Preliminary pediatric transesophageal echocardiography experiences

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With transesophageal echocardiography (TEE), a new echocardiographic window is obtained which enables cardiologists to explore the heart from the esophagus and stomach. However, the procedure, when first undertaken, may present certain difficulties for the cardiologist in interpreting the anatomical findings and approaching a diagnosis. We thus convey our first experiences and results of TEE in 107 pediatric patients.

Transesophageal echocardiography (TEE) was performed in 107 pediatric patients at our institution between December 1998-February 2001, using the standard techniques and following the standard criteria suggested by the American heart Association. The mean age of 54 male (50.5%) and 53 female (49.5%) patients was 7.8 years. Intubation difficulty was experienced in four cases. In one case, while drawing the transducer back from the esophagus, it kinked at the hypopharynx. None of the cases had major hemorrhage or esophageal rupture, and only a few cases had minor pharyngeal injuries or hemorrhages.

We used TEE in detecting vegetations in patients with possible endocarditis, and evaluating the prosthetic valves and abnormal pulmonary venous return. We also used TEE to clarify preooperative anatomical details, postoperative complications and residual defects of complex congenital cardiac anomalies. Transcattheter closure of 47 secundum atrial septal defects (ASD)'s and a muscular ventricular septal defect (VSD) (both during patient selection and during the procedure) were accomplished under TEE guidance. As the pediatric cardiologists gain more experience in performing TEE, this technique will have a wider and more effective use in the pediatric population.

Key words: transesophageal echocardiography, pediatric.

Transesophageal echocardiography (TEE) has provided a new echocardiographic window, to view the heart from the esophagus and stomach. It is a semi-invasive procedure that compliments the transthoracic echocardiography (TTE). Whenever it is believed the procedure would provide additional information about the diagnosis, or when the TTE does not provide an adequate visualization, this procedure is performed by a team including pediatric cardiologists and physicians experienced in resuscitating and intubating children[1-5]. When first undertaken, the procedure may present some difficulties for the cardiologist in showing the anatomical structures and interpreting the diagnosis[1]. The American Society of Echocardiography has suggested some standard rules for cardiologists attempting the TEE[6], which we followed to perform the procedure in 107 pediatric patients. Herein to convey our preliminary results and experiences with this procedure.

Material and Methods

One hundred and seven TEEs were performed between December 1998 and February 2001 in pediatric patients under general anesthesia, in the operating room or in the catheter laboratory. Toshiba Sonolayer SSH 160 A and ATL 3000 and

GE vingmed system five performance echocardiography machines, and 5 mHz biplane and multiplane transducers were used. The standard TEE techniques were applied[6].

In patients with atrial septal defect (ASD), the size of the septal defect; the anterior, posterior, superior and inferior rims; the total septal size; and the relation of the defect to the atrioventricular (AV) valves, superior vena cava (SVC), upper right pulmonary vein and to the coronary sinus were noted in caval, four chamber and aortic short-axis views. The procedure was repeated in patients whose ASDs were thought to be closed via the transcatheter route. During the second procedure the stretched ASD diameter was also measured by inflating a sizing balloon at the level of the defect.

Results

The ages of the patients (54 male, 53 female) ranged from 2.5 to 18 years (mean: 7.8). TEE was performed in seven patients with infective endocarditis in whom TTE did not provide adequate information about vegetations; in three patients with prosthetic mitral valve to evaluate thrombi; in a patient with partial anomalous return of the pulmonary vein to clarify the anatomical defect; in a patient with transposition of the great arteries (TGA) who had a senning operation to determine the venous baffle obstruction; in a patient with thorax deformity and congenital mitral stenosis to confirm the mitral pathology; in a postoperative patient with double outlet right ventricle (DORV) to search for residual ventricular septal defect; in a patient with Kawasaki disease; in 91 patients with ASD and in a patient with muscular ventricular septal defect (VSD) (Table I).

We encountered resistance in four patients during intubation. In one patient, the tip of the transducer kinked at the hypopharynx as it was withdrawn from the esophagus. None of the patients had major complications such as haemorrhage, esophageal rupture or laceration.

In two of the seven patients with infective endocarditis, vegetations were observed on the VSD patch and in the pulmonary artery of a patient operated for tetralogy of Fallot, and on the tricuspid valve of a patient with VSD. None of the patients with prosthetic mitral valve had valve dysfunction, or thrombi. The partial anomalous return of the right upper pulmonary vein to the SVC was revealed by TEE. In a patient with congenital mitral stenosis and thorax deformity, the parachute mitral valve and single papillary muscle were confirmed with TEE. The venous baffle obstruction was demonstrated in a patient with TGA who had a senning operation. Suspected residual VSD was ruled out in a postoperative patient with

Table I. Results of the Transesophageal Echocardiography

Transthoracic echo	Transesophageal echo	Number of patients
Operated TOF+IE	Vegetation on the VSD patch and in pulmonary artery	1
Inlet VSD+IE	No vegetation	1
VSD+IE	Vegetation on tricuspid valve	1
MR+IE	No vegetation	1
AV discordance+MR+IE	No vegetation	2
İnlet VSD+AV discordance+IE	No vegetation	1
MR with MVR	No thrombi	3
Congenital MS+thorax deformity	Shone anomaly	1
Partial anomalous return of pulmonary veins	Right upper pulmonary vein to SVC	1
Operated (senning) TGA	Obstruction of venous baffle	1
Operated DORV+VSD?	No VSD	1
Kawasaki disease	Normal coronary arteries	1
ASD	ASD	37
ASD	Closed by transcatheter technique	47
ASD	Not closed by transcatheter technique	6
ASD+dilated CMP	Not closed by transcatheter technique	1
Midmuscular VSD	Closed by transcatheter technique	1
Total		107

