INTRAOPERATIVE TRANSOSEPHAGEAL ECHOCARDIOGRAPHY IN VALVE REPLACEMENT SURGERY: OUR EXPERIENCE

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Transosephageal echocardiography (TEE) is applied widely during heart valve replacement surgery (1). The first successful demonstration of the use of the esophageal window for echocardiography was reported in 1976 (2). The esophageal echocardiography has provided an airless pathway especially in patients with chronic obstructive pulmonary disease, which yield interpretable echocardiographic windows and concluded as a safe diagnostic procedure (2). Transosephageal echocardiography (TEE) showed a huge improvement that, it became one of the essential diagnostic procedures for the valvular disease and valvular surgery (3-8). It has become the standard of care for evaluating the reparative or curative replacement valvular surgical procedures, thus providing an immediate gauge of the surgical results and helping to avoid suboptimal surgical results (8). From that time starting with the cardiology specialists, today TEE is performed perioperatively either cardiology or anesthesiology specialists or both of them according to the guidelines (9-12).
Our aim is to report our TEE guided perioperative valvular surgical results in the light of the literature.

Key Words: Transosephageal echocardiography, open heart surgery, valvular disease

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METHOD

This study was conducted between September 2003-November 2004 in our cardiovascular surgery department. The emergent cases, neurological, endocrinological and cases with renal pathologies, the ones who has this valvular surgery at the postoperative period and off-pump surgical patients were excluded from this study.

We included 39 patients from Mediterrian region of Turkey in this study, who were diagnosed for the valve replacement surgery with utilizing cardiopulmonary bypass open-heart surgery (n: 20, 52 % male). All patients' demographics were recorded and given in table 1.

The etiology of the valve lesions was rheumatic heart disease (9 case for aortic and 17 case for mitral valve, total 26%), prolapse of the valve (3 cases for mitral valve, 3%), endocarditis (4 cases for aortic valve and 3 cases for mitral valve, total 17%) and congenital heart defect (1 case with both primum type atrial and ventricular septal defect with a cleft mitral, 2%).

Anesthesia and Cardiopulmonary Bypass Procedure

All patients were received 5 mg of Diazepam 35 min preoperatively (Diazem® DEVA Drug Comp) and after 2 mg/kg Propofol (Propofol® Fresenius Kabi Deutschland Gmbh) for anesthesia induction and 10-25 µg/kg Fentanyl Citrate (Fentanyl Citrate® Abbott Lab), 0.1-mg/kg vecuronium (Norcuron® N.V.Organon) were injected for muscle relaxation. After these medications all the patients were intubated. All patients were started 1-4 µg/kg/hour Fentanyl citrate intravenously and 1-3 MAC Sevofluorane(Sevorane® Abbott Lab.) with 60/40 % oxygen via oxygen tube for the anesthesia.

All hemodynamics was recorded during the surgical procedure by inserting a Swan-Ganz catheter to right internal jugular vein (7f-110H, Edwards Lifesciences LLC, Irvine, CA 9264-5686 USA). Pulmonary artery and pulmonary wedge pressure measurements were obtained. Inserting the probe of the noninvasive cardiac output machine (NICO 7300, Novametrix Medical Systems Inc. Wallingford, CT, 064492 USA) to the endotracheal tube, we measured the cardiac output (CO), stroke volume (SV), pulmonary vascular resistance (PVR) and systemic vascular resistance (SVR) after starting the cardiopulmonary bypass pump (CPB) in the first 20 minutes of the surgical procedure. The CO and SV were indexed according to the body surface area (BSA).

The body temperature was monitored before and after the CPB via a thermal probe (Hewlett-Packard Viridia) both placed into the esophagus and urinary bladder and the temperature was tried to keep at 32 ºC during the valvular surgical procedure. All patients were anticoagulated with 300 IU/kg Heparin (Nevparin® Mustafa Nevzat Drug Comp) 5 min before the CPB and the adequacy of the anticoagulation were detected from the arterial blood by activated clotting time (ACT)(Hemochron 1000 USA), which the ACT level were tried to be kept above 450 sec with additional heparin dose administration. All patients' anticoagulation was reversed with

