The Impact of Intraoperative Transesophageal Echocardiography in Infective Endocarditis

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Abstract

Backgound: The use of intraoperative transesophageal echocardiogram in patients with infective endocarditis is usually reserved for cases of inadequate preoperative testing or suspected extension to perivalvular tissue.

Objectives: To explore the impact of routine intraoperative TEE in patients with infective endocarditis.

Methods: The impact of intraoperative TEE on the operative plan, anatomic-physiologic results, and hemodynamic assessment or de-airing was analyzed in 59 patients (38 males, 21 females, mean age 57.7 ± 16.8 years, range 20–82) operated for active infective endocarditis over 56 months.

Results: Immediate pre-pump echocardiography was available in 52 operations (86.7%), and changed the operative plan in 6 of them (11.5%). Immediate post-pump study was available in 59 patients (98.3%) and accounted for second pump-run in 6 (10.2%): perivalvular leak (3 cases), and immobilized leaflet, significant mitral regurgitation following vegetectomy, and failing right ventricle requiring addition of vein graft (1 case each). Prolonged de-airing was necessary in 6 patients (10.2%). In 5 patients (8.5%) the postoperative study aided in the evaluation and treatment of difficult weaning from the cardiopulmonary bypass pump. In 21 patients (35.6%) the application of intraoperative TEE affected at least one of the four pre-specified parameters.

Conclusions: Intraoperative TEE has an important role in surgery for infective endocarditis and should be routinely implemented.

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Infective endocarditis is a serious cardiovascular infection that requires surgical intervention in at least 30% of patients with acute disease and another 20–40% after healing [1]. Transesophageal echocardiography is a well-established modality for the diagnosis of infective endocarditis [2-5]. It is especially important in demonstrating the extravalvular extent of the infection [6]. The role of intraoperative TEE in patients who were referred to cardiac surgery with a diagnosis of infective endocarditis is less well established, and systematic evaluation of its contribution is lacking. The aim of the current study was to identify the added value of routine intraoperative TEE in patients undergoing open-heart surgery for infective endocarditis.

TEE = transesophageal echocardiogram

Patients and Methods

We reviewed the departmental database for all patients who underwent valve surgery due to active infective endocarditis between September 1999 and April 2005 during which intraoperative TEE was conducted. Active disease was defined when the diagnosis was established up to 2 months before surgery [7]. Intraoperative TEE was mandatory for operations involving native or prosthetic valves during the study period. Thirty-three patients (55.9%) were referred from other hospitals. All patients underwent TEE within 2 weeks prior to their operation.

All intraoperative TEE studies were performed by one of four cardiologists (Y.S., M.V., D.E.W., A.S.), experienced in intraoperative TEE, using a 3.7/5 or 4/7 MHz multiplane transducer (Hewlett-Packard, Andover, MA, USA) or a 6T Vingmed Ultrasound (General Electrical, Harten, Norway). For sonography we used Hewlett-Packard Sonos 1000 or 2000, Agilent 5500 scanners, or a Vivid 3 Premium digital cardiovascular ultrasound scanner (General Electrical, Tirat HaCarmel, Israel). Each study was recorded on a super-VHS tape. The TEE probes were introduced by anesthesiologists after the induction of general anesthesia. The preoperative study was performed before initiation of the cardiopulmonary bypass, usually while the chest was already open. The post-pump study was performed by the same cardiologist immediately after spontaneous circulation was resumed and was terminated at optimization of hemodynamics. The intraoperative TEE procedure was performed according to guidelines of the American Society of Echocardiography/Society of Cardiovascular Anesthesiologists [8]. It included a systematic evaluation of all the valves in multiple acquisition angles, cardiac chamber size and function, exclusion of intracardiac masses, and evaluation of the thoracic aorta. Intracardiac air bubbles were defined as small discrete highly moveable echogenic dots. Pooled air was defined as a strongly echogenic line or area adjacent to the wall usually at the highest level of each chamber. De-airing was considered complete when no pooled air was detected and discrete bubbles were either gone or very few remained.

