Head-up tilt for the evaluation of syncope of unknown origin in children

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Fifteen patients aged 10 to 18 years with syncope of unknown origin, and 10 healthy control children aged 11 to 18 years, were evaluated by head-up tilt to 60 degrees for 60 minutes. Six patients (43%) reproduced symptoms of syncope during the examination. Four had a typical vasovagal reaction; two had marked hyperventilation. None of the children in the control group had syncope. The head-up tilt test offers a simple, noninvasive, high-yielding diagnostic tool for evaluation of syncope in children. (J PEDIATR 1991;118:676-9)

The cause of syncope remains unclear in many patients, despite extensive medical evaluation.1 Recent studies have shown the usefulness of the head-up tilt in stimulating vasovagal reactions in adult patients with unexplained syncope.2-7 In this study the head-up tilt was used as a further investigation of recurrent syncope in pediatric patients more than 10 years of age whose evaluation had failed to reveal the cause.

METHODS

Fifteen consecutive patients (nine girls) with a history of unexplained syncope were studied. Their mean age was 14.4 years (range 10 to 18 years). Patients were referred from the pediatric emergency department or from the pediatric cardiology unit. They had had a mean of 5.9 syncopal episodes (1 to 20 episodes). The duration of symptoms ranged from 1 week to 9 years (mean 2.1 years).

All patients underwent a standardized basic evaluation consisting of the following: a complete history; physical and neurologic examination; blood pressure measurement in the recumbent and upright positions; complete blood cell count; urinalysis; measurement of electrolyte, blood urea nitrogen, and glucose concentrations; 12-lead electrocardiography; 24-hour ambulatory electrocardiographic monitoring; and evaluation by a pediatric cardiologist (who performed echocardiography). In all cases, syncope had occurred with little or no warning in different situations, and the history did not suggest the diagnosis. The evaluations also failed to reveal the cause of syncope. One patient was found to have mitral valve prolapse.

The patients were studied, at no specific time, in an isolated room in the nonfasting state. No intravascular instrumentation was used. Patients were connected to a standard cardiac monitor for continuous evaluation of heart rate and to a blood pressure monitor (Fig. 1, A and B). Heart rate and blood pressure were monitored initially while the patient was resting in the supine position for 10 minutes, and thereafter during a head-up tilt to 60 degrees for 60 minutes. As soon as symptoms developed, the patient was returned to the supine position and the test was ended. Ten healthy children (six boys) without a history of syncope or near syncope served as control subjects; their mean age was 14.5 years (range 11 to 18 years). Statistical analysis was done with the Fisher Exact Test.

RESULTS

One 10-year-old patient refused to complete the test after 15 minutes and was excluded from our study. Six patients (43%) became syncopal after a mean standing time of 48 minutes (range 30 to 60 minutes). A typical vasovagal re-
action with hypotension and bradycardia was observed in four patients (Table). Asystole for 3.2 to 17 seconds developed in three patients. One male patient, aged 12 years, had an asystole lasting 17 seconds (Fig. 2) that was accompanied by an anoxic seizure (tonic extension of the limbs). These patients regained consciousness immediately after the table was lowered to the supine position. Marked hyperventilation with secondary sinus tachycardia and normal blood pressure was a cause of syncope in two female patients; they remained unconscious for a few minutes despite lowering of the table. Eight patients had a normal response, remaining symptom free with a rise in heart rate but with no significant shift in blood pressure. None of the control children had syncope. This difference is significant \((p <0.05)\).

**DISCUSSION**

Vasovagal syncope classically occurs in the upright position. Erect posture without movement shifts blood to the lower extremities. Normally there is a compensatory increase in sympathetic tone, but when there is an inadequate vasoconstrictive response, hypotension develops. The venous pooling and the catecholamine excess also paradoxically trigger parasympathetic neural activity, resulting in a cardioinhibitory response and aggravation of hypotension.\(^8,9\) Head-up tilt is therefore a powerful stimulus to vasovagal syncope in susceptible patients and can establish the diagnosis when the history is not contributory. All other tests frequently used in the evaluation of syncope of unknown origin have no value in this kind of fainting.

Recently the head-up tilt test has become a standard diagnostic test for the evaluation of syncope in adults.\(^2-7\) Various researchers have used different protocols, the duration of tilt being 10 to 60 minutes and the angle 60 to 80 degrees. It seems clear that syncope is induced sooner when the angle is larger. Almquist et al.\(^4\) reproduced syncope in 27% of their patients during a 10-minute test using an 80-degree angle. Tilt reproduces syncope in 40% (7) to 67% (2) of patients. According to our experience, syncope developed during the last minutes of the 60-minute test in two patients, so a prolongation of the test would seem reasonable. In none of the control children did premonitory symptoms occur in the last minutes, but a new control group would be needed to determine whether the specificity is reduced by prolonging the test.

