Is Exercise Stress Testing a Cost-Saving Strategy For Risk Assessment of Pediatric Wolff-Parkinson-White Syndrome Patients?

Jose M. Moltedo, MD,[1] Ramesh V. Iyer, MD,[2] Howard Forman, MD, MBA,[3] John Fahey, MD,[4] Geoffrey Rosenthal, MD, PhD,[5] Christopher S. Snyder, MD[4,6]

1. FLENI, Section of Pediatric Cardiology, Buenos Aires, Argentina
2. Connecticut Children's Medical Center, Division of Pediatric Cardiology, Hartford, CT
3. Yale University School of Medicine, Department of Diagnostic Radiology, New Haven, CT
4. Yale University School of Medicine, Division of Pediatric Cardiology, New Haven, CT
5. Cleveland Clinic, Division of Pediatric Cardiology, Cleveland, OH
6. Ochsner Clinic Foundation, Division of Pediatrics, New Orleans, LA

ABSTRACT

Background: In Wolff-Parkinson-White syndrome (WPW) patients the loss of pre-excitation in a single heartbeat during exercise stress testing (EST) is a predictor of low risk of sudden death. The **purpose** of this study was to: 1) assess the frequency of loss of pre-excitation in a single heartbeat during exercise testing, and 2) compare the cost of EST versus trans-catheter electrophysiology study (EPS) in the risk assessment of WPW patients.

Methods: A retrospective review of 50 cases of patients with WPW who underwent EST was conducted including demographics, history of supraventricular tachycardia, associated congenital heart disease, maximum heart rate achieved, and loss of pre-excitation in a single heartbeat. Hospital costs of EST and EPS were compared.

Results: Of the 50 patients who underwent EST, 4 (8%), lost pre-excitation in a single heartbeat during EST. No differences were found regarding gender, age at diagnosis or EST, history of supraventricular tachycardia, presence of congenital heart disease or maximal heart rate. A cost comparison, utilizing the cost data: EST ($62.75) and EPS ($5,597) found EST to be a cost-saving approach in WPW patients. With 4 patients losing pre-excitation during EST, the cost saving of EST was $22,388 for this population of WPW patients.

Conclusions: A frequency of 8% loss of pre-excitation was found in a pediatric sample that underwent EST. Additionally, EST was shown to be a cost-saving strategy in risk assessment of pediatric WPW patients.

Key Words: Wolff-Parkinson-White syndrome, exercise stress test

Corresponding author:
Christopher S. Snyder, MD
Division of Pediatric Cardiology
Ochsner Clinic Foundation
1514 Jefferson Highway
New Orleans, LA 70121
Tel: 504 842 5200
Fax: 504 842 5647
Email: csnyder@ochsner.org

Introduction

The prevalence of Wolff-Parkinson-White syndrome (WPW) ranges from 10-300 per 100,000 individuals (1-3). The most frequent time of diagnosis is during infancy, with a secondary peak in young adulthood (4). The clinical manifestations of WPW are variable, ranging from an incidental diagnosis on a surface electrocardiogram to syncope or sudden cardiac death (5).

The incidence of sudden cardiac death in WPW patients is reported to range from 0 to 4% (4, 6). The mechanism of sudden death is felt to be rapid, disorganized, anterograde conduction down the accessory pathway during atrial fibrillation (AF), resulting in degeneration into ventricular fibrillation (VF) (7). VF is reported to occur in approximately 3% of pediatric WPW patients and in up to 50% of patients who suffered from an aborted sudden cardiac arrest (6, 8). Due to this potentially lethal combination of arrhythmias, it is critical to identify pediatric patients at risk. A number of methods to risk assess WPW patients have been reported, ranging from non-invasive studies such as drug challenges and exercise stress testing (EST), to invasive studies such as trans-esophageal or trans-catheter electrophysiology studies (8-10). Numerous studies have shown that the loss of pre-excitation in a single heartbeat during EST correlates with a no-risk accessory pathway (10-12). In other words, patients that lose pre-excitation during their EST are at no risk of sudden death due to their WPW. Despite this, limited data exist in pediatrics regarding the percentage of WPW patients who actually lose pre-excitation in a single heartbeat during EST (10-12). Additionally, no data exist regarding the cost savings of this method when compared to performing a trans-catheter EPS in risk assessing pediatric WPW patients.

