Journal of Cardiothoracic and Vascular Anesthesia ▮ (▮▮▮▮) ▮▮▮–▮▮▮

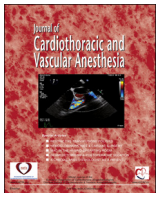
HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia ▮ (▮▮▮▮) ▮▮▮–▮▮▮



Original Article

Assessment of Image Quality of Repeated Limited Transthoracic Echocardiography After Cardiac Surgery

David J. Canty, MD, PhD[*,†,‡], Johan Heiberg, MD, PhD[*,†,1], Jen A. Tan, MBBS[*], Yang Yang, MD[§], Alistair G. Royse, MD[†,¶], Colin F. Royse, MD[*,†], Abdulelah Mobeirek, MD[‖], Fayez El Shaer, MD[‖], Turki Albacker[‖], Rakan I. Nazer, MD[‖], Muhammed Fouda, MD[‖], Bakir M. Bakir, MD[‖], Ahmed A. Alsaddique, MD[‖]

[*]*Department of Anesthesia and Pain Management, Royal Melbourne Hospital and Monash Medical Centre, Melbourne, Australia*

[†]*Department of Surgery, University of Melbourne, Melbourne, Australia*

[‡]*Department of Medicine, Monash University, Melbourne, Australia*

[§]*Department of Critical Care Medicine, Western Hospital, Footscray, Melbourne, Australia*

[¶]*Department of Surgery, Royal Melbourne Hospital, Melbourne, Australia*

[‖]*King Fahad Cardiac Centre & College of Medicine, King Saud University, Riyadh, Saudi Arabia*

Objectives: The use of limited transthoracic echocardiography (TTE) has been restricted in patients after cardiac surgery due to reported poor image quality. The authors hypothesized that the hemodynamic state could be evaluated in a high proportion of patients at repeated intervals after cardiac surgery.

Design: Prospective observational study.

Setting: Tertiary university hospital.

Participants: The study comprised 51 patients aged 18 years or older presenting for cardiac surgery.

Interventions: Patients underwent TTE before surgery and at 3 time points after cardiac surgery. Images were assessed offline using an image quality scoring system by 2 expert observers. Hemodynamic state was assessed using the iHeartScan protocol, and the primary endpoint was the proportion of limited TTE studies in which the hemodynamic state was interpretable at each of the 3 postoperative time points.

Measurements and Main Results: Hemodynamic state interpretability varied over time and was highest before surgery (90%) and lowest on the first postoperative day (49%) ($p < 0.01$). This variation in interpretability over time was reflected in all 3 transthoracic windows, ranging from 43% to 80% before surgery and from 2% to 35% on the first postoperative day ($p < 0.01$). Image quality scores were highest with the apical window, ranging from 53% to 77% across time points, and lowest with the subcostal window, ranging from 4% to 70% across time points ($p < 0.01$).

Conclusions: Hemodynamic state can be determined with TTE in a high proportion of cardiac surgery patients after extubation and removal of surgical drains.

Key Words: ultrasonography; transthoracic echocardiography; feasibility; image quality; monitoring

This project was supported by National Science, Technology and Innovation Plan (NSTIP), King Abdulaziz City for Science and Technology, Kingdom of Saudi Arabia (grant number: 11-MED 1932-02). The funding body had no involvement in study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the manuscript for publication.

[1]*Address reprint requests to* Johan Heiberg, MD, PhD, Royal Melbourne Hospital, Department of Anesthesia and Pain Management, PO Box 2135, Parkville VIC 3050, Australia.

E-mail address: johan.heiberg@clin.au.dk (J. Heiberg).

http://dx.doi.org/10.1053/j.jvca.2016.12.011

1053-0770/

OVER THE LAST DECADE, a rapid increase has occurred in the clinical use of transthoracic echocardiography (TTE), also referred to as "limited cardiac ultrasound" by critical care physicians, anesthesiologists, and intensivists.[1–5] It is well-established that hemodynamic state and valve pathology can be evaluated both noninvasively and quickly, even during a cardiac arrest.[6–8] The use of limited TTE in real time is used to complement clinical assessment rather than replace it and as such can be considered as "ultrasound-assisted clinical examination."[9]