Data were specifically gathered on the four following parameters: a) the impact of the pre-pump intraoperative TEE on the operative plan; b) post-pump abnormal anatomic/mechanical find-

ings justifying a second pump; c) assessment of difficult weaning from cardiopulmonary bypass pump; and d) prolonged de-airing, necessitating special care.

Statistical analysis

Numeric values are reported as mean ± standard deviation or as a proportion of the sample size. Categorical variables were compared with the chi-square test.

Results

The study group included 59 patients (38 males, 21 females, age 57.7 ± 16.8 years, range 20–82 years), who underwent 60 operations (one patient experienced recurrent infective endocarditis on mitral annuloplasty ring). Twenty-four patients (40.7%) were referred from our center, and 35 (59.3%) from other centers. There were 33 cases with infective endocarditis on native valves, 21 cases of prosthetic valve endocarditis, one case of endarteritis of aortic tube graft, and 5 patients eventually had no vegetations (4 with flail mitral valve, 1 with ruptured papillary muscle). The location of the lesions is depicted in Table 1. The operative procedures included aortic valve replacement in 39 patients, mitral valve replacement in 26, tricuspid valve replacement in 2, mitral valve repair in 6, tricuspid annuloplasty in 5, and tricuspid valvectomy in 1 [Table 2]. There were 13 cases (21.7%) of perivalvular abscess/fistula, 10 of which were noted in patients with prosthetic valve endocarditis. Coronary bypass grafting was required in two patients.

A pre-pump intraoperative TEE was available in 52 operations (86.7%), and changed the operative plan in 6 of them (11.5%). In three patients an additional procedure was avoided: two patients with regurgitating non-infected valve (mitral and tricuspid) that did not justify a repair attempt, and one case of suspected fistula to the right atrium that was not confirmed by intraoperative TEE (a false positive finding by transthoracic echocardiogram). In three cases an additional procedure was recommended due to the following findings: a hole in the aortic valve in addition to mitral valve vegetation, necessitating its replacement [Figure 1]; a hole in the mitral valve, necessitating its repair; and sig-

Table 1. Site of infection

	Total	Native	Prosthetic
Aortic only	26	15	11
Mitral only	17	12	5
Aortic and mitral	9	8	1
Tricuspid*	2	2	0
Endoaortic	2	1	1
Perivalvular abscess	13	5	8
Fistula	4	1	3

* One patient also had an infected pacemaker wire.

Table 2. Operative procedures

Procedure	Type of valve	No.
AVR		
	Mechanical	15
	Biological	13
	Homograft	8
	Stentless	1
	Ross procedure	1
	Composite graft	1
	Total	39
MVR		
	Mechanical	10
	Biological	16
	Total	26
TVR	Biological	2
Mitral repair		6
Tricuspid annuloplasty		5
Tricuspid valvectomy		1

AVR = aortic valve replacement, MVR = mitral valve replacement, TVR = tricuspid valve replacement.

