What Is the Yield of Screening Echocardiography in Pediatric Syncope?

Saskia Ritter, MD; Lloyd Y. Tani, MD; Susan P. Etheridge, MD; Richard V. Williams, MD; Janet E. Craig, PNP; and L. LuAnn Minich, MD

ABSTRACT. Objective. To determine the yield of screening echocardiography in the evaluation of pediatric syncope.

Design. All patients diagnosed with syncope from January 1993 to January 1999 were identified and their records were reviewed for age, weight, sex, year of presentation, personal and family history, physical examination, and cardiac diagnostic testing. Cardiac defects were identified by reviewing echocardiograms and reports.

Results. The 480 patients (268 females) ranged in age from 1.5 to 18.0 years old and ranged in weight from 10.3 to 113.6 kg. Final diagnoses included noncardiac causes in 458, long QT syndrome in 14, arrhythmias in 6, and cardiomyopathy in 2. An abnormal history, physical examination, or electrocardiogram identified 21 of the 22 patients with a cardiac cause of syncope. Of the 322 (67%) echocardiograms performed, abnormalities were detected in 37. These abnormalities included 26 minor valve anomalies, 7 hemodynamically insignificant shunt lesions, 2 mildly decreased left ventricular shortening fractions, and 2 cardiomyopathies. Only the 2 cardiomyopathies were considered to be potential causes of syncope, and in both cases, the electrocardiogram was markedly abnormal. A similar percentage of echocardiograms were ordered during the first and last 3 years of the study (61% vs 71%).

Conclusion. History, physical examination, and electrocardiography provide a screening protocol that allows the identification of a cardiac cause of syncope in the overwhelming majority of pediatric patients. In the absence of a positive screen result, the echocardiogram does not contribute to the evaluation of syncope in children. We speculate that primary care providers and pediatric cardiologists continue to use echocardiography because of the paucity of data regarding its value in pediatric syncope. However, this study shows little benefit of screening echocardiography and should discourage its routine use. Pediatrics 2000;105(5). URL: http://www.pediatrics.org/cgi/content/full/105/5/e58; syncope, pediatrics, echocardiography.

S
yncope is defined as a transient loss of consciousness and postural tone followed by complete recovery within a few minutes. It occurs frequently in children and most causes are benign.1,2 However, because some cardiac causes of syncope may be associated with a high mortality, it is crucial to accurately determine the cause of the syncopal event.3,4 In 1995, reports noting the frequent use but small contribution of echocardiography for the evaluation of adult syncope were first published.5-7 Similar studies have not been reported for children, and the role of echocardiography in the evaluation of pediatric syncope remains controversial. The purposes of this study were to determine the yield of echocardiography in the screening of pediatric syncope and the impact of the previously reported adult data on the use of echocardiography in the pediatric population.

METHODS

Study Population

The pediatric cardiology database was searched for all patients diagnosed with syncope from January 1, 1993 through December 31, 1998. Patients with previously diagnosed cardiac disease (including congenital heart lesions, cardiomyopathies, and arrhythmias) who subsequently developed syncope were excluded, leaving only those patients with the chief complaint of syncope at the initial encounter in the cardiology clinic. Patient records were reviewed for demographic data, including age, weight, sex, year of presentation, personal and family history (including history of syncope, cardiomyopathy, long QT syndrome, and sudden death), physical examination, and final diagnosis. Neurolly mediated syncope was defined for this study as presumed systemic hypotension and subsequent inadequate cerebral blood flow resulting primarily from a neural reflex-mediated combination of inappropriate vasodilatation and bradycardia.3 Echocardiograms and reports were reviewed independently by 2 cardiologists blinded to the final diagnoses. Because reports of the low yield of echocardiography in determining the cause of adult syncope were published in 1995,5-7 the percentage of patients having an echocardiogram was calculated for the first 3 years (1993–1995) versus the last 3 years (1996–1998) of the study.

Statistical Methods

Categorical data were compared using the x2 test or Fisher’s exact test (when the cells contained <5). Statistical significance was defined as P < .05.

RESULTS

The 480 patients who met the inclusion criteria ranged in age from 1.5 to 18.0 years (median: 13 years), ranged in weight from 10.3 to 113.6 kg (median: 60 kg), and consisted of 268 females and 212 males.

