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Araştırma

Transesophageal Echocardiography: Sine Qua Non in Cardiac Surgery

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ABSTRACT

Objective: *Intraoperative transoesophageal echocardiography (TEE) performed during cardiac surgery provides information about the cardiac pathology and the surgical repair. The aim of this study is to determine the importance of TEE in surgical decision making phase in patients undergoing cardiac surgery.*

Material and Method: *We reviewed the data for all patients who underwent cardiac surgery and TEE between January 2015 and December 2016. Intraoperative TEE examination was performed before and after the cardiopulmonary bypass (CPB). The data collected related to the type of surgery, preoperative echocardiographic findings, TEE findings before and after CPB and any differences between them were evaluated.*

Results: *A total of 284 patients who underwent cardiac surgery during 2 years period were evaluated using TEE. The initial TEE findings of 15.8% (n=45) of the patients differed from those observed before cardiopulmonary bypass (CPB). The results of the TEE assessments before and after CPB affected surgical decision-making in 3.5% (n=10) and 2.5% (n=8) of the cases, respectively*

Conclusion: *Perioperative TEE performed by the anesthesiologist can provide important information, may lead to alterations in the surgical strategy and improve the operative outcomes.*

Keywords: *transesophageal echocardiography, cardiac anesthesia, cardiac surgery*

ÖZ

Transözefageal Ekokardiyografi: Kardiyak Cerrahide Olmazsa Olmaz

Amaç: *Kardiyak cerrahi sırasında intraoperatif transözefageal ekokardiyografi (TÖE) kardiyak patoloji ve cerrahi onarım hakkında bilgiler verir. Bu çalışmanın amacı, kardiyak cerrahi uygulanan hastalarda cerrahi karar aşamasında TÖE'nin önemini belirlemektir.*

Gereç ve Yöntem: *Ocak 2015 ile Aralık 2016 tarihleri arasında TÖE ile kardiyak cerrahi olan hastaların verileri gözden geçirildi. Kardiyopulmoner baypas öncesi ve sonrası intraoperatif TÖE değerlendirmesi yapıldı. Cerrahinin tipi, ameliyat öncesi ekokardiyografi bulguları, kardiyopulmoner baypas öncesi ve sonrası TÖE bulguları ve aralarında oluşan farklılıklar değerlendirildi.*

Bulgular: *İki yıllık periyotta kalp cerrahisi uygulanan toplam 284 hasta TÖE kullanılarak değerlendirildi. Hastaların %15.8 (n=45)'inde TÖE bulguları kardiyopulmoner baypas öncesi ekokardiyografi bulgular ile farklılık gösteriyordu. TÖE değerlendirme bulguları ile KPB öncesi ve sonrası cerrahi karar verme sırasıyla %3.5 (n=10) ve %2.5 (n=8) oranında etkilenmekteydi.*

Sonuç: *Anestezist tarafından yapılan perioperatif TÖE cerrahi işlemler hakkında önemli bilgiler sağlayabilir, cerrahi işlemlerde değişikliğe neden olabilir ve erken cerrahi sonuçların başarısına katkı sağlayabilir.*

Anahtar kelimeler: *transözefageal ekokardiyografi, kardiyak anestezi, kardiyak cerrahi*

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INTRODUCTION

Intraoperative transesophageal echocardiography (TEE) has been used since 1980s [1] and has become a standard technique with continuously expanding applications in cardiac surgery. The European Association of Cardiothoracic Anaesthesiologists (EACTA), the European Society of Cardiologists (ESC), the Society of Cardiovascular Anesthesiologists (SCA) and the American Society of Echocardiography (ASE) recommend use of TEE in all adult patients undergoing cardiac surgery [2,3].

Transesophageal echocardiography enables anesthesiologists to determine the functional anatomy and pathology of the heart and monitor the hemodynamics of the cardiovascular system [4]. It can help to identify previously undiagnosed pathology and lesions or residual defects after surgical intervention [1]. Direct and rapid visualization of the heart via TEE improves the quality of surgical decision-making [4] and allows for an immediate correction if necessary. It is also an indispensable tool during minimally invasive cardiac surgery. The aim of this study is to determine the importance of TEE for surgical decision-making in patients undergoing cardiac surgery, and to evaluate the clinical usefulness of TEE.

