

Diagnostic Value of the Tilt-Table Test for the Assessment of Syncope in Children and Adolescents

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Objective - To assess the diagnostic value, the characteristics, and feasibility of tilt-table testing in children and adolescents.

Methods - From August 1991 to June 1997, we retrospectively assessed 94 patients under the age of 18 years who had a history of recurring syncope and presyncope of unknown origin and who were referred for tilt-table testing. These patients were divided into 2 groups: group I (children) - 36 patients with ages ranging from 3 to 12 (mean of 9.19 ± 2.31) years; group II (adolescents) - 58 patients with ages ranging from 13 to 18 (mean of 16.05 ± 1.40) years. We compared the positivity rate, the type of hemodynamic response, and the time period required for the test to become positive in the 2 groups.

Results - The positivity rates were 41.6% and 50% for groups I and II, respectively. The pattern of positive hemodynamic response that predominated in both groups was the mixed response. The mean time period required for the test to become positive was shorter in group I (11.0 ± 7.23 min) than in group II (18.44 ± 7.83 min). No patient experienced technical difficulty or complications.

Conclusion - No difference was observed in regard to feasibility, positivity rate, and pattern of positive response for the tilt-table test in children and adolescents. Pediatric patients had earlier positive responses.

Key words: tilt-table test, neurocardiogenic syncope, children and adolescents

Syncope is a relatively common symptom during childhood. Prodinger et al¹ reported that 15% to 50% of the adolescents have at least 1 episode of syncope by the end of adolescence. Other research carried out in university students reported a 47% prevalence of syncope in this population.

Syncope accounts for approximately 1 out of 2000 visits to the pediatric emergency department². Its incidence in children and adolescents under medical follow-up is 0.125%, and it is more frequent in girls, with a peak at 15 to 19 years of age. The episode is usually isolated and relates to an acute disease or psychological stress, or both, or noxious stimuli³. In many cases, even after an extensive evaluation, the cause remains undetermined. Despite being benign most of the time, syncope usually generates anxiety and uncertainty in the patient, the family, and the environment where they live.

Syncope is a symptom with multiple causes from benign situations to etiologies with a potential risk of sudden death. Therefore, clarifying its cause is important. In children and adolescents, the neurocardiogenic etiology is supposedly the most frequent⁴. The tilt-table test appeared in the last decade and has been widely used for diagnosing neurocardiogenic syncope. However, controversies persist in the literature in regard to its feasibility and diagnostic value in pediatric patients^{5,6}.

The objective of this study was to evaluate the diagnostic value, the characteristics of the results, and the feasibility of the tilt-table test in children with a history of recurring syncope of unknown origin in comparison with that in an adolescent population.

Methods

The study was carried out retrospectively. Data were collected through review of the medical records of patients under the age of 18 years who underwent tilt-table testing in the period from August 1991 to June 1997 at the laboratory of the Autonomic Evaluation of Arrhythmia Unit - Heart Institute. The study comprised patients who had had 2 or more episodes of syncope or repetitive episodes of presyn-

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cope of unknown origin, after noninvasive or invasive cardiovascular clinical and neurological evaluation, according to the requirements of each case. Ninety-four patients were selected and divided into 2 groups according to age bracket: group I, 36 patients, with ages ranging from 3 to 12 years (mean age of 9.19 ± 2.31 years); group II, 58 patients, with ages ranging from 13 to 18 years (mean of 16.05 ± 1.40 years).

The patients underwent tilt-table testing during the morning while they were fasting, in a calm, quiet, and dimly lit environment. No patient was receiving medication that might interfere with the result of the test. No sensitizing agents, venous puncture, or invasive procedures were used.

For tilt-table testing, a tilting gurney (orthostatic gurney - Carci Ind. e Com. - São Paulo, modified in the bioengineering sector of the Heart Institute) was used with maximum angulation of 60° and a platform for the feet. In the horizontal dorsal decubitus position, the patients were monitored for blood pressure with a noninvasive digital monitor (2300 - Finapres - Ohmeda) and electrocardiography was performed with a polygraph Hewlett-Packard (HP). Recordings of the pressure curves, of heart rate, and of electrocardiography were performed with an HP polygraph coupled with a monitor (Sistema Labele). These recordings were filed in a program for acquisition of biological signs, which was designed by the information and technology sector of InCor specifically for performing the tilt-table test.

The patients rested for 20min in the horizontal dorsal decubitus position, and the gurney was then tilted in approximately 5s until the 60° angle was reached. The patients were observed for 40min or less, until reaching the criteria of positivity of the test (a decrease in systolic blood pressure >30 mmHg or a drop in heart rate, or both, associated with presyncopal or syncopal symptoms, or both) ⁷. According to the behavior of blood pressure and heart rate, the positive hemodynamic responses were classified as follows: 1) vasodepressive: a drop in blood pressure with no significant change in heart rate; 2) mixed: arterial hypotension accompanied by a drop in heart rate; 3) cardioinhibitory: cardiac asystolia (pause >3 s) accompanied by arterial hypotension; 4) tachycardic postural syndrome: an increase in heart rate $>30\%$ as compared with the baseline heart rate during the prolonged period of monitoring in the orthostatic decubitus position, or heart rate >120 bpm in the first 10min, accompanied by symptoms of postural intolerance, without triggering the neurocardiogenic reflex.

