Intraoperative Transesophageal Echocardiography for the Evaluation and Management of Diastolic Dysfunction in Patients Undergoing Cardiac Surgery: A Survey of Current Practice

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Objectives: **To characterize existing practice patterns for intraoperative evaluation and grading of diastolic dysfunction in patients undergoing cardiac surgery.**

Design: **A 14-question, multiple-choice survey of current practice for patients with diastolic dysfunction and the use of intraoperative transesophageal echocardiography (TEE) to evaluate, grade, and monitor changes in diastolic function.**

Setting: **Online survey.**

Participants: **Members of the Society of Cardiovascular Anesthesiologists.**

Interventions: **None.**

Measurements and Main Results: **Of 515 respondents, there was a near-even spread between those based in an academic setting (53%) and those based in private practice (43%). Most respondents (81%) had completed training with certification in TEE. Most respondents (86%) currently modified their intraoperative management, at least some of the time, if they believed a patient was experiencing diastolic dysfunction, with 72% varying the nature of any modification according to the identified grade of diastolic dysfunction. Although 62% of respondents usually evaluated diastolic dysfunction in the pre-bypass period, only 59% of those evaluating diastolic dysfunction typically graded the dysfunction, with a variety of algorithms used for this purpose. The majority of respondents (62%) typically did not re-evaluate diastolic function using TEE in the post-bypass period. In 2 sample patients with Doppler data provided, there was marked variation in grading of diastolic dysfunction by respondents; this variation remained marked even within subgroups of respondents who typically used the same grading algorithm.**

Conclusions: **Marked variation currently exists in how intraoperative TEE is used to evaluate, grade, and monitor diastolic function during cardiac surgery. This suggests clinically important knowledge gaps that should be addressed.**

KEY WORDS: echocardiography, diastolic dysfunction, cardiac surgery, transesophageal echocardiography, Doppler, heart failure

HEART FAILURE is an established risk factor for adverse perioperative outcomes and commonly is present in patients undergoing cardiac surgery.[1,2] Approximately half of all patients with the clinical syndrome of heart failure experience preserved left ventricular ejection fraction,[3] often reflecting diastolic dysfunction. Transthoracic echocardiography (TTE) is used widely to evaluate diastolic function, and echocardiographically identified diastolic dysfunction is reported to be an independent predictor of mortality.[4,5] Moreover, diastolic dysfunction identified using TTE before cardiac surgery was associated with increased perioperative complications, including mortality.[6–9]

Intraoperative transesophageal echocardiography (TEE) has become accepted widely as a routine diagnostic and monitoring tool for patients undergoing cardiac surgery, offering the potential for real-time and repeated evaluation of diastolic dysfunction during a period in which multiple variables may interact to alter this important aspect of cardiac function. However, the validity and utility of intraoperative TEE for this purpose are uncertain,[10] and expert narrative reviews disagree as to whether an assessment of diastolic function should be considered part of routine intraoperative examination.[11,12] A 2012 survey of cardiac anesthesia practice across 200 selected institutions found that left ventricular diastolic dysfunction was evaluated routinely by only 46% and 19% of academic and non-academic institutions, respectively.[13] Around the same time, 3 varied approaches to the intraoperative grading of diastolic function using TEE were proposed: (1) a highly simplified approach by Swaminathan et al[14] using only the peak velocity of early mitral inflow (E) measured using spectral Doppler and peak early diastolic mitral annular velocity (e') measured using tissue Doppler; (2) a more detailed assessment proposed by Matyal et al[12] using mitral annular tissue Doppler and spectral Doppler of trans-mitral and pulmonary venous flow and incorporating the response to a Valsalva maneuver; and (3) a proposal by Mahmood et al[11] using E and e' together with an assessment of mitral inflow propagation velocity and left atrial size.

However, current practice for the intraoperative evaluation and grading of diastolic function remains unknown. Indeed, it is unclear whether clinicians currently modify perioperative management strategies according to perceived presence and grade of diastolic dysfunction, how any disagreement in the evaluation of diastolic function between preoperative TTE and intraoperative TEE is interpreted, and whether intraoperative TEE is used as a real-time monitor of change in diastolic function to guide perioperative management strategy. The authors sought to characterize existing practice patterns with

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This work was supported by intramural funding from the Department of Anaesthesia and Perioperative Medicine, Alfred Hospital and Monash University, Melbourne, Australia.

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1053-0770/2601-0001$36.00/0
http://dx.doi.org/10.1053/j.jvca.2015.11.002

regard to the intraoperative evaluation and grading of diastolic dysfunction by surveying a broad representative group of clinicians actively practicing cardiac anesthesia.

MATERIALS AND METHODS

The Human Research and Ethics Committee of the authors' institution approved the survey before distribution with a waiver of the requirement for written informed consent.