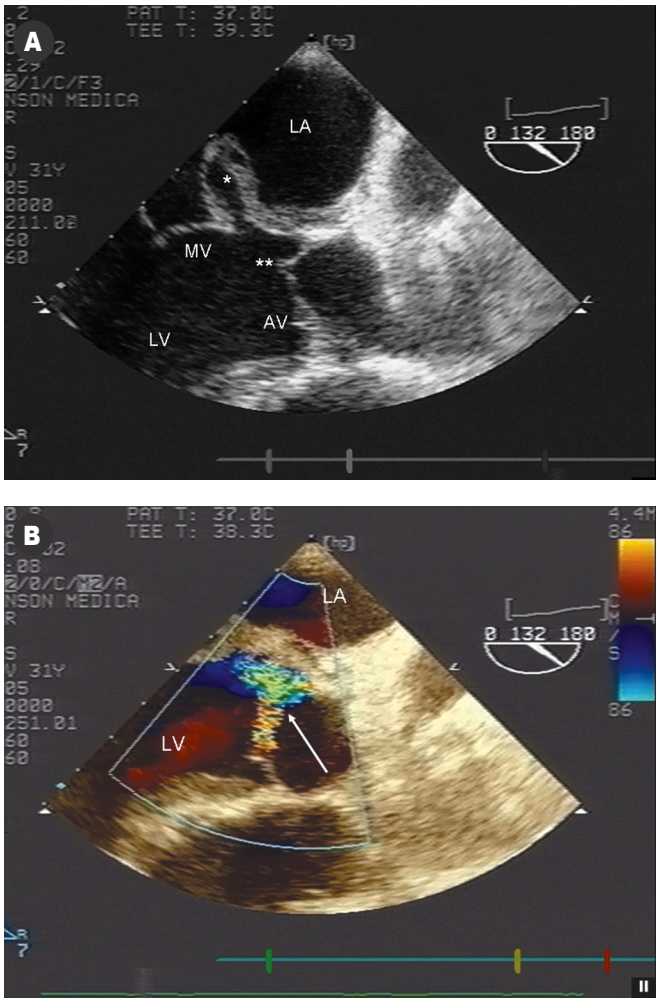

Figure 1. Preoperative echocardiogram in a patient referred for surgery due to mitral valve infective endocarditis causing mitral valve aneurysm with perforation (asterisk). **[A]** An additional hole was diagnosed (double asterisk). AV = aortic valve, LA = left atrium, LV = left ventricle, MV = mitral valve. **[B]** Color-Doppler application, showing aortic regurgitation through the aortic valve hole (arrow).

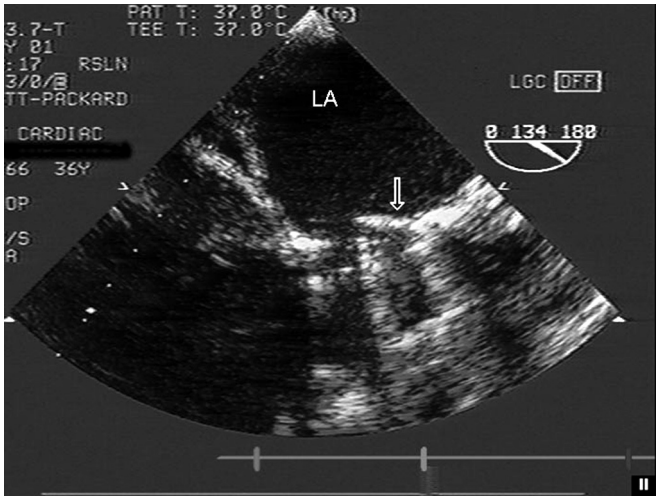

Figure 2. Immediate postoperative echocardiogram after mitral valve replacement by a bi-leaflet valve, showing diastolic immobilization of one leaflet (arrow).

nificant regurgitation of a non-infected aortic valve justifying its replacement.

Post-pump intraoperative TEE was available in 59 patients (98.3%), and accounted for second pump-run in 6 patients (10.2%), due to valvular problems in 5 of them and to hemodynamic instability in the other. Perivalvular leakage was noted in three patients (two mitral, one aortic). The site of leakage was precisely identified by intraoperative TEE and the leakage was sealed *in situ*. One patient suffered from immobilized leaflet of a mitral valve attributed to Bioglue after a complex reconstruction of the aortic root [Figure 2]. The leaflet was mobilized by cleaning and reorientation. In one patient, significant mitral regurgitation was noted following vegetectomy and patch plasty, and the valve was replaced. An additional patient suffered from right ventricular failure, necessitating the addition of a saphenous vein graft. A second pump run was required in 3 of the 9 patients with double valve endocarditis (33.3%), 2 of the 17 patients with isolated mitral valve endocarditis (11.7%), and 1 of the 26 patients with isolated aortic valve endocarditis (3.8%) (chi-square 5.7, $P = 0.058$). Disturbing anatomic or hemodynamic findings were observed in another three other patients with complex infective endocarditis extending beyond the valve: residual pseudo-aneurysm of the left ventricular outflow tract in one patient, residual small left ventricular outflow tract to right atrial fistula in another patient, and increased gradients through an aortic homograft in the third patient. The surgeons did not regard these findings as justifying a second pump run.