TOF : Tetrology of Fallot.
IE : Infective endocarditis.
VSD : Ventricular septal defect
MR : Mitral regurgitation
AV : Atrioventricular.
MVR : Mitral valve replacement.
MS : Mitral stenosis.
ASD : Atrial septal defect
CMP : Cardiomyopathy
SVC : Superior vena cava

DORV. The coronary arteries of the patient with Kawasaki disease were normal. Among the 54 patients scheduled for transcatheter closure of their ASD defects, 47 were successfully closed. The balloon-stretched ASD diameter in the remaining seven patients was too large (> 25 mm) for transcatheter closure. In all patients with device occlusion of the ASD, TEE was repeated immediately after the procedure. Twenty-one of these patients had trivial residual shunt. No SVC, upper right pulmonary vein, AV valve or coronary sinus obstruction was observed postprocedurally. TEE was also used during the VSD closure to measure the VSD diameter and select the appropriate device and after the procedure to check the residual shunt, which was only trivial.

Discussion

Transesophageal echocardiography (TEE) is done under general anesthesia in children, especially those under 10 years of age[6]. Physicians experienced in handling infants and small babies should perform it, since it is a semi-invasive procedure[1,6]. The American Society of Echocardiography has suggested some standard rules for cardiologists intending to perform TEE[6]. These are:

- Having performed at least 30 endotracheal intubations, mostly to children under two years of age.
- Having interpreted complex heart diseases echocardiographically in at least 400 patients (50% being under 1 year of age), or for at least six months.
- Having done and interpreted 30-50 monoplane or biplane TEEs under supervision.

If the echocardiographer is not a pediatric cardiologist, and if an intraoperative TEE is needed, a pediatric cardiologist must be consulted during the procedure[1].

We started this study with a 22-year experience with TTE. Experienced anesthesiologists were ready to help with the intubation of small children.

No death has been reported in children due to TEE. Complications are rare, seen in only 1.6-4.9% of patients[1,6-8]. These are mostly insignificant pharyngeal hemorrhage, transient arrhythmias and hypotension (the latter is due to compression of the descending aorta, or the posterior pulmonary vein in total anomalous pulmonary venous return). Airway obstruction may be seen in children between 5-10 kg[6,9]. In a 15 kg patient, airway obstruction was reported with an adult TEE probe[6]. Therefore, the appropriate choice of probe is essential. The probe should always be carefully manipulated at anteflexion. When a clear image cannot be obtained or when the probe cannot be advanced forward, it should be kept in mind that it may have kinked[6].

We observed insignificant pharyngeal hemorrhage in a few of our patients; no case had massive hemorrhage. The anesthesiologists helped with the intubation of two cases in which there was resistance to the probe while advancing through the cricopharynx. In another case, inability to advance the probe was due to the kinking of the tip of the transducer at the level of the hypopharynx. When the procedure was repeated after the probe with appropriate position, it was successfully advanced to the esophagus. We did not observe arrhythmia, hypotension, or airway obstruction in any of the cases.

Although we did not encounter any difficulty in interpreting the images of basal short axis or four-chamber views, we did encounter some difficulty at first in interpreting the caval-interatrial septal image of the long-axis view. This was easily overcome, however, after working on a few cases.

The size of the applied probe is very important to obtain a better image[7,10,11]. A pediatric probe should be used for all children under 15 kg, whereas the adult probe is used for ones over 20 kg. The probe selection is done individually for the patients between 15-20 kg with regard to the uniqueness of the patient and the experience of the performing echocardiographer. When a small-diameter probe is used in children over 20 kg, the image quality may not be optimal due to the trapped air between the probe and the esophagus. We observed similar problems in four of our cases in whom we used pediatric probes.

Transesophageal echocardiography (TEE) is considered a more valuable and sensitive tool for demonstrating the vegetations in infective endocarditis when compared to TTE[1,6,12,13]. It was performed in seven patients with congenital heart disease and infective endocarditis in whom the TTE did not produce clear-cut images. Vegetations were observed with TEE in only two of these patients.

This procedure is also preferred for evaluating prosthetic valves and partial anomalous venous return. We performed TEE in three cases with prosthetic mitral valve and in one case with partial anomalous pulmonary venous return. TEE revealed no dysfunction of prosthetic valves and thrombus was not observed. The anomalous return of the upper right pulmonary vein to the SVC was confirmed with TEE.

The transesophageal echocardiography (TEE) may be used for guiding invasive procedures like ASD or VSD closure, as in our study[14]. We used TEE in selection of patients for transcatheter closure and during and after the procedure itself. In seven of our patients, who were accepted as suitable candidates for transcatheter closure, the procedure was not performed since the inflated balloon size of the ASD diameter was > 25 mm. Echocardiographic and angiographic measurements of the inflated balloon diameter were similar. The TEE immediately after and the TEE on the following day revealed no complications.

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