

Clinical importance of transesophageal electrophysiologic study in the management of supraventricular tachycardia in children

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Transesophageal electrophysiologic study (TEEPS) is a semi-invasive method widely used for evaluation of symptoms related to arrhythmia. In this study, we aimed to determine the accuracy of TEEPS in the diagnosis and differentiation of mechanisms of supraventricular tachycardias (SVTs) by comparing results of transesophageal and intracardiac electrophysiologic studies. We performed TEEPS and a subsequent radiofrequency ablation (RFA) procedure in 76 patients. Indications of TEEPS were risk assessment for Wolff-Parkinson-White syndrome in 32 patients and diagnosis and differentiation of tachycardia mechanisms in 44 patients. The procedure was well tolerated in all patients. Positive predictive value of TEEPS in our study was 91% for differentiation of SVT mechanisms. The results suggest that TEEPS is safe, useful and effective in the evaluation of symptoms related to arrhythmia, in differentiation of mechanisms of SVTs, and finally in defining the treatment options of SVT. The technique also provides an opportunity for risk assessment and deciding the treatment modality in Wolff-Parkinson-White patients.

Key words: supraventricular tachycardia, transesophageal electrophysiologic study, electrophysiologic study.

Transesophageal atrial pacing is a semi-invasive method useful for the diagnosis and differentiation of supraventricular tachycardias (SVTs)¹. Atrial stimulation from the esophagus can initiate and terminate tachycardia². Samson et al.³ determined an excellent correlation between findings of transesophageal electrophysiologic study (TEEPS) and a subsequent invasive electrophysiology. Information about the causative mechanism of the tachycardia is important for management of SVTs and evaluation of symptoms of tachycardias. In this study, we aimed to determine the accuracy of TEEPS in the diagnosis and differentiation of mechanisms of SVTs by comparing results of TEEPS and intracardiac electrophysiologic study (IEPS).

Material and Methods

Patients: The study group consisted of 76 patients (44 male, 32 female) who underwent both TEEPS and IEPS from May 1999 to December 2006 at Hacettepe University

Pediatric Cardiology Department. Average age at time of transesophageal study was 11±3.3 years (range: 4-17, median: 11 years).

Transesophageal electrophysiologic study (TEEPS): The technique was previously described by Benson et al.⁶ TEEPS was performed in the fasting state in the electrophysiology laboratory after explaining the possible discomfort induced by esophageal pacing and obtaining informed consent from patients or parents. Midazolam was administered by nasal route (0.3-1 mg/kg) or through a venous line (0.05-0.1 mg/kg) to all patients. A 6 Fr quadripolar electrode (Fiab, Esokid 4, Italy) with electrode spaced at 10 mm was positioned through the nares in the esophagus with the aid of fluoroscopy at the appropriate depth where optimum atrial signals were obtained⁵. Before insertion, the tip of the catheter was coated with 1% lidocaine in all patients.

Atrial stimulation was done with a programmable stimulator (Fiab Programmable Cardiac Stimulator 8817 with a pulse width and amplitude capacity between 5-20 msec and

5-45 mA consecutively). A standard ECG machine was used for recording. Single and pair extrastimuli at progressively higher rates were performed until the atrioventricular (AV) effective refractory period was reached. Incremental pacing to the point of second-degree AV block and burst pacing at cycle lengths similar to those producing second-degree AV block were performed. When sustained tachycardia was not induced under basal conditions, we repeated the pacing protocol after isoproterenol (0.05-0.1 $\mu\text{g/kg/min}$) infusion. We terminated the induced tachycardia by atrial overdrive pacing. The endpoint of the procedure was either an induction of tachycardia or completion of the protocol.

Intracardiac electrophysiologic study (IEPS): The technique was previously described by Samson et al.³ All studies were performed in the fasting state in the electrophysiology laboratory after obtaining informed consent from patients or parents. Antiarrhythmic medications were discontinued at least five half-lives. Sedation was obtained using intravenous midazolam (0.1 mg/kg) and if necessary we used intravenous ketamine. We inserted three or four quadripolar electrode catheters percutaneously and positioned them to record electrograms from the high right atrium, right ventricular apex and coronary sinus. We determined anterograde conduction and refractory characteristics by premature extrastimuli and atrial mapping within the right atrium and coronary sinus during tachycardia.

