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Electrophysiological study generally is negative in patients <40 years suspected of supraventricular tachycardia but also complaining of chest pain and/or syncope☆

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ABSTRACT

Background: The diagnosis of paroxysmal supraventricular tachycardia (SVT) frequently is a dilemma. Electrophysiological study (EPS) is the only means to evaluate the nature of symptoms when noninvasive studies remain negative. Our objectives were to determine the clinical factors of negativity or positivity of (EPS) in patients suspected of SVT.

Methods: EPS was performed in 2650 patients complaining of tachycardia and suspected of SVT. Transesophageal EPS consisted of programmed atrial stimulation in control state and after isoproterenol. Patients were followed from 1 month to 18 years (2.93 ± 4 years).

Results: SVT was induced in 1944 patients, age 48 ± 19.5. EPS remained negative in 706 patients, age 34 ± 17 ($p < 0.0001$). Age <40 years, feeling of dizziness/syncope or chest pain associated with tachycardia, the absence of heart disease or short PR interval was more frequent in patients with negative EPS (respectively 64, 42, 26, 96, 88.5%) than in patients with induced SVT (34, 14, 4, 88, 59%) ($p < 0.0001$).The positive predictive value for the prediction of a negative EPS of age <40, chest pain, syncope or their association was 63.5, 42, 26.5, 11% and negative predictive value was 66, 86, 94.5, 99.5%. At multivariate analysis, age <40 (0.000, OR 2.79), the presence of syncope associated with tachycardia (0.000, OR 5.075) or chest pain (0.000, OR 17.923) was an independent factor of negative EPS.

Conclusions: Among patients complaining of nondocumented tachycardia, suspected of SVT, the association of tachycardia with chest pain and/or syncope and age <40 years generally was correlated with a negative EPS and did not indicate initially invasive studies. In the remaining patients transesophageal EPS is indicated.

1. Introduction

When the different recordings of external ECG monitoring remain negative, the diagnosis of tachycardia is a dilemma. Electrophysiological study (EPS) remains the only means to evaluate the nature of infrequent symptoms [1]. EPS can be performed by intracardiac route or esophageal route when a supraventricular tachycardia is suspected. Paroxysmal supraventricular tachycardia (SVT) with a normal ECG in sinus rhythm is generally considered as benign [2] and therefore, intracardiac EPS is mainly indicated before SVT ablation in patients with documented SVT. Several years ago, a semi-invasive technique was reported and the method led to enlarge the indications of EPS; transesophageal EPS was shown as a highly accurate means of diagnosing and characterizing various mechanisms of SVT [3–6]. The method was shown as safe, useful and effective for the evaluation of arrhythmia-related symptoms, for the evaluation of the mechanism of SVT and finally for the choice of the treatment.

The purpose of the study was to determine the clinical factors of negativity or positivity of EPS in patients suspected of SVT and then to propose a diagram of EPS indications in patients complaining of tachycardia.

2. Methods

2.1. Population

Two thousand seven hundred forty patients, aged from 6 to 92 years, mean 44.6 ± 19.7, 1083 males and 1657 females complained of tachycardia. Tachycardia was not documented or ECG in tachycardia was

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not interpretable. The ECG in sinus rhythm was normal and without preexcitation syndrome. The clinical data of these patients were prospectively collected.

These patients were referred by a cardiologist either because the tachycardia was poorly tolerated with anxiousness or dizziness or episodes of palpitations were recurrent and not documented.

The number of tachycardia events ranged from one to 40 episodes.

2.2. Methods

The study complies with the Declaration of Helsinki; the research protocol was approved by the Commission Nationale Informatique et Libertés (CNIL), in keeping with French law for single-center usual care observational studies. Prior to EPS and ablation, informed consent was obtained for clinical purposes from all patients and in the case of children, from children and their parents. There was no conflict of interest for any author.

1. Clinical data and initial ECG were collected. Symptoms associated with the feeling of tachycardia and familial history of SVT were noted
2. Exercise test was performed in 654 patients and 24 Hour Holter monitoring was systematic.
   Echocardiography was performed in patients suspected to have heart disease.
3. Transesophageal EPS was performed in all patients. Study was approved by an ethics committee and informed consent was obtained prior to the study from the patients and in the case of children, from children and their parents.

Patients were in a fasting state for at least 3 h prior to undergoing transesophageal EPS and were not sedated. All drugs were discontinued before EPS in 525 patients who were treated without success with beta-blockers or verapamil without documentation of the tachycardia.

EPS was always performed in the electrophysiology laboratory with adequate life-saving material and in the presence of qualified medical staff, after clear explanations of the technique. Patients were informed of the possibility of chest pain due to pacing current of more than 12 to 15 mA.

