

Role of Intraoperative Transesophageal Echocardiography in Cardiac Surgery: an Observational Study

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Abstract

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AIM: This study is based on the hypothesis that the routine use of transesophageal echocardiography in cardiac surgery will influence the surgical decision taken by the surgeon intra-operatively in Kasr-Alainy hospitals.

METHODS: Patients were examined with intraoperative transesophageal echocardiography (TEE) before and after cardiopulmonary bypass. Complete and comprehensive intraoperative TEE examinations will be performed by TEE certified cardiac anesthesiologists. Data that will be collected from the intraoperative examination and will be compared with preoperative transthoracic echocardiography, and the surgical decision that was taken preoperatively will be revised again with the cardiothoracic surgeon before the start of surgery. Also, TEE will be used again after weaning from bypass for revision and assessment of our decision.

RESULTS: We examined the utility of TEE in 100 patients undergoing different types of cardiac procedures in Kasr Al-Ainy hospital. This prospective clinical investigation found that the pre- and post-CPB TEE examinations influenced surgical decision making in 10% of all evaluated patients.

CONCLUSION: Intraoperative TEE has the potential to influence clinical decision making for cardiac surgical patients significantly. It is useful in surgical planning, guiding various hemodynamic interventions, and assessing the immediate results of surgery. Thus, IOTEE should be used routinely in all patients undergoing all types of cardiac surgeries.

Introduction

Transesophageal echocardiography (TEE) is a relatively recent development in imaging. The major innovations in TEE have all occurred since 1970. Early workers had both Doppler and M-mode technology available for use via the oesophageal route, but the most significant development was the rigid, mechanical, two-dimensional, echocardiographic transesophageal endoscopy in 1977 [1], [2].

The establishment of TEE in perioperative cardiac anaesthetic care has resulted in a significant change in the role of the anaesthetist who, using TEE can provide new information which may change the course and the outcome of surgical procedures [3].

The accuracy of perioperative transesophageal echocardiography in the diagnosis of structural abnormalities is quite high, producing results that are reliable and reproducible. The information obtained from TEE influences important therapeutic decisions in valvular surgery, coronary

artery surgery, and thoracic aortic surgery [4].

Advances in intraoperative monitoring techniques aid the cardiovascular surgeon in patient management and, possibly, contribute to improved outcomes. Although the usefulness of TEE in influencing clinical decisions during valvular heart surgery is well documented, the clinical utility of routine TEE in patients undergoing all types of cardiac surgery remains unresolved [5].

Patients and Methods

Population Selection

This study was conducted in Kasr Al-Ainy Hospital, Cairo University in the period from September 2018 to May 2019 after approval from Ethics and research committee of anaesthesia department, faculty of medicine, Cairo University

The study included 100 adult patients with different types of cardiac procedures in Kasr Al-Ainy hospital. The patients were informed, and written consent was obtained. Patients with contraindication to using TEE were excluded from the study as oesophageal pathology including stricture, trauma, active upper GI bleeding or recent upper GI surgery

Our phased array probe is only suitable for adults, and as such, the cases evaluated in this study include adult operations only. The patients were informed before the operation about the procedure with a written, formatted paper and consent was taken only after questioning regarding swallowing difficulty and other oesophageal abnormalities the patient may have experienced.

Echocardiography

All studies were performed with a TEE probe (ATL, HDI 5000, CV, and Bothell, WA) which is a 5 MHz phased array multiplane transducer that permits Doppler Color Flow imaging either with pulsed or continuous wave facilities. Complete and comprehensive intraoperative TEE examinations were performed by TEE certified cardiac anesthesiologists. Results of the examinations were discussed with the attending cardiac surgeon. Data that was collected from the intraoperative examination was compared with preoperative transthoracic echocardiography, and the surgical decision that was taken preoperative was revised again with the cardiothoracic surgeon before the start of surgery. Also, TEE was used again after weaning from bypass for revision and assessment of our decision.

Standard images of all patients included a long-axis view of the left atrium, left ventricle and the mitral and aortic valves; a transgastric short-axis view of the left ventricle at the papillary muscle level; a four-chamber view visualizing the two atrioventricular valves and all four chambers; and an interatrial septal view.

Some images were taken as warranted by clinical circumstances. Doppler colour imaging was performed using enhanced maps with an optimal Doppler signal obtained by angulation of the transducer tip to interrogate blood flow in multiple planes in all views.

Left ventricular function was evaluated by comparison of transgastric short-axis imaging at the midpapillary level and midesophageal 2-chamber or 4-chamber images before bypass and at the end of the operation. Decreased segmental wall motion or a global decrease in contractility was defined as a decreased ventricular function.