Tachycardia mechanisms: Atrioventricular nodal re-entrant tachycardia (AVNRT) was presumed to be present under the condition of regular tachycardia, no evidence of AV dissociation or 2:1 AV block, and a ventriculoatrial (VA) interval of ≤ 70 ms. Atrioventricular re-entrant tachycardia (AVRT) was presumed to be present under the condition of regular tachycardia, no evidence of AV dissociation, and a VA interval ≥ 70 msec⁶.

Ectopic atrial tachycardia (EAT) involves an abnormal automaticity, and tachycardia can not be induced or terminated by pacing. In atrial reentrant tachycardia, there is a reentrant mechanism in the atrium. This form of tachycardia is independent of atrioventricular conduction; it will persist in the setting of second-degree block. In atrial ectopic and atrial reentrant mechanisms, tachycardia persists in the setting of second-degree atrioventricular block. They are independent of atrioventricular conduction³. In case of pre-excitation, the anterograde effective refractory period of the accessory pathway is defined as the longest atrial coupling interval at which the accessory pathway fails to conduct to the ventricle³.

Results

Indications for TEEPS were risk assessment in Wolff-Parkinson-White (WPW) syndrome in 32 patients (42%), palpitation in 30 patients (40%), palpitation-chest pain in 9 patients (12%), and palpitation-syncope in 5 patients (6%) (Table I). During transesophageal study, we found the following 75 mechanisms in 76 patients: manifest accessory pathway AVRT in 32 patients, concealed accessory pathway AVRT in 20 patients, AVNRT in 16 patients, EAT in 3 patients, permanent reciprocating junctional tachycardia (PRJT) in 1 patient, and intraatrial reentrant tachycardia in 3 patients. In 1 patient, we induced wide QRS tachycardia by transesophageal pacing and stopped it again by transesophageal pacing. In 1 patient, we could not induce tachycardia by transesophageal study. However, we detected SVT on event recorder. We induced sustained tachycardia in 26 and atrial flutter in 3 patients with manifest accessory pathway AVRT. We could not induce sustained tachycardia in 3 patients with manifest accessory pathway but since their effective refractory periods were short, we performed radiofrequency ablation procedure.

Table I. Clinical Characteristics of the Patients

Average age at time of transesophageal study	11 \pm 3.3 years (range: 4-17, median: 11 years)
Number of patients	76 patients (44 male, 32 female)
Indication for transesophageal study	
Risk assessment for WPW syndrome	32 patients (42%)
Palpitation	30 patients (40%)
Palpitation, chest pain	9 patients (12%)
Palpitation, syncope	5 patients (6%)

During IEPS, we detected the following 76 tachycardia mechanisms: manifest accessory pathway AVRT in 32 patients, concealed accessory pathway AVRT in 17 patients, AVNRT in 20 patients, PJRT in 1 patient, EAT in 3 patients, and intraatrial tachycardia in 3 patients.

We compared the results of TEEPS and IEPS excluding the manifest accessory pathway AVRT. Tachycardia mechanisms were identical in 39 and different in 4 patients. In 1 patient, the result of transesophageal study was normal. However, we observed SVT on event recorder and performed IEPS and induced AVNRT. We further evaluated tachycardia mechanisms of patients whose results were different between TEEPS and IEPS: tachycardia mechanism was AVNRT in 3 patients and Mahaim tachycardia in 1 patient who was diagnosed with AVRT by transesophageal study. The concordance between TEEPS and IEPS was 91% except for the patient with Mahaim tachycardia (positive predictive value 91%) (Table II).

In our study, we applied TEEPS for risk assessment of WPW in 32 patients. Sustained tachycardia was induced in 26 patients. In all of them, the VA interval was found to be longer than 70 msec and atrial fibrillation was induced in 3 of the patients. We could not induce tachycardia in 3 of these patients. The accessory pathway effective refractory period (APERP) was found to be shorter than 250 msec in these 3 patients. In the IEPS prior to ablation, the APERPs of these 3 patients were found to be similar to the results of TEEPS. Symptomatology of these patients was evaluated and complaints included: syncope

(2 patients), syncope-tachycardia (3 patients), chest pain-tachycardia (2 patients), and tachycardia (20 patients); 5 patients were asymptomatic. We induced atrial fibrillation in 3 patients who complained of syncope or syncope-tachycardia.