Esophageal catheter (Fiab catheter, Sorin, France or sp8 catheter, Prothia) was passed through the oral cavity and optimal esophageal position was determined by the best recording site of esophageal atrial activity. Oral cavity anesthesia was only necessary in 3 children and 4 adults due to a too important nausea reflex. Three patients not included in the population refused the study.

Our protocol was previously reported [5,7].

Surface electrocardiograms and esophageal electrogram were simultaneously recorded on paper at speeds of 25 or 100 mm/s (C. R. Bard, Inc., Lowell, Massachusetts). Cardiac stimulation was performed with a biphasic stimulator (Micropace, C. R. Bard, Inc., Lowell, Massachusetts) used for intracardiac study. Pulses of 10 ms duration were used; output varied from 8 to 18 mA (mean 13 ± 4 mA).

Incremental atrial pacing was performed until type I second degree atrioventricular block occurred. Programmed atrial stimulation at a basic cycle length of 600 and 400 ms with the introduction of one and two extrastimuli was performed. When a SVT was induced, the protocol was stopped. In the absence of tachycardia induction, isoproterenol (0.02 to 1 $\mu g \cdot min^{-1}$) was infused then to increase the sinus rate to at least 130 bpm and the pacing protocol was repeated.

Arterial blood pressure was continuously monitored during the study by an external sphygmomanometer (Baxter, Japan).

All patients were allowed to leave the hospital after EPS and were authorized to drink and eat immediately after the study except patients in whom oral cavity anesthesia was performed.

2.3. Measurements and definitions

Sustained supraventricular tachyarrhythmia was defined as a tachycardia lasting 1 min or longer. Patients with reproducibly induced SVT that lasted 30 s to 1 min were also considered as pathological. Other patients were considered as having a negative study.

When tachycardia was induced, the atrial electrocardiogram was recorded in order to determine the exact nature of the induced arrhythmia. Criteria included measurement of ventriculoatrial interval and morphology of atrial activity in leads I, III and V1: atrial activity was inside the ventriculogram and not visible in these leads but only on the esophageal electrogram when AV nodal re-entrant tachycardia (AVNRT) was induced; when atrial activity followed the ventriculogram, the negativity of P wave in lead D3 indicated a re-entrant tachycardia; the negativity of P wave in D1 and/or a P wave occurring after the atrial esophageal electrogram was in favor of a re-entrant tachycardia via a concealed left accessory pathway [8]. When P wave was positive in D1 and P wave in V1 occurred before esophageal atrial activity, possible mechanisms included atypical AVNRT or a re-entry through a concealed septal or right accessory pathway. Paroxysmal SVT was induced several times to provoke a functional bundle branch block and to note changes in ventriculoatrial interval at this time.

2.4. Follow-up

Mean follow-up ranged from 1 month to 18 years (mean 2.93 ± 4 years). In patients with inducible tachycardia and accessory pathway, beta blockers and flecainide were generally prescribed, until radiofrequency ablation; in other tachycardias, the indication of ablation depended on the recurrence of tachycardia, the tolerance and the age. The follow-up was stopped generally one year after successful SVT ablation.

In patients with a negative study and persistent symptoms, long-term Holter monitoring (2 to 3 weeks) using the system "SpiderFlash-t" of SORIN (France, Italy) was performed from 1 month (delay for the appointment) up to 1 year after EPS. With its prolonged autonomy, SpiderFlash-t is considered as an excellent alternative to implantable loop recorders. The system allows the recording of the ECG for up to 15 min before, and 15 min after arrhythmia detection or patient initiated.

A second EPS was performed in 31 patients at the demand of the referent doctor.

2.5. Statistical analysis

Data were expressed as the mean ± standard deviation. Statistical analysis used the Student's t paired test for quantitative data and the chi square test for discrete variables and ordinal tests.

The diagnosis value was defined according classical data: The positive predictive value was the proportion of positive tests results that were true positives. The negative predictive value was defined as the proportion of patients with a negative test result who were correctly diagnosed.

We used logistic regression with results of EPS as dependent variables. Age, gender and all variables associated with a p-value <0.10 on univariable logistic regression analysis were entered in the multivariable models. No selection process within the multivariable models was performed. C-index was used to illustrate the predictive accuracy of the multivariable logistic model.

A p value <0.05 was considered statistically significant. All statistical analyses were performed using the SPSS package for Windows (version 21, IBM Corp., Armonk, NY, USA) and Stata 12 SE (StataCorp., TX, USA).

3. Results

3.1. Results of noninvasive studies

Twenty-four hour Holter monitoring did not permit to evaluate the mechanism of tachycardia. The study remained negative in 2150 patients. ECGs were of poor quality in 204 patients. Tachycardia was