Other variables apparently affect the frequency and the time necessary for induction of syncope (for example, the resting supine time and the use of an indwelling catheter\(^2,4\)). In the adult control groups with no history of syncope, symptoms developed in up to 10% of the cases.\(^3,4\) Syncope was not induced in any of our age-matched children.

In our work, syncope was reproduced by tilt in 6 of 14 patients, but a vasovagal reaction occurred in only four patients; in the other two, hyperventilation was the cause of syncope. This observation has not been described in adults;
Continuous electrocardiographic strip during 60-degree head-up tilt shows blocked P wave followed by prolonged asystole and several ventricular escape beats. After table was returned to recumbent position, electrocardiogram showed blocked P waves followed by restoration of sinus rhythm (1 second equals five large squares).

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age/sex (yr)</th>
<th>No. of syncopal episodes</th>
<th>Duration of syncope</th>
<th>Organic heart disease</th>
<th>ECG</th>
<th>Standing time before syncope (min)</th>
<th>Mechanism of syncope</th>
<th>Monitoring findings during syncope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10/M</td>
<td>8</td>
<td>2 yr</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>14/M</td>
<td>5</td>
<td>3 yr</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>18/M</td>
<td>9</td>
<td>1 yr</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>17/M</td>
<td>3</td>
<td>1 yr</td>
<td>MVP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>18/F</td>
<td>4</td>
<td>1 yr</td>
<td>Normal</td>
<td></td>
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</tr>
<tr>
<td>6</td>
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<tr>
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<td>5</td>
<td>1 1/2 yr</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>14/F</td>
<td>3</td>
<td>6 mo</td>
<td>Normal</td>
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</tr>
<tr>
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<td>17/F</td>
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<td>3 yr</td>
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<tr>
<td>10</td>
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<td>5</td>
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<tr>
<td>11</td>
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<tr>
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<td>4</td>
<td>6 mo</td>
<td>Sinus tachycardia</td>
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</table>

ECG, Electrocardiogram; MVP, mitral valve prolapse.

this is not surprising, however, because this cause is rare in adults but relatively frequent in adolescents. The head-up tilt is therefore a stressful situation that may induce hyperventilation in susceptible persons.

Various medications have been used to prevent vasovagal syncope. The head-up tilt is useful in identifying which drug to use in each patient and in evaluating the success of treatment. When the most important component of the syncopal event is atrioventricular block, anticholinergic treatment with atropine or scopolamine is helpful. Propranolol is useful when increased sympathetic tone is the pathogenic mechanism. Induction of syncope by isoproterenol during tilt reveals this mechanism. Etilefrine is highly effective when the mechanism is reduced sympathetic tone. Raviele et al. treated seven of their patients with drugs found to be effective during the head-up tilt test, and none had recurrence of their symptoms during a 12-month follow-up period. Milstein et al. reported a 100% success rate in preventing syncope in 10 patients with head-up tilt–induced syncope who were treated with orally administered disopyramide, an anticholinergic and negative inotropic agent that also tends to increase peripheral vascular resistance.

We conclude that the head-up tilt test offers a simple, noninvasive diagnostic tool for evaluation of syncope of unknown origin in children. When the mechanism is vasova-
gal or vasodepressor-induced syncope, lowering the table rapidly restores consciousness; no deaths have been reported. The syncopal event is only a reproduction of the patient's usual symptoms, so we believe that this is a safe procedure that can be used in an ambulatory setting, providing that there are monitoring equipment and a physician present during the test and that the table can be lowered immediately.

REFERENCES


FELLOWSHIPS

Available fellowships in pediatric subspecialties and those for general academic pediatric training are listed once a year, in May, in THE JOURNAL OF PEDIATRICS. Each October, forms for listing such fellowships are sent to the Chairman of the Department of Pediatrics at most major hospitals in the United States and Canada. Should you desire to list fellowships, a separate application must be made each year for each position. All applications must be returned to Mosby-Year Book, Inc., by February 15 of the listing year to ensure publication. Additional forms will be supplied on request from the Journal Editing Department, Mosby-Year Book, Inc., 11830 Westline Industrial Drive, St. Louis, MO 63146-3318/314-453-4317.