Discussion

Transesophageal atrial pacing is a semi-invasive method useful for the diagnosis and differentiation of SVTs in all age groups. Palpitation is a very unpleasant and even terrible experience for children and their parents. Pediatricians and pediatric cardiologists must relieve their patients' anxiety. Families usually ask for noninvasive methods for evaluation of the symptoms in their children and want to obtain definite diagnosis. The technique seems to be safe and relatively easy with a low risk. No long-term morbidity and mortality have been reported as a result of transesophageal studies using standard techniques⁵. In our study group, the investigation was well tolerated and could be completed in all patients without any complication related to the procedure.

Transesophageal electrophysiologic study seems to be very effective in the differential diagnosis of SVTs. Differential diagnosis between AVRTs and AVNRTs depends on the VA interval being <70 msec or >70 msec. Our study demonstrated that there is a high concordance between TEEPS and IEPS in differentiating the SVT mechanisms (positive predictive value was 91%). This concordance is very similar to that of Samson et al.³ In our clinic, we use VA interval in the differential diagnosis in TEEPS. Since the concordance between TEEPS and IEPS

Table II. Comparison of Results of Transesophageal and Intracardiac Electrophysiologic Studies

Mechanism of tachycardia in TEEPS/Number of patients	Mechanism of tachycardia in IEPS/Number of patients
WPW/32	WPW/32 (inducibility of tachycardia, assessment of risk and accessory pathways)
Normal/1	AVNRT/1
AVNRT/16	AVNRT/ 16
AVRT/19	AVRT/15, AVNRT/3, Mahaim tachycardia/1
EAT/3	EAT/3
PJRT/1	PJRT/1
Wide QRS tachycardia/1	Mahaim tachycardia/1
IART/3	IART/3

AVNRT: Atrioventricular nodal reentrant tachycardia. AVRT: Atrioventricular reentrant tachycardia. EAT: Ectopic atrial tachycardia. IART: Intraatrial reentrant tachycardia. PJRT: Permanent junctional reentrant tachycardia. TEEPS: Transesophageal electrophysiologic study. IEPS: Intracardiac electrophysiologic study. WPW: Wolff-Parkinson-White.

is very strong, we can conclude that the 70 msec cut-off point can be used accurately in the distinction of AVRT and typical AVNRT. This result also shows that TEEPS can be used safely and effectively for evaluation of symptoms related to arrhythmia in children.

Transesophageal atrial stimulation may provide a nearly ideal tool to assess the risk and the need for radiofrequency ablation in WPW syndrome patients who might not otherwise be referred for the procedure⁵. Whether symptomatic or not, initial presentation in patients with WPW syndrome may be sudden death⁷⁻¹⁰. The underlying etiology is generally a very high ventricular rate and atrial fibrillation⁹. The most important indicator of the ventricular fibrillation development during atrial fibrillation is the length of APERP^{11,13}. Since the APERP is shorter in children than in adults, the probability of initially presenting with ventricular fibrillation or sudden death is higher in children with WPW syndrome^{14,15}. The gold standard for the determination of APERP is electrophysiologic study. In our study, we applied TEEPS for risk assessment of WPW in 32 patients. Sustained tachycardia was induced in 26 patients, and atrial fibrillation was induced in three patients. We could not induce tachycardia in three patients. The APERP was found to be shorter than 250 msec in five patients. We observed that APERPs were similar in TEEPS and IEPS. We can conclude that TEEPS is also effective for risk assessment in WPW syndrome.

In conclusion, TEEPS is safe, useful and effective in the evaluation of symptoms related to arrhythmia, in the differential diagnosis of SVTs, and finally in defining the treatment options of SVT. The technique also provides an opportunity for risk assessment and deciding the treatment modality in WPW patients.

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