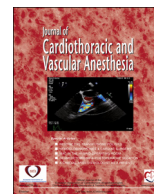




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Original Article

Feasibility and Impact of Focused Intraoperative Transthoracic Echocardiography on Management in Thoracic Surgery Patients: An Observational Study

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Objectives: Intraoperative focused transthoracic echocardiography (TTE) is feasible and has an effect on the management of hemodynamically unstable surgical patients. Furthermore, in noncardiac thoracic surgery, TTE might provide additional information for hemodynamic treatment. Transthoracic accessibility during thoracic surgical interventions is assumed to be difficult. For patients positioned on their right side, a modified subcostal transthoracic view might be helpful.

Design: A prospective observational study.

Setting: Single-center university hospital.

Participants: The study comprised 105 consecutive patients undergoing noncardiac thoracic surgery.

Interventions: Focused TTE was performed during anesthetic induction after intubation for mechanical ventilation. Intraoperative focused TTE, after positioning and draping for surgery, was attempted again for all 105 patients. Changes in patient management due to the results of the TTE were documented and analyzed.

Measurements and Main Results: Presurgical TTE with mechanical ventilation was applied successfully in 98.1% of 105 patients. Intraoperative imaging was successful in 90 patients (85.7%). Results of intraoperative TTE led to the modification of perioperative management in 39 patients (37.1%), 20 (22.0%) of these during surgery.

Conclusions: TTE in noncardiac thoracic surgery is feasible using a modified subcostal view and has an effect on hemodynamic management in a considerable number of patients.

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Key Words: focused transthoracic echocardiography; intraoperative transthoracic echocardiography; thoracic anesthesia; lung surgery; subcostal view

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NONCARDIAC THORACIC surgery can be associated with significant morbidity and mortality.¹ Surgery in patients with limited cardiovascular or respiratory reserve carries increased risk of adverse events.^{2,3} Transesophageal echocardiography (TEE) is an established semi-invasive technique for

hemodynamic monitoring and decision-making in cardiac and other high-risk surgeries^{4,5} and carries the risk of rare but potentially disastrous injuries.^{6,7} Furthermore, TEE probe insertion potentially can displace the tracheal tube for one lung ventilation (OLV). In addition, a TEE probe is not available in every clinic within the perioperative setting. Preoperative and intraoperative hemodynamic (minimal) invasive monitoring using, for example, pulse contour analysis to guide therapeutic decisions has been proven to be beneficial in high-risk surgical patients.⁸ Nonetheless, due to the costs and limitations during (open) chest surgery,^{9,10} standard usage in these cases is uncommon. Intraoperative, noninvasive focused transthoracic echocardiography (TTE) is feasible¹¹ and has an effect on intraoperative hemodynamic monitoring and decision-making in high-risk surgery.¹²

However, intraoperative TTE for thoracic surgery commonly is considered to be difficult because of patient positioning, draping, and mechanical ventilation. For this study, the authors evaluated the hypothesis that intraoperative TTE is both feasible and can alter patient management even in noncardiac thoracic surgery.

Methods

This study was approved by the Institutional Review Board of the University Hospital of Marburg. Written consent was waived by the Institutional Review Board. Between February 2013 and February 2014, 105 consecutive patients scheduled for noncardiac thoracic surgery were examined for the study.

General anesthesia was induced and conducted according to the local standard operating procedures. During induction of anesthesia with mechanical ventilation, an initial limited TTE examination as proposed by the American Society of Echocardiography,¹³ using portable ultrasound devices (Vivid S5 or Vivid S6; GE Medical Systems, Solingen, Germany) equipped with 3S-RS phased-array-sector probes (1.5-3.6 MHz), was performed by experienced TTE examiners (T.K., T.S., M.E., M.Z.). For testing of feasibility, if accessible, all 4 cardiac views according to the Focus Assessed Transthoracic Echocardiography (FATE) protocol¹⁴ (parasternal long- and short-axis, apical, and subcostal 4-chamber view) were displayed and rated on an established scale, from 1 (impossible) to 5 (perfect), as previously described.^{11,15} Other views were additionally performed whenever indicated. After positioning the patients for surgery, TTE was attempted again. Patients positioned on their right side were examined via a modified subcostal approach (Fig 1). For obtaining this view the probe was placed just below the xyphoid with its notch at 3 o'clock at a shallow angle, orientating it from the patient's sternum to the left shoulder, until the 4-chamber view came into sight. For the short axis, the probe was rotated counter clockwise for 90 degrees. If necessary, Doppler echocardiography (eg, for suspected valvulopathy or right heart failure) could have been performed. Patients were regarded as examinable if 1 of 4 views of the FATE protocol was rated as grade 4/5 or 2 views were rated as grade 3. If feasible, TTE examination was repeated during surgery, when OLV was established or



Fig 1. Perioperative transthoracic echocardiography applying a modified subcostal approach for a patient positioned on his right side before completion of preparation and draping.

whenever hemodynamic instability occurred. In these cases, the surgeon was informed and TTE was performed from under the draping, and sometimes the surgery was interrupted briefly to allow for echocardiographic diagnosis (Fig 2).

Left ventricular function, volume load, and dimensions of both ventricles were assessed visually, as previously described.^{11,12,15} Right ventricular systolic function was evaluated using tricuspid annular plane systolic excursion (TAPSE). Hypovolemia was defined as touching left ventricular's papillaries/walls combined with a collapse or collapsibility index > 0.5 ¹⁶ or a distention or distensibility index $> 18\%$ in case of positive pressure ventilation¹⁷ of the inferior vena cava in the subcostal view. Aortic stenosis was assessed with continuous pulse wave Doppler measurements. All findings were recorded and documented.

For external quality assurance, the recorded views and findings were re-evaluated individually and reviewed by a cardiologist (Marco Campo dell'Orto) postoperatively. In case of differing interpretations between the cardiologist and anesthesiologist, the lower grading was accepted.

Any pathology that was detected with TTE was analyzed and could lead to altered patient management. The decision concerning the placement of a central venous line was made taking the TTE examination into account; whenever right ventricular pathologies, such as pulmonary hypertension, right heart insufficiency, or newly diagnosed left heart failure were detected, a central venous catheter was placed after anesthetic induction. In cases of severe pulmonary hypertension,

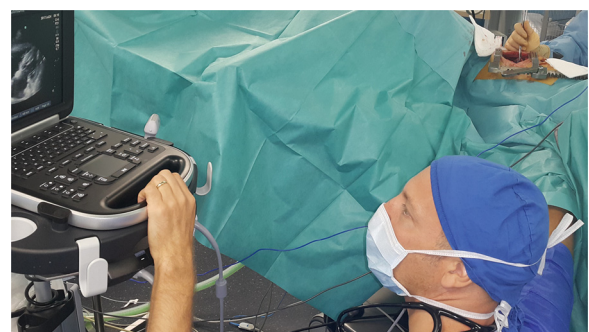


Fig 2. Access to subcostal transthoracic echocardiography view during thoracic surgery (intraoperative transthoracic echocardiography) for a patient positioned on his right side.

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