managing burn and trauma patients, from assessment of cardiac filling and function, guiding resuscitation, especially useful in the case of presumed sepsis, and guiding management of conflicting surgical requirements.

Case I. hTEE detects underfilling, rules out LV dysfunction. Donald Reiff, MD, and S. Chris Bellot, MD. University of Alabama at Birmingham, Birmingham, AL.

An immuno-suppressed patient with AIDS, 65% BSA burned and presumed sepsis, had been resuscitated with a modified Brooke formula. hTEE was ordered three days post admission, and notably following resuscitation. hTEE revealed an underfilled LV, hypovolemia not detected by PAC (diastolic pressure 17 mmHg). Administration of a fluid bolus (2 L over 45 min) and followup hTEE revealed more normal filling and a significant improvement in resuscitation measured by SvO2. hTEE was further used to rule out LV dysfunction and guide fluid administration. In summary, hTEE imaging provided critical information on fluid status and guided medical management, in a high-risk burn patient.

Case II. hTEE guides resuscitation of patient with septic shock and ARDS post MVA. Benjamin Kohl, MD and Niels Martin, MD. Hospital of the University of Pennsylvania, Philadelphia, PA.

A 72-year-old male presented with multiple orthopedic injuries post MVA and underwent several orthopedic interventions, as well as a tracheostomy. The patient was discharged to a rehabilitation facility for further ventilator weaning. During early rehabilitation, the patient developed anasarca and worsening hypotension with subsequent development of ARDS. He was transferred back to the primary facility, presenting with ARDS secondary from septic shock and hypotension requiring multiple vasopressors (neosynephrine, norepinephrine, vasopressin) for support. The patient later became progressively oliguric with concomitant development of acute renal failure. An ImaCor hTEE probe was placed to guide volume repletion and vasopressor titration, revealing moderate RV dilation and moderately depressed RV systolic function. These findings were consistent with acute right heart failure due to anasarca and septicemia. The patient was started on inhaled prostacyclin to reduce RV afterload and epinephrine was initiated, with subsequent titration of vasopressin and neosynephrine. Ongoing hTEE imaging demonstrated improvement in RV size and function. The oliguria was resolved and the patient responded to treatment.

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Case III. hTEE reveals and guides resuscitation first for hypovolemic shock, later for sepsis in a severely burned patient. Donald Reiff, MD. University of Alabama at Birmingham, Birmingham, AL.

A 40 year old morbidly obese female who sustained 74% total body surface area burns with inhalation injury during a house fire underwent standard trauma resuscitation using the Brooke formula. She received a total of 20 L of crystalloid and 2.9 L of albumin in 10 hours. The patient underwent her first burn wound excision on post injury day 4; her post-operative course was largely uncomplicated. Approximately 36 hours post-operatively the patient experienced her first episode of hypotension (80/40) with a heart rate of 145 in sinus rhythm. At this point she had received a total of 49.3 L crystalloid, 9.2 L albumin with a urine output of 6.7 L. Other important physiologic data included an abrupt climb in her lactic acid from normal to 4.2, a low grade fever of 102.0 (relatively normal for a burn of this size) and WBC trending up from normal (9.4) to 14.6.

The clinical issue facing us was identifying the cause of this new hypotension. Two more likely etiologies were hypovolemic shock (36 hrs post major surgery) and sepsis. Because of the diverging therapeutic interventions for these two likely etiologies, we placed an hTEE probe, revealing LVEDA of 6.8 cm2 and normal FAC. Based upon these findings the patient was bolused fluids and had her maintenance rate was advanced as well. Shortly thereafter, the clinical problem was resolved.

However, approximately 18-hours later, the patient again developed significant hypotension with MAP approaching 50 mmHg, also a slight climb in WBC to 18.6 and recorded fever of 103.6. With the hTEE probe still in place, a subsequent exam revealed LVEDA 9.9 cm2 and FAC 85%. A new diagnosis of sepsis was assigned, levophed and antibiotics were initiated and normal blood pressure was restored.

Case IV. hTEE guides management of a trauma patient with right ventricular rupture. Benjamin Kohl, MD. Hospital of the University of Pennsylvania, Philadelphia, PA.

A 41-year-old female presented to the ER following an MVA. She had a remarkable history of orthotopic heart transplant 10 years prior. One week prior to admission, she developed an acute coronary syndrome, requiring percutaneous coronary intervention. Upon examination, she was found to have multiple orthopedic injuries as well as bilateral cerebral contusions.

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Computed tomography showed RV freewall discontinuity consistent with RV rupture apparently contained within the thorax. Although immediate surgery is normally required for cardiac wall rupture, anticoagulation therapy due to the cerebral contusions had been performed. It was therefore decided to defer surgery if possible, based on RV function. An hTEE probe was placed to monitor RV function. hTEE imaging demonstrated normal biventricular function and stable RV status over the next three days. The patient underwent successful repair of the RV rupture and made a full recovery.

Conclusion

This miniseries illustrates the use of hTEE to assist in the multi-faceted challenge of trauma management. Together these cases show the impact of hTEE for hemodynamic assessment and management of complex trauma cases.

References

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