Valve function was assessed by comparison of pre- and final post-bypass images. Cusp mobility and morphology were evaluated by two-dimensional echocardiography before use of Doppler colour flow

imaging. Valve insufficiency was graded as first, second, third- and fourth-degree insufficiency, with first-degree insufficiency representing mild and second- and third-degree insufficiencies defining moderate, and finally, fourth-degree insufficiency describing severe regurgitant flow.

Results

This study showed that out of 100 TEE examinations, there was 56 females (56%) and 44 males (44%). Age ranges between 15 and 50.

Out of 100 patients 25 cases (25%) were mitral valve operations, 35 cases (35%) were aortic valve operations, 9 cases (9%) were tricuspid valve operations, 5 cases (5%) were VSD operations, 6 cases were ASD operations, 20 cases (20%) were CABG operations.

Table 1: Different types of operations done and their percentages

Operation	Count	Percentage
Mitral	25	25.0%
Aortic	35	35.0%
Tricuspid	9	9.0%
VSD	5	5.0%
ASD	6	6.0%
CABG	20	20.0%

Results of our study showed that there were changes in findings between pre-operative transthoracic echocardiography and intra-operative transesophageal echocardiography in the mitral valve, aortic valve and tricuspid valve. Also, there was a change in the surgical decision by the post bypass transesophageal echocardiography in 2 mitral valve operations.

Table 2: Differences between findings of pre-operative TTE and findings of intra & post-operative TEE

	Preoperative transthoracic echo		TEE		
	Count	Percentage	Count	Percentage	
Mitral	Normal	73	73.0%	65	65.0%
	Abnormal	27	27.0%	35	35.0%
Aortic valve	Normal	62	62.0%	59	59.0%
	Abnormal	38	38.0%	41	41.0%
Tricuspid	Normal	91	91.0%	87	87.0%
	Abnormal	9	9.0%	13	13.0%
Septal Abn.	Normal	80	80.0%	80	80.0%
	Abnormal	20	20.0%	20	20.0%
Aorta	Normal	88	88.0%	88	88.0%
	Abnormal	12	12.0%	12	12.0%
RWMA	Normal	75	75.0%	78	78.0%
	Abnormal	25	25.0%	22	22%

Pre-pump events

Out of 100 TEE examinations, there were only 8 cases that the surgical decision was changed in them, 4 were females, and 4 were males. Thirty percent of the altered surgical management involved the mitral valve, and 40% involved the tricuspid valve, and 10% involved the aortic valve.

Post-pump events

The post-CPB IOTEE revealed unexpected findings requiring immediate surgical correction in 2 patients following mitral valve repair where one case showed a severe paravalvular leak and the second case showed the systolic anterior motion of mitral valve with a high-pressure gradient across the left ventricular outlet.

Aortic valve

Of the 35 cases undergoing aortic valve replacement, One of the cases in which TEE changed the surgical decision intra-operatively was 30 years old female patient, her pre-operative trans-thoracic echocardiography showed severe aortic stenosis with pressure gradient = 80 mmHg, while intra-operative TEE showed subaortic membrane and the valve was normal, so the decision was the only removal of the membrane, and the pressure gradient became 15 mmHg.

Mitral valve

Of the 25 cases undergoing mitral valve surgery, 20 cases were assigned for mitral valve replacement, and 5 for mitral valve repair. One of the cases that were assigned for repair showed severe calcification of subvalvular apparatus, so, the surgical decision was changed for mitral valve replacement. Two of the cases that were assigned for coronary artery bypass grafting showed severe ischemic mitral regurgitation that required mitral valve repair in addition to coronary revascularization.

Tricuspid valve

The surgical decision was changed in 4 cases where the preoperative echo showed mild tricuspid regurg and the pre bypass IOTEE showed severe tricuspid regurg that required tricuspid valve repair.

CPB-Weaning

An example for medical decision change in a male patient 45 years old, his post bypass TEE examination showed poor RV contractility and elevated pulmonary artery pressure, so the decision was to add milrinone (primacor) to improve contractility of the right ventricle.

Discussion

Our prospective study showed that routine use of intraoperative TEE in patients undergoing

cardiac surgery revealed new cardiac pathology in 20% of patients is in concordance with previous clinical observations. The new TEE information altered surgical management in 10% of patients. 50% of the altered surgical management involved the mitral valve, and 40% involved the tricuspid valve, and 10% involved the aortic valve. The pre bypass IOTEE affected the surgical decision in 8 of our cases while the post bypass IOTEE affected 2 of our cases.