Cardiorespiratory complications are common after cardiac surgery, and current monitors used to diagnose these are invasive and have limitations. Routine application of TTE in patients after cardiac surgery may have been limited by the assumption that adequate images cannot be obtained due to mediastinal air, drains, dressings, and the supine position. However, it has been shown that only 1 or 2 cardiac windows can provide enough information that is useful for determining the hemodynamic state,[10] which, as described by Royse et al,[11] can be estimated using TTE by assessing biventricular volumes and contractile functions and the movement of the interatrial septum. Recently, the authors reported that TTE after cardiac surgery led to a change in diagnosis of important cardiac pathology in two-thirds of patients, compared with clinical assessment and conventional pressure monitoring.[12]

The reported image quality after cardiac surgery is very variable in the literature, with the proportion of interpretable imaging ranging from 61% to 100%.[12–14] In part, this problem is caused by inconsistent methods of assessing image quality.[13,14] The definitions of interpretable imaging often range widely depending on the clinical question (eg, left ventricular dysfunction or potential pericardial effusion).[12–19] In addition, an objective image quality scoring system is important to fill the need that is created by the growing surge in people learning TTE (ie, an assessment tool that can be used by mentors for training beginners and also for examination for board certification). The authors developed a comprehensive image quality scoring system, which objectively assesses the interpretability of TTE imaging of the cardiac structures that is used to assess hemodynamic state and valve function.

The aim of this study was to test the hypothesis that the hemodynamic state could be evaluated in a high proportion of patients at repeated intervals after cardiac surgery using a limited TTE protocol.

Methods

A detailed description of the original study design, including participants, screening, recruitment, and data collection, has been published previously.[12] In brief, the aim of the original study was to determine the effect of limited TTE on diagnosis and clinical decision-making after cardiac surgery. This substudy received ethics approval as part of the approval for the original study from the King Saud University Health System, Riyadh, Saudi Arabia, and the Melbourne Health Human Ethics Committee, Melbourne, Australia, and conformed to the ethical guidelines of the 1975 Declaration of Helsinki. Written informed consent was obtained from all patients. This article adheres to the applicable Equator guidelines.

Study Population

Patients were eligible if they were included in the previously published study in which the inclusion criteria were age of 18 years or older and presentation for cardiac surgery at the King Fahad Cardiac Centre.[12] These patients underwent TTE at the following 4 time points: (T1) before surgery, (T2) on the first day after surgery, (T3) after extubation and removal of all surgical drains, and (T4) at discharge from the general ward. In this study, patients were included if TTE images from the original study were retrievable from the database at time points T1, T2, and T3. There were no exclusion criteria in this study.

Data Acquisition

Echocardiography was performed using an iE33 echocardiography machine (Philips Medical Systems, Amsterdam, The Netherlands) and a 1.5- to 3.6-MHz transthoracic probe. Echocardiographic data were stored in an electronic database (Xcelera; Philips) in digital format with at least 2 loops per image.

Trained technicians supervised by expert echocardiographers performed TTE on all patients in the supine position. Before surgery, the TTE followed the conventional comprehensive TTE protocol of the echocardiography laboratory, which complies with the American Society of Echocardiography guidelines.[20] After surgery the TTE was performed using the iHeartScan protocol (Hemodynamic Echocardiography Assessment in Real Time; the Ultrasound Education Group, University of Melbourne, Melbourne, Victoria, Australia), a limited study designed to diagnose abnormal hemodynamic state, hemodynamically significant valve disease, and pericardial effusion.[21] This echocardiography protocol included 2-dimensional and color-flow Doppler using the parasternal, apical, and subcostal windows. The protocol was designed to be performed in fewer than 10 minutes.

Data Analyses

Data were retrieved and de-identified by a researcher with no involvement in the image acquisition. The images were assessed independently offline for interpretability of hemodynamic state, interpretability of valve function, and image quality (defined later) by 2 observers considered experts with years of experience in performing and interpreting TTE (YY, JAT). The observers were blinded to each other's assessment, the time point of TTE (T1 to T4), and clinical information on the patients. Because all endpoints were based on dichotomized variables, the image was assessed by a third observer in case of disagreement between the 2 primary observers. None of the observers had any involvement in clinical management of the patients, and they were blinded to the time point of the respective study.

Please cite this article as: Canty DJ, et al. (2017), http://dx.doi.org/10.1053/j.jvca.2016.12.011