ORIGINAL ARTICLE

Routine Intraoperative Transesophageal Echocardiography: Impact on Intraoperative Surgical Decision Making, a Single Center Interim Analysis

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ABSTRACT

Transesophageal echocardiography (TEE) has become an important part of armamentarium for anesthesiologists in the management of patients undergoing cardiac surgery. Many studies have demonstrated the safety and utility of TEE in cardiac surgery. With advances in hardware and software, easy availability of resources for learning and optimal understanding of image generation and interpretation, many new findings crop up in the operating room (OR) which may have been missed in preoperative transthoracic echocardiography (TTE), leading to necessary changes in planned surgical procedure. In our retrospective analysis of 726 cases in which TEE was performed over the last 1 year, changes in decision was made in 65 (8.9%) of cases. This included 42 unanticipated findings prior to cardiopulmonary bypass and 23 new findings after CPB, requiring revision in 15 cases. With the increasing use and further impending advances of TEE, the number of cases in which surgical decision will be altered may increase in near future.

Keywords: Transesophageal echocardiography, Cardiac surgery, Intraoperative echocardiography.

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INTRODUCTION

Transesophageal echocardiography (TEE) is being used in operation room for more than 2 decades, with numerous published reports regarding its utility and efficacy during the perioperative period.[1-5] Cardiothoracic surgeons rely on intraoperative TEE findings for the planning, execution and evaluation of their surgeries as it allows continuous monitoring throughout the intraoperative period without transgressing the sterile operative field.[6] Guidelines published jointly by American Society of Echocardiography (ASE), American Heart Association (AHA), Society of Cardiovascular Anesthesiologists (SCA) and American College of Cardiology (ACC) have been updated in 2010 to include virtually all adult cardiac surgeries.[7] The earlier studies[8-10] published before the 2010 guidelines, were based on the use of intraoperative TEE were according to category I or IIa indications of 1996 guidelines.[11] We reviewed the impact of routine real-time intraoperative TEE on surgical decision making by retrospectively analyzing the data of our center from January 2012 to December 2012. The present study evaluates the impact of perioperative TEE on surgical decisions.

MATERIALS AND METHODS

In our center, a comprehensive TEE examination (S7-2, X7-2t and S7-3t TEE probes, attached to iE33 Matrix™ Echocardiography system, Philips, Andover, MA) is performed for all open heart surgery planned in patients ≥10 kg, unless there are contraindications or TEE probe is unavailable. Initial comprehensive TEE examinations are performed by cardiac anesthesia fellows trained in TEE and transthoracic echocardiography (TTE) examination. The findings are confirmed by the consultant cardiac anesthesiologist. The data are documented and discussed with the cardiac surgeon and the cardiologist in case of any anticipated change in surgical plan. Similarly, the findings after weaning from cardiopulmonary bypass (CPB) are confirmed and validated by cardiac anesthesia consultant and the need to go on second CPB in case of any residual defect is discussed with cardiologist and cardiac surgeon. For the present analysis, we have defined significant impact on surgical decision making as unanticipated new findings in pre-CPB TEE resulting in change in surgical procedure, significant TEE finding after CPB resulting in any additional procedure or second CPB run and significant findings after sternal closure.

RESULTS

Out of 1,216 patients operated at our center during the year 2012, 739 (60.77%) patients underwent open heart surgery. Intraoperative TEE was performed in 726 patients (98.2%), out of which 505 (69.5%) were male and 221 (30.5%) female. Table 1 presents the preoperative diagnosis as per operative list. There were 42 new pre-CPB TEE findings (6.2%) which altered the surgical management intraoperatively in 38 patients (Table 2), and in the

Table 1: Preoperative diagnosis

Diagnosis	*Total (number, %)*	*Adult (number, %)*	*Pediatric (number, %)*
ACHD	104 (14.3)	42 (40.4)	62 (59.6)
CCHD	117 (16.1)	14 (11.9)	103 (88.1)
CAD	233 (32.1)	233 (100)	—
CAD + VHD	17 (2.3)	17 (100)	—
VHD	223 (30.7)	219 (98.2)	4 (1.8)
Aortic surgery	32 (4.5)	30 (93.7)	2 (6.3)

ACHD: Acyanotic congenital heart disease; CCHD: Cyanotic congenital heart disease; CAD: Coronary artery disease; VHD: Valvular heart disease