This study was designed 1) to evaluate the percentage of pediatric WPW patients who lost pre-ex-

citation in a single heartbeat during exercise stress testing and 2) to assess the potential cost savings of performing an exercise stress test on all WPW patients as compared to trans-catheter electrophysiology study (EPS).

Methods

An IRB approved, retrospective study was conducted using the records of all patients with WPW who underwent EST at Yale-New Haven Children's Hospital between 1994 and 2002. Data obtained included: age at diagnosis and EST, gender, history of supraventricular tachycardia, and presence of congenital heart disease. For the purpose of this study, all patients with ventricular pre-excitation were labeled as WPW, regardless of presence of tachycardia. The exercise stress test tracings and results were reviewed, including maximal heart rate achieved and presence of loss of pre-excitation in a single heartbeat. Physician supervised exercise stress tests were performed with a treadmill or bicycle ergometer using Bruce or Incremental protocols with continuous electrocardiographic monitoring and regular blood pressure determinations.

The Fisher's exact and Student's t-tests were used to evaluate differences between the groups, regarding gender, age at diagnosis, history of supraventricular tachycardia or associated congenital heart disease, age at EST, and maximal heart rate during the EST between the two groups (the SAS System Version 8e. SAS Institute, Cary, NC)

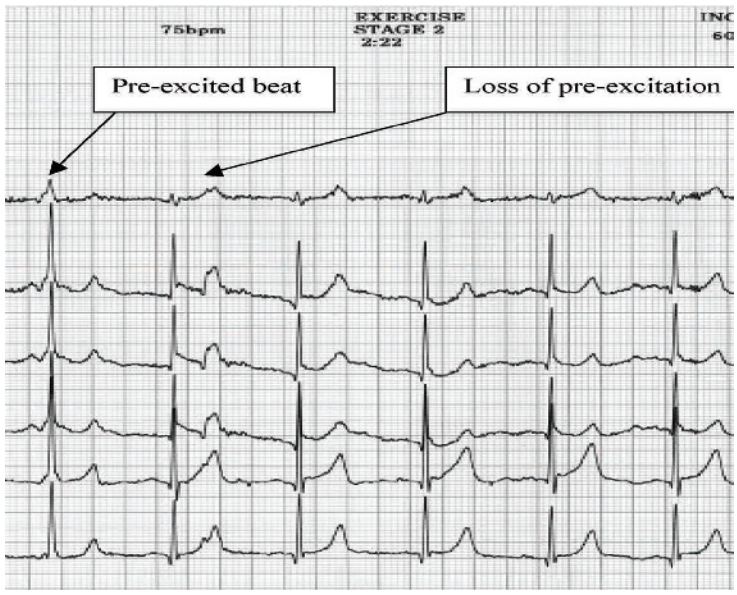
Hospital cost estimates obtained from administrative data of Yale-New Haven Hospital were the proprietary cost accounting product. The estimates of cost for EST and EPS were based upon the best available real cost data. Cost for a supervised EST was estimated at $62.75, which included 30 minutes of physician and nursing time; cost of paper, insurance, and ECG pads; an estimate of the cost of electricity and maintenance of the room, as well as depreciation of the treadmill. The estimated cost for performing an uncomplicated diagnostic trans-catheter EPS was $5,597.00, which included 3 hours of physician and nursing time, depreciation of the equipment involved (stimulator, electrophysiology system, angiography equipment, defibrillator), catheters (3), sedation, needles, intravenous fluids and start-up kit, insurance, and ECG pads.