The circumstances triggering the syncopal event included sitting or standing for a long period (46%), hot environment (16%), chest pain (13%), sight of blood (7%), turning head (5%), and an acute illness (4%). Dizziness or lightheadedness was the most frequent prodrome to syncope (63%), but patients also reported nausea (41%), blurred vision (26%), spots before eyes (7%), and tinnitus (7%). After the syncopal episode, 38% of patients reported fatigue, 27%
had a headache, and 16% had jerking or shaking movements. Syncope occurred with exercise in 153 patients. The family history was positive for syncope in 162 patients. Of these 162 patients, 116 had noncardiac causes and 46 had cardiac causes of the syncope (8 with cardiomyopathy, 7 with long QT syndromes, and 31 with sudden death). The physical examination was abnormal in 40 of 480 patients (8.3%), including 32 patients with a click and 8 with a pathologic murmur. Electrocardiograms were performed in 449/480 (94%) of patients and were abnormal in 15%. Echocardiograms were performed in 322 (67%) patients and were abnormal in 12%. Primary care providers ordered 54 of the 322 (17%) echocardiograms before referring the patient to the cardiology clinic.

Final diagnoses are summarized in Table 1. Noncardiac causes were found in 95%, including 71% with neurally mediated syncope. Cardiac causes were identified in 5% and included long QT syndrome (without documented ectopy) in 14 patients and arrhythmias in 6 (3 patients with sinus node dysfunction and 1 each with atrial ectopic tachycardia, right ventricular outflow tract tachycardia, and supraventricular tachycardia with Wolff-Parkinson-White syndrome). The remaining 2 patients had cardiomyopathies (1 hypertrophic and 1 arrhythmogenic right ventricular dysplasia).

Of the 22 patients with a cardiac cause of their syncope, 16 had a history of exercise-induced syncope, a positive family history, or an abnormal physical examination. The electrocardiogram was abnormal in 5 of the remaining 6 patients. Compared with patients with a noncardiac cause of syncope, patients with cardiac causes had no significant differences in the frequency of exercise-induced syncope, positive family history, or abnormal examination (Table 2). However, compared with patients without cardiac syncope, a significantly greater proportion of patients with cardiac syncope had an abnormal electrocardiogram (11% vs 73%; P < .0001). When a screening protocol of a personal history of exercise-induced syncope, positive family history, abnormal physical examination, or abnormal electrocardiogram was used, 21 of the 22 patients with a cardiac cause of syncope were identified (sensitivity: 96%; Table 3). The only patient not identified by this protocol had sinus node dysfunction diagnosed by 24-hour Holter monitoring. His echocardiogram was normal.

Of the 322 patients undergoing an echocardiogram, 37 (12%) had an abnormality identified. Abnormalities included 26 minor valve lesions (18 mitral, 5 tricuspid, 2 aortic, and 1 pulmonary), 7 hemodynamically insignificant shunt lesions (5 septal defects, 1 patent ductus arteriosus, and 1 tiny coronary-to-pulmonary artery fistula), 2 mildly decreased left ventricular shortening fractions (25% and 27%), and 2 cardiomyopathies (1 hypertrophic and 1 right ventricular dysplasia). Only the 2 cardiomyopathies were considered to be cardiac causes of syncope, and in both cases, the electrocardiogram was markedly abnormal. Echocardiographic abnormalities were detected in 11 of 230 patients (4.8%) with a normal examination and electrocardiogram, and in 26 of 92 patients (28.3%) with an abnormal examination or electrocardiogram. The 4 patients with an abnormal echocardiogram who had a cardiac cause of syncope included the 2 patients with cardiomyopathies and 2 patients with minor valve abnormalities who also had long QT syndrome (Table 4). Overall, the sensitivity of echocardiography for detecting a cardiac cause of syncope was 18%.

There was no detectable difference (but the power is low) between the number of echocardiograms ordered during the first 3 years versus the last 3 years of the study (61% vs 71%; P = .27; β = .2).

**DISCUSSION**

Syncope is common in children and may result from many causes, including abnormalities of the autonomic nervous system, as well as cardiac, metabolic, neurological, and psychological disorders. Although most causes of syncope are benign, a cardiac cause may be associated with a high mortality rate. Therefore, one of the major goals of the evaluation of a child with syncope is to differentiate benign causes from potentially life-threatening but treatable cardiac disorders.