MATERIAL and METHODS

After approval of the Ethical Board of University, we reviewed the data of patients who underwent cardiac surgery between January 2015 and December 2016 and who were monitored via TEE by the same anesthesiologist.

The TEE (Siemens Acuson Sequoia 512 echocardiography; Siemens Healthcare, Norwood, MA, USA) probe (5 MHz phased array multiplane transducer) was inserted after endotracheal intubation and removed before skin closure. Intraoperative TEE views and measurements were obtained in all patients according to recent guidelines [2,3]. TEE views were examined and recorded before cardiopulmonary bypass (CPB) surgery, and compared with preoperative Transthoracic Echocardiography (TTE) results. Left ventricular wall motion, valve function, and the great vessels were examined, and vessel cannulation was guided with TEE during minimally invasive procedures. TEE views were also examined after CPB before decannulation end reversal of anticoagulation. Patients with normal TEE findings were decanulated, and the operations were completed. All examinations were discussed with the surgeon.

Patient demographics, type of surgery, preoperative echocardiographic diagnosis, and TEE findings before and after CPB and the differences among them were collected and recorded. The TEE views were recorded to the DVDs and external hard discs.

Protective sheath was used for the TEE probe and probe was washed, disinfected with solutions after all procedures.

RESULTS

Cardiac surgeries were performed in 390 patients between January 2015 and December 2016 in our hospital and intraoperative TEE was performed in 284 of these patients (mean age, 57.6±13 years; 190 [66.9%] males and 94 [33.1%] females) (Table 1). Any contraindications to probe insertion were encountered for any patient. No failed insertions or complications related to manipulation of the TEE probe were observed in any patient.

Table 1. Surgeries.

	n=284	% 100
Isolated coronary artery by-pass graft surgery	133	46.83
Robotic surgery	39	13.73
Aortic valve replacement	16	5.63
Mitral valve repair or replacement	13	4.58
Ascending aortic replacement	9	3.17
Miscellaneous (double or triple valve repair/replacement, valve+ coronary artery bypass graft, Benthall/David procedures, valve+ascending aortic surgeries, etc.)	74	26.06

The initial TEE views of 15.8% (n=45) of the patients differed from their preoperative TTE results (Table 2). Valve regurgitation and a patent foramen ovale (PFO) were frequently observed intraoperatively but not mentioned in the preoperative TTE reports. The new pre-CPB TEE findings led to a change in surgical management in 3.5% of the patients (n=10) (Table 3).

Table 2. New findings that differed from preoperative transthoracic echocardiography.

	n (of 45)	15.85 %
Patent foramen ovale	11	3.87
Ascending aorta atherosclerotic plaque	7	2.46
Pleural effusion	5	1.76
Atrial thrombus/mass	3	1.06
Mitral regurgitation	11	3.87
Tricuspid regurgitation	3	1.06
Aortic regurgitation	1	0.35
Mitral and tricuspid regurgitation	3	1.06
Bicuspid aortic valve	1	0.35

Table 3. Surgical procedures due to new pre-cardiopulmonary bypass transesophageal echocardiography findings.

	n = 10	3.52 %
Atrial mass resection/thrombectomy	3	1.06
Patent foramen ovale closure	4	1.40
Mitral repair, ring annuloplasty	2	0.70
Ascending aorta graft replacement	1	0.35

Table 4. Surgical procedures because of new post-cardiopulmonary bypass transesophageal echocardiography findings.

	n=8	2.8 %
CABG after AVR	1	0,35
TVR after Tricuspid valve repair	4	1,40
MVR after Mitral valve repair	1	0,35
AVR after Aortic valve repair	2	0,70

CABG, coronary artery bypass graft; AVR, aortic valve replacement; TVR, tricuspid valve replacement; MVR, mitral valve replacement

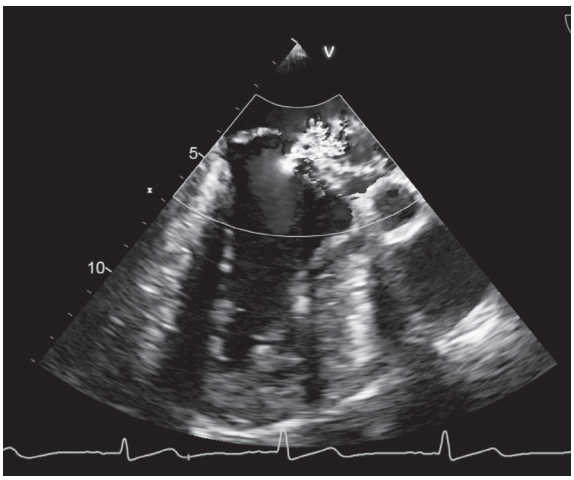

Figure 1.