Table 1. Comparison of Group I vs. Group II patients

	GROUP I	GROUP II
	Loss of pre-excitation (N=4)	No loss (N=46)
Gender (% of females)	25%	75%
Age at diagnosis (years)	7	10
(mean ± SD)	(± 3.2)	(± 2.4)
Age at EST (years)	13.7	12.3
(mean ± SD)	(± 4.3)	(±3.9)
History of SVT	75%	59%
Congenital heart disease	0%	6%
Max heart rate (bpm)	183	179
	(± 5.6)	(± 5.1)

EST: exercise stress test; SVT: supraventricular tachycardia; bpm: beats per minute

Figure 1. Sudden loss of pre-excitation during exercise stress test



Results

Of the 50 patients with WPW who underwent EST, 4 (8%) had sudden loss of pre-excitation in a single heartbeat (Group I) (Figure 1). The other 46 WPW patients (92%) had no loss of pre-excitation (Group II).

No statistically significant differences existed between Groups I and II with respect to age at diagnosis, age at exercise stress test, gender, history of supraventricular tachycardia, associated congenital heart disease, and maximal heart rate achieved during stress testing ($p > 0.05$) (Table 1).

No complications were observed during EST. One patient developed a non-sustained episode of supraventricular tachycardia. In addition, no sudden cardiac events were noted in either group of patients prior to or after their evaluation by EST.

With 4 patients losing pre-excitation during their EST, and therefore being classified as no risk, they did not require an EPS. The cost saving was $22,388 for this small population of patients who would not need to be referred for the more expensive EPS testing.

Discussion

In this study of pediatric WPW patients who underwent EST, 8% had sudden loss of pre-excitation in a single heartbeat with abrupt normalization of the QRS complex. This finding is concordant with the reported incidence of sudden loss of pre-excitation both in pediatric and adult populations, which ranges from 6-10% (10-12) and suggests that a number of pediatric WPW patients may not require further testing to assess their accessory pathways conduction properties. In other words, those who lost pre-excitation during their EST would be at zero risk of having a sudden cardiac event due to atrial fibrillation degenerating to ventricular fibrillation. Therefore, more aggressive, invasive electrical testing would be unnecessary. This finding alone should stimulate an interest in performing an EST on all pediatric WPW patients.

Further evaluation of the data did not reveal any differentiating factors such as gender, age at diagnosis or EST, history of supraventricular tachycardia or presence of congenital heart defects that could be used to identify those patients who would lose pre-excitation in a single heartbeat on EST. Therefore, none of these factors could be utilized to determine which patients would lose pre-excitation during their EST prior to performing their EST. With the small sample size and risk of type 2 error, one cannot be certain that patient factors are not associated with loss of pre-excitation. More studies with larger sample sizes should be performed to answer these questions.

The utilization of cost data was chosen instead of reimbursement data due to the discrepant reimbursements throughout the country. The cost of the two modalities was arrived upon utilizing data concerning average physician and nursing time, three catheters, ECG paper, intravenous fluids, sedation, needles and pads (ECG and defibrillator) as well as a cost estimate of electricity, insurance, maintenance of room and depreciation of equipment. We conservatively arrived at the cost per patient of an EST as $62.75 and that of an EPS at $5,659.75. This study found that 8% of those exercised did indeed lose pre-excitation, therefore resulting in a test that is a cost-saving strategy in the work-up of pediatric WPW patients. No account was made of the intangible or indirect cost savings of this strategy, such as loss of time from work or school, parental worry, recovery time and potential complications. Since these risks are much less when performing an EST when compared to an EPS, the additional cost savings could have become a significant factor if analyzed.

Limitations

Several limitations exist with this study. The retrospective nature of the review creates a selection bias, as only WPW patients who underwent EST were included. In addition, with regards to the absence of statistically significant differences between the groups in the variables analyzed, with only 4 subjects in the group that lost pre-excitation in a single beat the variability could be high.