<p>| TABLE 1. Summary of Final Diagnoses (n = 480) |</p>
<table>
<thead>
<tr>
<th>Cause of Syncope</th>
<th>Number of Patients</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noncardiac syncope</td>
<td>458</td>
<td>95</td>
</tr>
<tr>
<td>Long QT syndrome</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>2</td>
<td>.4</td>
</tr>
</tbody>
</table>

<p>| TABLE 2. Comparison of an Abnormality in the Screening Protocol (History, Physical Examination, and Electrocardiogram) in Patients With Cardiac Versus Noncardiac Causes of Syncope |</p>
<table>
<thead>
<tr>
<th>Positive Variable</th>
<th>Noncardiac (n = 458)</th>
<th>Cardiac (n = 22)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise-induced</td>
<td>143</td>
<td>10</td>
<td>.19</td>
</tr>
<tr>
<td>Family history</td>
<td>153</td>
<td>9</td>
<td>.50</td>
</tr>
<tr>
<td>Physical exam</td>
<td>38</td>
<td>2</td>
<td>.09</td>
</tr>
<tr>
<td>Electrocardiogram</td>
<td>52</td>
<td>16</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

| TABLE 3. Abnormalities of the Screening Protocol (History, Physical Examination, and Electrocardiogram) in Patients With Cardiac Versus Noncardiac Causes of Syncope |
|------------------|------------------|
| cardiomyopathy | 2 |
| Long QT syndrome | 14 |
| Noncardiac syncope | 458 |
| Cardiac syncope | 22 |

| TABLE 4. Abnormal Echocardiogram Versus a Cardiac Cause of Syncope |
|------------------|------------------|
| Abnormal echocardiogram | 4 |
| Normal echocardiogram | 33 |

Sensitivity = 18%; specificity = 93%; positive predictive value = 11%; and negative predictive value = 96%.
is the most common cause of syncope, but rarely occurs before 10 years of age. It is characterized by prodromal symptoms and is often triggered by specified events. Loss of consciousness or postural tone lasts less than a minute and is followed by complete recovery. The recovery period itself may be associated with prolonged fatigue and headache. In addition to this benign form, however, syncope may be the presenting symptom of a cardiac abnormality in children, especially in those children presenting with exercise-induced syncope.8,11 Because of the reported high mortality rate in this group, parents and referring pediatricians may be understandably anxious and want a cardiac cause completely excluded by all possible means.2,3,10 Parental and physician anxiety may lead to the frequent use of echocardiography in the evaluation of syncope in an attempt to unequivocally identify the rare heart diseases that may be associated with arrhythmias and risk of sudden death. Adult studies have reported that ~60% to 70% of patients with syncope undergo echocardiography. In patients without clinical evidence of an underlying cardiac disease, however, the echocardiogram was seldom abnormal.5,7,15,16 These studies have led to the latest American College of Cardiology/American Heart Association guidelines recommending the use of echocardiography only in patients with clinically suspected heart disease or exercise-induced syncpe.7

Because there are no comparable data in children, the diagnostic approach to pediatric syncope remains controversial and without uniform recommendations. In a previous study involving pediatric patients, McHarg and colleagues17 found no clinical or historical features to reliably distinguish cardiac causes of syncope from noncardiac causes such as neurally mediated syncope. However, in our study 16 of 22 patients (73%) with a cardiac cause of syncope had a history of exercise-induced syncope, positive family history, or abnormal physical examination. Furthermore, the McHarg study did not evaluate a screening protocol of a history of exercise-induced syncope, positive family history, abnormal physical examination, or abnormal electrocardiogram (used to identify 21/22 patients in this study). Similar to the previously published adult studies,5 we found echocardiography was ordered in 67% of cases but did not contribute to the diagnosis if the history, physical examination, and electrocardiogram were normal. We found only 2 patients with cardiomyopathy, a rare cause of pediatric syncope, which may be associated with a high mortality. Both of these patients had markedly abnormal electrocardiograms. Based on this study, we conclude that a comprehensive, cost-effective approach for the evaluation of childhood syncope should consist of a detailed history, thorough physical examination, and electrocardiogram; then, if 1 or more of these is abnormal, an echocardiogram may be warranted.

This study is limited by being retrospective; however, complete data were obtained from the clinical records. In addition, to decrease potential diagnostic errors, 2 cardiologists blinded to the results independently reviewed the echocardiograms.

**CONCLUSION**

We conclude that although a history and physical examination alone are not sufficient to identify all patients with a cardiac cause of syncope, a screening protocol, including a thorough history, physical examination, and electrocardiography will allow the identification of a cardiac cause of syncope with a sensitivity of 96%. In the absence of a history of exercise-induced syncope, positive family history, abnormal physical examination, or abnormal electrocardiogram, the echocardiogram does not contribute to the evaluation of pediatric syncope. We speculate that primary care providers and pediatric cardiologists continue its routine use because of the paucity of data regarding its value. However, this study shows little benefit of screening echocardiography and should discourage its routine use for the evaluation of pediatric syncope.

**REFERENCES**

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