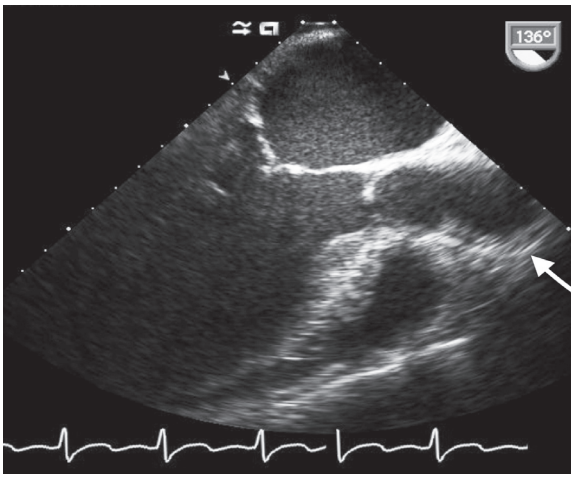

Figure 2.

In other words, 10 of the 45 patients (22%) had additional surgical procedures that were identified using intraoperative TEE.

Four of these 10 patients were initially sheduled for isolated CABG surgery. Severe degenerative mitral valve (MV) regurgitation was detected in two of the four patients. (Figure 1.) Downsizing ring annuloplasty was performed in two patients in addition to CABG. Ascending aortic graft replacement was performed in the third patient and the atherosclerotic plaque was greater than 5 mm (Figure 2). A left atrial thrombectomy was performed after detecting a left atrial thrombus in the fourth patient.

In two patients TEE detected atrial thrombus/mass in the left or right atrium. One of them was scheduled for double valve replacement (mitral [MVR] and aortic [AVR] valve replacement) and the other patient scheduled for pericardial tamponade surgery underwent resection of the right atrial mass observed on TEE.

Eleven patients had intraoperatively detected PFO that were surgically occluded during valve surgery in 4 patients. However, we did not perform an atriotomy to close the PFO in the other seven patients who were undergoing coronary artery bypass graft (CABG) surgery.

Five patients had pleural effusion that was not mentioned in the previous TTE reports but was easily identified with intraoperative TEE.

Valve regurgitation was found in 18 patients not mentioned in the preoperative TTE reports. The regurgi-

tation was severe enough to require MV ring annuloplasty in 2 of the 18 patients. The others had mild regurgitation. One patient had a tricuspid AV but was diagnosed with a bicuspid AV and a frenulum, which was easily identified with TEE.

After CPB before decannulation and reversal of anticoagulation, we analyzed the cardiac function and anatomy with TEE. We detected that, valve repair procedures were incomplete in seven patients, leading to tricuspid valve replacement in four, MVR in two, and AVR in one patient (Table 4). Anterior and anteroseptal akinesis of the left ventricle was detected by TEE in an additional patient undergoing AVR after CPB. This patient received a bypass graft to the left anterior descending artery (LAD) (Table 4).

After CPB, the TEE results only affected surgical decision-making for the valve procedures, as no coronary greft revision were required for any of the isolated CABG surgeries.

Thirty-nine patients underwent robotic cardiac procedures. They had peripheral CPB cannulation from the superior or inferior vena cava and the femoral artery. Venous cannulas were placed in the right atrium or one to the vena cava depending on the surgical procedure, and a mid-esophageal 90° bicaval view was obtained. The positions of all cannulas were guided by TEE, and no complications were observed.

In all patients we used TEE for the hemodynamic monitorization especially of the volume therapy after the KPB.

As a result, we changed our surgical strategy in 18 (6.3%) patients based on the perioperative TEE findings in overall. All patients were weaned from CPB without any difficulty.

DISCUSSION

Transesophageal echocardiography enables anesthesiologists to perform perioperative hemodynamic and functional monitoring of the cardiovascular system. TEE has become indispensable for intraoperative management of cardiac patients, as anesthesiologists use it to evaluate cardiac function during surgery. Obtaining heart functions allows the surgeon to correct inadequate repairs and treat surgical complications before the patient leaves the operating room, which reduces the number of reoperations.