Relevant to cost benefit, the analysis did not include the indirect costs (i.e. lost time from school or work, recovery and risks derived from an invasive procedure), or intangible costs (i.e. patients' anxiety and pain, parents' anxiety), that may have further strengthened the results.

In addition, there could be a very high cost associated with the misclassification of patients. If a patient's EST is interpreted as though the patient lost pre-excitation, when in fact they did not, the patient would not have any further testing performed. This could result in a misclassified patient suffering from sudden cardiac death. This misinterpretation may be avoided through careful attention to the electrocardiogram during the EST, having only experts interpret these ESTs and erring on the side of caution (i.e. referring patient for EPS if any question remains).

Conclusions

This study demonstrated 1) a prevalence rate of 8% for sudden loss of pre-excitation in a pediatric sample of Wolff-Parkinson-White patients that underwent exercise stress testing, and 2) that exercise stress testing appears to be a cost-saving strategy when compared to trans-catheter electrophysiology studies for risk assessment of pediatric patients with Wolff-Parkinson-White syndrome. In addition, larger studies are necessary to further assess the cost benefit of performing an exercise stress test on all patients looking at a multitude of factors not evaluated in this study, such as intangible and indirect cost savings.

References

1. Al-Khatib SM, Pritchet EL. Clinical features of Wolff-Parkinson-White syndrome. Am Heart J 1999;138(3 Part 1):403-413.
2. Wellens HJ, Rodriguez LM, Timmermans C, Smeets JP. The asymptomatic patient with Wolff-Parkinson-White electrocardiogram. PACE 1997;20:2082-2086.
3. Conti CR. What happened to the Wolff-Parkinson-White syndrome? Clin Cardiol 2001;24:531-532.
4. Munger TM, Packer DL, Hammil SC, et al. A population study of the natural history of Wolff-Parkinson-White syndrome in Olmsted County, Minnesota, 1953-1989. Circulation 1993;87(3):866-873.
5. Perry J. Supraventricular tachycardia. In: Garson A Jr, Bricker JT, Fisher DJ, Neish SR (eds). Science and Practice of Pediatric Cardiology, Baltimore: Williams & Wilkins, 1998:2059-2101.
6. Bromberg BI, Lindsay BD, Cain ME, Cox JL. Impact of clinical history and electrophysiologic characterization of accessory pathways on management strategies to reduce sudden death among children with Wolff-Parkinson-White syndrome. J Am Coll Cardiol 1996;27(3):690-695.
7. Klein GJ, Bashore TM, Sellers TD, Pritchett EL, Smith WM, Gallagher JJ. Ventricular fibrillation in the Wolff-Parkinson-White syndrome. N Engl J Med 1979;301:1080-1085.
8. Deal BJ, MacDonald D, Beerman L, et al. Cardiac arrest in young patients with Wolff-Parkinson-White syndrome (Abstract). PACE 1995;18 (Pt II): 815.
9. Gaita F, Giustetto C, Riccardi R, Mangiardi L, Brusca A. Stress and pharmacologic tests as methods to identify patients with Wolff-Parkinson-White syndrome at risk of sudden death. Am J Cardiol 1989;64:487-490.
10. Bricker JT, Porter CJ, Garson A Jr, et al. Exercise testing in children with Wolff-Parkinson-White syndrome. Am J Cardiol 1985;55:1001-1004.
11. Sharma AD, Yee R, Guiraudon G, Klein GJ. Sensitivity and specificity of invasive and non-invasive testing for risk of sudden death in Wolff-Parkinson-White syndrome. J Am Coll Cardiol 1987;10:373-381.
12. Daubert C, Ollitraut J, Descaves C, Mabo P, Ritter P, Gouffault J. Failure of the exercise test to predict the anterograde refractory period of the accessory pathway in Wolff-Parkinson-White syndrome. PACE 1988;11:1130-1138.