Six patients underwent mitral valve repair. Post-pump intraoperative TEE identified significant residual mitral regurgitation in one patient and the valve had to be replaced. Recurrent infective endocarditis on the ring was found in another patient 4 weeks after the initial operation and the valve had to be replaced.

De-airing was performed with intraoperative TEE control in all cases. Prolonged de-airing was necessary in 6 patients (10.2%). In 5 (8.5%) the postoperative intraoperative TEE aided in the evaluation and treatment of difficult weaning from the cardiopulmonary bypass pump, which was attributed to failure of the left ventricle in three cases and failure of the right ventricle in two, one of whom received a saphenous vein graft to the right coronary artery as mentioned above.

The total number of patients in whom the application of intraoperative TEE affected at least one of the pre-specified parameters (operative plan, quality control, hemodynamic assessment or de-airing) was 21 (35.6%).

Discussion

We showed that the application of intraoperative TEE in patients undergoing surgery for infective endocarditis affected at least one of the pre-specified parameters (operative plan, quality control of valve repair/replacement, hemodynamic assessment or de-airing) in one-third of the patients, making it an integral part of the operation. Most importantly, it was associated with a considerable percentage of second pump-run (10.2%), thus avoiding serious postoperative consequences.

Intraoperative TEE during cardiac surgery is known to play an important role in the evaluation and quality control of a variety of pathologies [9-12]. Its value in valve repair is undisputable [13,14]. Recent studies have highlighted the role of intraoperative TEE in valve replacement [15-18]. We have previously shown, in a study of 417 valve replacement operation for various indications, that pre-pump intraoperative TEE affected the therapeutic decisions in 29.3% of patients, and that the immediate post-pump study necessitated a second pump-run in 3.6% [18]. An additional post-pump contribution was the evaluation of difficult weaning from cardiopulmonary bypass and difficult de-airing in 11.3% and 10.8%, respectively.

TEE has an invaluable role in the diagnosis of infective endocarditis and its extent [2-5]. Patients referred for surgery for this condition have usually undergone meticulous evaluation, including TEE. However, infective endocarditis is a dynamic process: over time, the vegetation may grow, shrink or embolize; the infectious process may extend outside the valve tissue to form fistulous tracts and abscesses; and other valves may become involved, e.g., the anterior mitral leaflet in infective endocarditis of the aortic valve [19]. Therefore, an immediate preoperative TEE may occasionally add useful data on the extent of the infectious process and the odds of valve reparability. In addition, the presence of friable tissues may expose the patient to a higher probability of perivalvular leak, which can be readily identified by intraoperative TEE. In our study, intraoperative TEE indeed identified three cases of perivalvular leak. Moreover, it could point to its precise location and guide the surgeon.

The issue of repeating TEE during the operation in a patient who already underwent preoperative TEE is not yet resolved. Recent guidelines consider intraoperative TEE as a class I indication only when preoperative testing was inadequate or extension to perivalvular tissue is suspected [20]. Certainly, when valve repair is an option, intraoperative TEE is clearly indicated, and this mostly applies to the mitral valve. During the last few years there has been a trend toward repairing rather than replacing

these valves, if not seriously damaged [21-23]. Senni et al. [21] showed that intraoperative TEE helped to determine the best surgical approach in patients with mitral valve infective endocarditis by identifying the mechanism of mitral regurgitation [21]. In certain cases it allowed repair rather than replacement of the mitral valve. Iung and co-workers [22] used intraoperative TEE for quality control in nearly half of their patients who underwent repair for infected mitral valve. Post-pump TEE images are useful in evaluating the adequacy of the repair and the function of the new prostheses. In our study, intraoperative TEE guided mitral valve repair in six patients, and identified one failure. The single patient who developed recurrent infective endocarditis reminds us that radical debridement plays a key role in this condition. It should be noted that intraoperative TEE may not be sensitive enough to identify very small foci of residual infection, and it is the role of the surgeon to ascertain macroscopic eradication of any infected tissue.

Conclusions

In our experience, intraoperative TEE provides useful data for the planning of surgery and for the quality control of the operative results. We believe that the impact of intraoperative TEE on the operative plan and postoperative quality control justifies the routine implementation of intraoperative TEE in infective endocarditis.

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