Protamin Sulphate with a dose of 3 IU/kg (Protamin® Abbott Lab) after the CPB. All patients were utilized the same perfusion pump (Stockert, SHRP 1010), membrane oxygenator and circulation lines. Sodium chlorur with 20 mL/kg (0.9 % Mediflex® Eczacıbaşı-Baxter), mannitol with 1.5 mL/kg (20 % Mannitol® Eczacıbaşı-Baxter), 30 mEq sodium bicarbonate (Sodium bicarbonate® Galen Drug Comp) and 8 mg Dexametason (Deksamet® Biosel Drug Comp) were put into the starting solution and the flow was titrated with 2.4 L/min for each kg/m2, trying to keep the mean arterial pressure at 60-80 mmHg.

We utilized +4 ºC St.Thomas II solution (Plejisol® Abbott Lab), with 16-mEq/L potassium and 20-mEq/L bicarbonate, which were added to this cardioplegic solution and start to infuse from the aortic root with a dose of 10-12 mL/kg and a pressure of 80-100 mmHg. Sodium chlorur (0.9 %) at +4ºC were used for the topical cooling at the same time. After this, we put 3.6 mEq/L potassium and 100 mL Plejisol into the 300 mL blood drawn from the CPB pump and infuse this cold blood cardioplegic solution into the aortic root or coronary sinus catheter. The warm blood (+36 ºC) was then infused antegradely before opening the aortic cross-clamp.

Transthoracic and Transosephageal Echocardiographic Procedures

Transthoracic echocardiographic (TTE) studies were performed with a System Five instrument (GE Vingmed Sound, Horten, Norway) utilizing a phased array duplex 2.5 MHz transducer. Aortic root and left atrium diameter was measured by two-dimensional echocardiographic images of the left ventricular parasternal long-axis view according to the American Society of Echocardiography guidelines (13). All TEE procedures were performed utilizing 5 MHZ TEE probe and System V echocardiography machine (GE Horton, Norway). We utilize TEE as a routine perioperative diagnostic procedure for every open-heart valve surgical procedure in our hospital. Our perioperative TEE method was described elsewhere before (1). Transthoracic echocardiograms and cardiac catheterizations were performed to all patients before their surgical procedures. All TTE were assessed three times by two different cardiology specialists. The left ventricular ejection fraction and fractional shortening, left ventricular mass were measured utilizing both the Teicholz and the Simpson method with the program provided by our echocardiography machine and reported as the mathematical average of these measurements.

RESULTS

The statistical comparison of male and females in our surgical group showed that both groups are statistically identical in terms of age, sex and BSA (Table 1) .

Table 1. Demographic characteristics of the valvular surgical patients

Parameters	Male	Female	P
AGE (Year)	50.75±18.56	49.66±17.99	>0.05
SEX	20 (52%)	19 (48%)	>0.05
BODY SURFACE AREA (Kg/m2)	1.73±0.17	1.66±0.14	>0.05

When we include both men and women in one group, the average age was 50.75±18.56 years, and BSA was 1.73±0.17 m2. The interobserver and intraobserver reproducibility of the echocardiographic measurements were 70 %. The intra and interobserver variability were 7 and 8 % for the echocardiographic assessment. The average left ventricular mass was 144.18±29.48 grams. The average left ventricular internal diastolic diameter was 51.12±6.72 mm and systolic diameter was 33.31±7.34 mm. The enddiastolic and endsystolic volumes were measured as 127.75±41.62 mL and 48.5±23.32 mL, respectively. The left ventricular ejection fraction, fractional shortening, aortic root diameter and left atrial diameter were measured as 53.75±6.95, 33.62±5.42, 32.62±6.2 and 43.06±10.09, respectively. Spontaneous echo contrast, mostly known as SEK was found positive in 4 cases that were waiting for the mitral valve surgery. Except one case, which the left ventricular ejection fraction was found as 50%, the other three cases ejection fractions' were calculated as 58%, 62% and 60%. Left ventricular segmental wall motion abnormality was found in 11 (29%) cases but all these abnormalities didn't adversely affect the left ventricular systolic performance. Left ventricular diastolic dysfunction was found in 25 (67%) cases and 2 (5%) cases were excluded from this statistical analysis because of the atrial fibrillation. Left ventricular diastolic dysfunction is a common finding in both men and women. Mitral valve replacement was performed in 16 cases (41%). Aortic valve replacement was performed in 9 cases (24%). The coronary artery bypass surgery was performed to 9 cases (24%), and shunt closure to 2 cases were performed (5%) as an additional procedure to valve replacement. De-Vega annuloplasty operation was performed to 2 cases (5%) besides valve replacement.