Table 2: New findings in TEE examination during the pre-CPB period

Planned surgery	*Preoperative echo*	*Pre-CPB echo*	*Surgical modification*	*No. of cases*
CABG + MVR	Severe MR	Mild MR	MVR not done	6
DVR	Moderate to severe MR	Mild or trivial MR	AVR only	4
MVR	Severe MR	PDA	Ligation of PDA + MVR	2
ICR	TOF	DORV	BD Glenn	2
ICR	TOF	Small LV	Fontan procedure	2
ICR	TOF + ASD	TOF + TAPVC	ICR	1
ASD closure	ASD	ASD + coronary artery fistula	Closure	1
MVR	Severe MR, trivial AR	Moderate AR	DVR	2
MVR + TV repair	Severe MR, severe TR	TR trivial/mild	MVR only	5
MVR	Severe MR	MVP	Repair	3
Bentalls procedure	Bicuspid aortic valve	Tricuspid aortic valve	AVR + aortoplasty	1
AVR + RA clot removal	Periaortic abscess + RA clot	Periaortic abscess, Extrinsic compression of RA abscess, RA clot	AVR	1
AVR	Severe AS	Severe AS + HOCM	AVR + myomectomy	3
Excision of LA myxoma and vegetation	LA myxoma + IE	Myxoma + ruptured chordae	Myxoma exicision + MVR	1
DVR	Severe MR, moderate AR	Mild AR	MVR only	3
CABG	CAD + Mid muscular VSD	Additional large apical VSD + pericardial hematoma	CABG + VSD repair	1
CABG + direct closure of VSD	CAD + 6 mm muscular VSD	CAD + 22 mm VSD	CABG + PTFE patch closure of VSD	1

MVR: Mitral valve replacement; AVR: Aortic valve replacement; DVR: Double valve replacement; CABG: Coronary artery bypass grafting; IE: Infective endocarditis; MR: Mitral regurgitation; AR: Aortic regurgitation; ICR: Intracardiac repair; PDA: Patent ductus arteriosus; TOF: Tetralogy of Fallot; HOCM: Hypertrophied obstructive cardiomyopathy; LA: Left atrium; RA: Right atrium; AS: Aortic stenosis; TAPVC: Total anomalous pulmonary venous connection; DORV: Double outlet right ventricle; PTFE: Polytetrafluoroethylene; MVP: Mitral valve prolapse; BD Glenn: Bidirectional Glenn

remaining four cases surgery was postponed after the TEE examination. In 23 (3.2%) patients residual defect was detected by TEE after CPB (Table 3), and second CPB run was performed in 15 (65.2%) of these patients. Four patients with residual ventricular septal defect (VSD), two patients with gradient across right ventricular outflow tract (RVOT) and two patients with residual patent foramen ovale (PFO) were not subjected to second run of CPB as there was a consensus that the same cannot be corrected due to technical reasons [due to residual apical VSD or left anterior descending (LAD) branch of left coronary artery crossing RVOT]. After the second CPB, TEE did not reveal any significant residual lesion. Thus, intraoperative TEE at any point of time during surgery had resulted in change of surgical plan in 8.95% (65/726) of cases.

Table 3: Post-CPB lesions found in TEE examination

Residual VSD	14
Residual PFO	3
Gradient across RVOT	4
Para valvular leak	2

The unanticipated pre-CPB TEE findings were highest in case of mitral valve pathology [14 out of total 42 new pre-CPB findings (33.3%)]. Similarly new pre-TEE finding due to aortic valve pathology, congenital heart disease and tricuspid valve pathology were 23.8% (10), 14.28% (6) and 11.9% (5) respectively. The probability of getting a new or unpredictable intraoperative TEE finding in congenital heart disease is 2.7% (6/221 congenital cases).

In 84 patients findings in the preoperative TTE needed to be reassessed by TEE before final decision to intervene. In these patients, TEE was used to assist in finalizing the surgery where the operating surgeon had asked for a comment on specific pathology, for example mitral

regurgitation (MR) in cases of coronary artery disease (CAD). These cases were not included as having a significant impact in the analysis irrespective of change in grading of MR, as they were anticipated. Only unanticipated positive findings were included for analysis in this study.

DISCUSSION

Past studies evaluating the impact of intraoperative TEE on surgical decision have found a change in surgical decision range varying from 4 to 31% of cases.[4,12] Eltzschig et al[8] retrospectively analyzed 12,566 patients due for cardiac surgery and found the incidence of 7.0 and 2.2% change in surgical decision based on pre-CPB and post-CPB TEE respectively. Their study population was mostly coronary and valve surgeries and the TEE examination was performed in 35 to 84% of cases. The result would have probably been different in case more patients underwent TEE examination. Similarly, in the study done by Klein et al[9] the planned surgical procedure was changed in 15% of their study population of 2,473 patients. In their case TEE was done in 44% of total cases with 69% predictable and 31% unpredictable change or new findings. The use of TEE was as per the category I and IIa indications of perioperative TEE.[7] In a prospective study of 5,016 patients to evaluate the usefulness of TEE, Mishra et al[10] found 27.13 and 11.65% unsuspected findings in CABG and valve procedures respectively which help to formulate or modify the surgical plan. Majority of the findings were related to either aortic atheromas or regional wall motion abnormalities in CAD patients (>20%). These were not included in the present study, as these are expected in patients with atherosclerotic heart disease and are looked for specifically, hence cannot be termed unanticipated. The incidence of inadequate valve repair was 2.06% in post-CPB TEE of their study, without any further details.