In our study, 45 (15.8%) patients had findings that differed from those found on preoperative TTE. Most of them were mild valve regurgitation, atherosclerotic plaque in the aorta, or PFO.

Transesophageal echocardiography is sensitive to the detection of atheromatous plaque in the aorta. However, it is limited by an inability to visualise the distal ascending aorta and proximal aortic arch because of the acoustic shadow of the trachea or left bronchus. Sharony et al. [5] reported 913 (15.9%) patients with severe atheromatosis in the arcus or ascending aorta among 5,737 patients undergoing CABG. Of these, 211 underwent off-pump surgery related to atheromatosis detected by TEE. In our study, seven (2.5%) patients had atheromatosis in the ascending aorta. Only one had an ascending aortic replacement who was scheduled for CABG preoperatively.

The usefulness of intraoperative TEE has been reported; however, routine use of TEE, particularly for low-risk patients undergoing CABG, is controversial. Holger et al. [1] reported a large series in which de novo pre-CPB TEE findings affected surgical decision-making in 5.4% of the cases. In our study, four (1.4%) patients preoperatively scheduled for isolated CABG had previously undergone additional surgery determined by TEE. Two patients underwent mitral ring annuloplasty, one an ascending aortic graft replacement, and the other one an atrial thrombus resection.

Post-CPB TEE can be used to assess a surgical intervention. New findings in eight patients (2.8%) in our study that were diagnosed post-CPB led to reinstitution of CPB for a surgical correction. Holger et al. [1] reported that 2.2% of the vcases had new findings diagnosed post-CPB that led to reinstitution of CPB for a surgical correction, whereas Qaddoura et al. [6] reported a rate of 2%, and Buck et al. [7] reported a rate of 6.3% for repeat CPB.

Transesophageal echocardiography is very sensitive for evaluating valves, diagnosing the mechanism and quantifying the degree of dysfunction. We encoun-

tered nine (3.1%) patients who required a valve intervention, and severe regurgitations were detected in pre-CPB (n=2) and post-CPB TEEs (n=7).

Transesophageal echocardiography is also very sensitive for detecting post-CPB regional wall motion abnormalities associated with possible graft kinking or occlusion. Myocardial ischemia can be detected and localised in less than one minute after the onset of inadequate perfusion. The transgastric short axis papillary muscle level view can be used to localize the ischemic area prematurely, because the area perfused by three main coronary arteries can be seen at that level in one view [8]. In addition, air can be monitored during weaning from CPB in patients undergoing intracavitary surgery. Wall motion and valve function can be examined post-CPB. Segmental wall changes or arrhythmias can occur with air in the coronary arteries and worsening of the oxygen delivery-consumption ratio. We did not encounter any wall motion abnormality or coronary bypass graft revision in patients who underwent isolated CABG surgery. We detected only one patient with a wall motion abnormality after CPB who underwent AVR. The patient was hypotensive during the post-CPB period. The mechanical AV was functioning normally when we checked valve function and wall motion with TEE, and no air bubbles were seen in the aorta or cardiac cavity. However, akinesia of the anterior and anteroseptal walls was detected along with ECG changes, and particle embolisation into the LAD was suspected. CPB was reinstituted, and the LAD was revascularised. The patient's hemodynamics and wall motion abnormalities returned to normal, and CPB was terminated without difficulty.

Overall, 18 (6.5%) patients had surgical changes related to new perioperative TEE findings.

All new pre-CPB and post-CPB TEE findings were validated by the team, which avoided unnecessary interventions that could have contributed to morbidity. However, some new findings changed the procedure, which may have improved patient outcomes.

Nowadays 3D echocardiography has advantage for detecting the pathology especially on the valve procedures. Besides, this advantage of 3D TEE, 2D TEE must be learned very well. To have a good 3D views we need to have good 2D views because echocardiography machine combined different 2D views together to construct 3D views.

Transesophageal echocardiography is a safe method with a morbidity rate of 0.2%, particularly for airway trauma and indirect effects [9]. We did not detect any complications related to TEE.

CONCLUSION

Intraoperative TEE was useful for surgical planning and monitoring hemodynamic variations, as it provides valuable information to help reduce surgical complications, improve patient outcomes, and avoid additional surgical procedures. TEE should be used routinely in all patients undergoing cardiac or aortic procedures that have no contraindications for inserting the probe.

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