Intraoperative TEE evaluation was made by multiplane two-dimensional echocardiography; color Doppler and pulse wave Doppler after CPB before sternum closure. Perivalvular leakage was detected in 2 (5%) prosthetic valve cases. One of the St Jude bileaflet cases' perivalvular leakage was originated between the two suture lines and assessed after the CPB. During the open-heart surgery the heart was stopped and after starting the CPB, the perivalvular leakage was sutured again. The second TEE assessment of this valve demonstrated no perivalvular leakages. One of the St Jude bileaflet cases' perivalvular leakages was originated where the suture needle passed the myocardium. The TEE demonstrated that the needle itself caused the perivalvular leakage. Again utilizing the same method the perivalvular leakage was resutured and no residual perivalvular leakage was detected with TEE after the CPB.

The SVR and PVR were found as 1479.4±777.83 and 150.66±103.96 dyn.sec/cm5, respectively. The CI was calculated as 2.17±0.71 mL/min/m2, the SI was calculated as 22.33±7.4 mL/beat/m2.

The total CPB and cross-clamp time were found as 104.6±50.87 and 66±32.66 minutes.

DISCUSSION

We have found that intraoperative transosephageal echocardiography is a useful clinical diagnostic tool and applied widely during heart valve replacement surgery. It is used to formulate the surgical plan, assess cardiac function and evaluate the surgical outcome (1, 14). Although it is reported that the alteration rate of the surgical procedure by utilizing the intraoperative TEE during the surgical procedure was 0.3%, we have found a 2.5% alteration rate very comparable to the literature (14). This discrepancy may be due to the TEE probe technology that we utilize a multiplane TEE probe while the other group was utilized a biplane TEE probe (14). After assessing the mitral regurgitant jet size, the effective orifice area, the regurgitant volume and fraction and the subvalvular structures, while the surgeon was opened the left atrium, he decided to replace the mitral valve for this one case rather than reconstruction (2.5%) which the alteration rate with TEE in our intraoperative TEE series, showed a good correlation with the literature (15). Three De Vega procedures was performed under TEE guidance that the degree of the tricuspid annuloplasty ring tightness was based on the echo gradient obtained from the tricuspid annulus flow. One shunt operation was checked with TEE and agitated saline and no residual shunt was detected. Air embolism is certainly one of the many potential causes and is believed to be responsible for at least some postoperative strokes (16, 17). Air embolism during cardiac surgery was dreaded because this complication is avoidable. The microbubbles are found far more often-following valve replacement surgery than CABG (18-20). We have detected air bubbles in our 18 MVR and 13 AVR cases, which almost constitutes the 79% of our surgical series. In every air-detected case, the surgeon was warned and the air inside the heart chamber was taken out by hand and needle manipulation from the apex of the heart. This is almost identical to the literature, but none of our case had experienced either pre-peri or postoperative stroke related to these bubbles (21). Therefore TEE may be a more sensitive and accurate method for detecting venous air and fat embolism than other commonly used monitors in patients undergoing neurosurgical, valvular or orthopedic surgical procedures (21).

The hemodynamic parameters of our study correlate with the literature, which we can easily conclude that the type of anesthesia or the anesthetic agent didn't affect the hemodynamic outcomes The inhalation anesthetic agent Sevoflurane was used as maintenence because of hemodynamic stability (22-25).

Conclusion; Transosephageal echocardiography is an integral part of decision-making and monitoring in the perioperative period for patients undergoing valvular open-heart surgery. Multiplane TEE probes allow us to diagnose the perivalvular or the valvular defects or prosthetic valvular abnormalities perioperatively and led us a more precise surgical approach and provide maximum technical support to the cardiovascular surgeon and maximum surgical benefit for the patient. Routine intraoperative TE-E in valve surgery permits the identification and management of potentially serious complications before discontinuing CPB.

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