In the present study we found 8.95% incidence of change in surgical plan. The incidence of changed surgical plan after intraoperative TEE was 2.7 % in patients operated for congenital cardiac disease. The main reason for detection of new findings was due to comprehensive TEE done by anesthesiologist who has not reviewed the patient's case reports earlier. Instead of doing the TEE with a pre mindset diagnosis and searching for data just to reconfirm the established pathology or diagnosis, TEE was done with a prefixed sequence to cover almost all standard views, cardiac structures and function. The anesthetic management and monitoring of patient were done by the primary anesthesia fellow posted in that particular operating room (OR), relieving the fellow performing TEE of rest of the duties. TEE provides anatomically more detailed images in comparison to TTE though the latter is extensively used for initial diagnosis and preoperative planning.[13,14]

Over one-fifth (21.5%) of perioperative TEE alterations were related to mitral valve pathology, mostly of regurgitant lesions. There is a decrease in severity of MR under anesthesia, due to systemic vasodilatation and offloading of left ventricle.[14-17] Before commenting on the severity of the MR under anesthesia, steps were taken to restore the preinduction heart rate, and mean arterial blood pressure. Trivial or mild regurgitation was not addressed surgically. Interestingly the postoperative follow-up TTE in intensive care unit did not reveal any residual moderate or severe MR both after extubation and before discharge, thus justifying the intraoperative decision.

We analyzed the causes of 5.8% (42/726) unexpected pre-CPB TEE findings, which may be due to long waiting period for surgery, better imaging in TEE, high case load on TTE clinic and dedicated team for TEE in our OR. Also the most common etiology for valvular heart disease in our population is rheumatic heart disease, where the severity or involvement of valves may change during waiting period. The severity of a stenotic or regurgitant lesion may change during anesthesia, resulting in an unanticipated or new TEE finding. The anesthesiologist who had performed pre-CPB TEE was blinded to the preoperative diagnosis or detailed echocardiography results and had followed a sequence to view and acquire images of all standard views. This resulted in finding of rare diagnoses like patent ductus arteriosus (PDA) in patients with MR, total anomalous pulmonary venous connection (TAPVC) in a patient of Tetralogy of Fallot among others.

The number of pediatric patients (age <14 years) in the analysis was 23.5% (171/726) among whom new unexpected findings were 3.51% (6/171). The incidence of new finding is more in cyanotic congenital heart disease patients 83.3% (5 out of 6). TTE can be better performed in detail in an anesthetized child rather than in awake uncooperative or sedated children, where deeper level of sedations in unmonitored setup are feared, given the nature of complex congenital diseases. Postinduction TTE gave the basic idea and orientation regarding the congenital heart disease, which helped during the performance of TEE in obtaining a rare pathology. To the best of our knowledge this is the first set of data about the unanticipated TEE findings in pediatric cardiac surgery patients.

Complications of TEE in preoperative period like traumatic bleeding, bronchospasm, cardiac arrhythmia, thermal injury, esophageal tear, ulcer or perforation have been reported[18,19] earlier. No complication attributed to TEE was observed by the authors except mild sore throat, which may be due to endotracheal intubation also.

LIMITATIONS

This is an interim report; the results may change during retrospective analysis at a later stage. Also epicardiac imaging is not performed routinely at our center. This could have changed cannulation and cross clamp sites. The fellows were in the learning phase of 3-dimensional (3D) echos and hence whether it would have made a substantial change in the number of new findings remains an unaddressed question. Loss of data due to incomplete documentation or other causes cannot be ruled out, although strict adherence to data collection was made. Expected changes in the diagnosis were not included in the study. This could have added substantial numbers to the present study, making our results comparable with other published literature. The study was not designed to perform a 'cost effectiveness analysis', and hence risk benefit ratio cannot be assessed from this study.

CONCLUSION

Intraoperative TEE resulted in change in surgical plan in 8.95% of cases, by detecting new unanticipated finding during pre- or post-CPB period. We propose TEE for every case of open heart surgery if the facility and expertize is available, irrespective of age or diagnosis, unless contraindicated and TTE before TEE in congenital heart disease. This will reduce the chances of difficult weaning from CPB, prolonged CPB time, postoperative stormy ICU course, morbidity or mortality. This will also decrease the need for second surgery for correction of the unanticipated or residual lesion.

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