Survey Development

A 14-question survey was developed for online use by the authors (D.R.M., E.L., S.H., C.D.), all of whom are either board certified in perioperative TEE by the National Board of Echocardiography or testamurs in perioperative TEE. Each question provided finite multiple-choice responses. To prevent respondents from answering questions that may not reflect their typical practice, adaptive questioning was used, meaning that based on responses to specific questions not all respondents were asked all 14 questions. Before distribution, survey usability and functionality were tested on a group of cardiac anesthesiologists within the authors' institution who had not participated in its development (Appendix A).

Survey Distribution

After approval by the research committee of the Society of Cardiovascular Anesthesiologists (SCA), the survey was distributed by e-mail on April 29, 2015 to the SCA membership, representing slightly more than 4,000 recipients, with a reminder e-mail sent approximately 2 weeks later. In each case the e-mail provided a brief description of the purpose of the survey, including an assurance of anonymity of response and a request to not respond more than once. The e-mail contained a hyperlink to the survey, administered through the SurveyMonkey (Palo Alto, CA) platform.

A maximum of 14 questions were asked on 13 screens. Respondents were able to change responses at any time before survey completion. No additional techniques were used to prevent or detect duplicate or incomplete responses, and internet protocol addresses of respondents were not stored. Final responses were collected for analysis on June 9, 2015.

Objectives

Questions 1 to 3 defined individual respondent demographics according to practice type; level of training, including advanced training/certification in TEE; and annual cardiac anesthesia caseload. Questions 4 to 6 sought to characterize existing practice regarding intraoperative management of patients believed to experience diastolic dysfunction and the proportion of cardiac surgery cases for which intraoperative TEE is used. Questions 7 to 10 characterized existing patterns of intraoperative TEE use to evaluate, quantitatively grade, and manage diastolic function in the pre-cardiopulmonary bypass (CPB) period, and questions 11 and 12 characterized post-CPB use of TEE to evaluate and manage diastolic dysfunction. Finally, questions 13 and 14 asked participants to evaluate and grade diastolic dysfunction on the basis of echocardiographic parameters presented in 2 sample cases sourced from the authors' existing institutional database, providing a pragmatic perspective on potential implications of current variation in the evaluation of diastolic dysfunction in clinical practice.

Statistical Analysis

Data were downloaded from the SurveyMonkey platform as a .csv file and imported into Stata 12 (StataCorp, College Station, TX) for subsequent analysis. Analysis predominantly was descriptive, with counts and proportions provided for responses to each question and then stratified according to practice type, level of training, and caseload to facilitate use of the chi-square statistic or Fisher's exact test. Grading of diastolic dysfunction in the 2 sample patients was further analyzed for an effect of the specific grading algorithm typically used by each respondent. For each survey question, the term "respondents" was used to describe the number of responses to that specific question with data from all available responses included for analysis; p values <0.05 were considered statistically significant.

RESULTS

The survey was completed, in whole or in part, by 515 respondents. A slight majority of respondents (53%) identified their predominant cardiac anesthesia practice as academic or university based, whereas 43% identified their predominant cardiac anesthesia practice as private practice. The great majority of respondents (81%) had completed training with advanced TEE training and certification; annual cardiac anesthesia caseload was reported as >50 for 82% of respondents and >100 for 49% of respondents (Figs 1–3).

Most respondents (86%) reported modifying their intraoperative management strategy always or sometimes if they believed that a patient was experiencing diastolic dysfunction (Table 1), with the nature of any modification frequently varying (72%) according to identified grade of diastolic dysfunction (Table 2). Responses did not vary according to practice type, level of training, or caseload. More than 90% of respondents used intraoperative TEE for $>75\%$ of cardiac patients, with frequency of use appearing lowest in respondents without advanced TEE training/certification and those with an average caseload <25 cases per year (Table 3).

When using intraoperative TEE 62% of respondents specifically evaluated diastolic function in the pre-CPB period in $>75\%$ of patients, with only 23% of respondents evaluating pre-CPB diastolic function in $<25\%$ of patients (Table 4). However, only 59% of respondents typically graded any identified diastolic

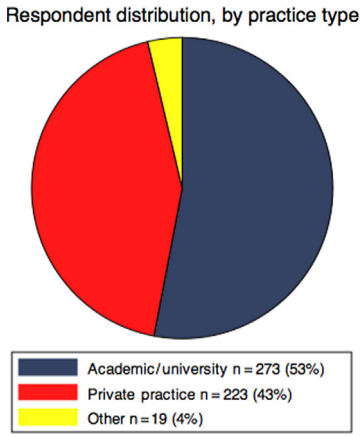

Fig 1. Distribution of respondents according to practice type.