The finding that new intraoperative TEE information altered surgical management in 25% of patients is the highest percentage reported to date. Although the clinical study by Savage et al., [6] published in 1997 reported altered surgical management in 33% of patients, this relatively small (82 patients) study evaluated only "high-risk" patients undergoing isolated myocardial revascularisation.

The pre-CPB TEE examination allows the cardiac surgeon to confirm the preoperative indication for surgery, and therefore to avoid an unnecessary intervention with its associated morbidity. Newly recognised pathologic findings can change the planned procedure, and avoid an additional surgical procedure in the future. This wide range of new findings reported in the literature (10-40%) reflects the great variation in study design and patient populations evaluated (retrospective/prospective, CABG surgery only, valve surgery only, mixed, etc.). Similarly, in literature, the new intraoperative TEE information altered surgical management in a wide range of patients by 5-33%. Also, the most frequent pre-CPB finding was either undetected valve dysfunction or a change in the preoperatively diagnosed valve pathology [7].

In a small series of 75 patients, Bergquist et al. analysed the impact of IOTEE on intraoperative anaesthetic management during routine CABG. They found that 17% of intraoperative clinical interventions (such as the need for fluid boluses, need for vasopressors or dilators) were influenced predominately by the IOTEE although its contribution to surgical interventions was only 3% [8]. Mishra et al., in a large IOTEE series, reported a subset of patients having only CABG surgery. In this nonconsecutive series with IOTEE based on probe availability and high-risk, IOTEE impacted on the surgical plan in 27% of patients [9]. According to Rosenhek et al., over one-fifth (21.5%) of perioperative TEE alterations were related to mitral valve pathology, mostly of regurgitant lesions. There is a decrease in the severity of MR under anaesthesia, due to systemic vasodilatation and offloading of the left ventricle. Before commenting on the severity of the MR under anaesthesia, steps were taken to restore the preinduction heart rate and mean arterial blood pressure, but this study was performed on patients undergoing valve surgeries only [10].

Tasoglu I et al. performed a study on a large group of patients (466) that undergone different heart surgery types. TEE examinations performed before

and after the cardiopulmonary bypass influenced surgical decisions by 14.8% and 9.0% respectively, that was a relatively high percentage, especially when we know that the new findings in intraoperative TEE regarding the mitral valve, for example, were 77 cases (60.6%) [11]. The use of post-CPB TEE imaging to evaluate surgical results is very important. The post-CPB TEE examination can provide a direct and immediate assessment of the surgical procedure, and therefore can expedite the decision to return to CPB when necessary. In recently published prospective studies, the incidence of new post-CPB findings that prompted a second CPB run was 2-6% [12].

In our study, immediate surgical correction was required in 2%, a case of severing MR for MVR, operated and a new finding by post-CPB examination was suture dehiscence resulting in hemodynamic instability. Another case of mitral valve repair showed post bypass systolic anterior motion of mitral valve with a significant gradient across the left ventricular outlet and the surgical decision was to replace the mitral valve with a mechanical bileaflet valve.

Some of the previously published studies assessing the use of TEE in cardiac surgical patients have detailed how information from TEE simplified/alterd hemodynamic management. There is no doubt that TEE provides valuable information regarding myocardial contractility and preload, thus clarifying the proper treatment of hemodynamic instability. The authors chose to focus solely on how TEE affected surgical management, realising that essentially, all patients undergoing cardiac surgery have their hemodynamic management altered via information obtained from TEE [6].

Minhaj et al. is the first study to assess the effect of routine intraoperative TEE in a patient population that includes OPCAB. In this study, intraoperative TEE information influenced decisions regarding use/nonuse of CPB in 8 patients (3%). Such decisions (use/nonuse of CPB) should be made only after thoughtful contemplation of the risks and benefits of each approach (on the pump or off-pump) in each particular patient. Because of the well-known risks of initiating CPB (neurologic dysfunction, renal dysfunction, pulmonary dysfunction, hematologic abnormalities), such decisions also may profoundly affect patient outcome. With the increased use of OPCAB by cardiac surgeons (20% of the present patient population was scheduled for OPCAB), the importance of intraoperative TEE information in guiding surgical management and perhaps influencing the patient outcome may play an even greater role shortly [7].

Limitations in our study; the number of cases was small due to the short time of the study. Despite operating in a large facility, our study had a shortage of information about CABG patients as TEE is not used as much as in valvular heart diseases.

In conclusion, intraoperative TEE has the

potential to influence clinical decision making for cardiac surgical patients significantly. It is useful in surgical planning, guiding various hemodynamic interventions, and assessing the immediate results of surgery. Thus, IOTEE should be used routinely in all patients undergoing all types of cardiac/aortic surgery. It is generally believed that the use of TEE in "higher-risk" populations will yield a higher incidence of new findings.

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