Positivity was calculated using the following ratio: number of patients with a positive test/total number of patients with a history of syncope. Inference was performed using the analysis of Fisher exact test, the chi-square test, and the Mann-Whitney test. We adopted the significance level of 5% ($\alpha=0.05$).

Results

Comparative data related to sex, number of previous syncopal episodes, and duration of the history are shown in

table I. No significant difference was observed when comparing the 2 groups.

In regard to the positivity of the test, group I had a rate of 41.6% (with 15 positive tests), and group II had a rate of 50% (with 29 positive tests). The type of positive response predominating in both groups was the mixed response. Distribution of the hemodynamic responses is shown in table II, and no statistical difference was observed in this distribution.

The mean period of exposure required for the test to become positive was shorter in the group of children (11.0 ± 7.23 min – minimum of 2min and maximum of 24min) as compared with that of the group of adolescents (18.44 ± 7.83 min – minimum of 2min and maximum of 35min) ($p=0.009$).

No sedation was required for performing the test in any child. No complications occurred, and in all positive cases, the reflex was spontaneously reversed with repositioning of the gurney to the horizontal dorsal decubitus position, no intervention being necessary. Only rarely was the mother required to remain in the testing room to keep the child calm so the test could be performed.

Discussion

Based on this study, we observed that the positivity rate of the tilt-table test in children and adolescents with syncope of unknown origin was similar in both groups

Table I – Comparative data between the groups of children and adolescents in regard to age, sex, number of syncopal episodes, and duration of the history

Variable	Group		
	Children	Adolescents	
Sex (female)	20 (55.5%)	39 (67.2%)	P= 0.279*
Age			
minimum	3 years	13 years	
maximum	12 years	18 years	
(mean)	(9.19 ± 2.31)	(16.05 ± 1.40)	
Syncopal episodes (mean)	7.84 ± 16.5	6.18 ± 8.17	P= 0.859**
Duration of history (months)	29.43 ± 29.65	29.58 ± 41.61	P= 0.253**

* Fisher exact test; ** Mann-Whitney test.

Table II – Distribution of the hemodynamic responses to the test in the 2 groups

Type of response	Groups	
	Children	Adolescents
Negative	21 (58.3%)	29 (50%)
Mixed positive	10 (27.7%)	18 (31%)
Positive vasodepressive	4 (11.1%)	7 (12%)
Positive cardioinhibitory	1 (2.7%)	1 (1.7%)
Tachycardic postural syndrome	0 (0%)	3 (5.1%)

P=0.669 (chi-square test).

(41.6% and 50%, respectively). In a previous study carried out at our institution and comprising 125 patients with a mean age of 34.6 years, the positivity rate was 41.6%, which is very comparable to the results of the present study. Pavri et al⁸ analyzing data of 333 patients undergoing passive tilt-table testing in 12 studies reported that the positivity rate of the test ranged from 7% to 55% with a mean of 24%. Linzer et al⁹ in a study with 425 patients reported a positivity rate of the tilt-table test ranging from 26% to 90%.

Since the initial studies by Kenny et al¹⁰ in 1986, tilt-table testing has shown effectiveness and safety in identifying patients with neurocardiogenic syncope, and, soon after, several investigators initiated its use in pediatric patients. However, the nonexistence of a gold standard and the lack of standardized protocols in regard to tilting angulation during the test, concomitant invasive procedures, administration of sensitizing pharmacological agents, and chronological factors, have made the determination of positivity and specificity difficult, resulting in great variations in the results obtained.

Pongiglione et al¹¹, in a study comprising 20 patients (mean age of 12.5 years) with recurrent syncope who underwent the passive tilt-table test at 60° for 15min, followed by the sensitizing test with isoproterenol, reported an 80% positivity rate (16 patients). Of these, 4 patients had a positive test in the passive period and 12 patients after the use of isoproterenol. Thilenius et al¹² reported a 74.2% positivity rate and reproduction in symptoms in 80% of the patients using the passive protocol at 60° for 10min, followed by isoproterenol infusion in a total of 35 patients with ages ranging from 8 to 19 years. Alehan et al¹³, in a study comprising 20 patients (mean age of 12 years) undergoing the passive protocol at 60° for 25min followed by the sensitizing test with isoproterenol, obtained a 75% positivity rate, and only 25% of the patients had a positive test in the passive period. Later, in another study¹⁴, the same investigators performed the tilt-table test with the sensitized protocol or the passive type at 60° for 45min. They studied 65 patients and 30 controls with mean ages of 11.4 and 12.8 years in the 2 groups, and they aimed to compare the sensitivity and specificity of the tilt-table test with and without isoproterenol. They reported positivity and specificity rates of 76.6%/86.7% and 48.5%/93.4%, respectively, for the 2 groups. Grubb et al¹⁵ studied 30 patients who had had at least 3 episodes of syncope in the last 6 months, 14 years being their mean age, and used the passive protocol with a tilt angle of 80° for 30min. The protocol was followed by the sensitizing test with isoproterenol. They reported a 70% positivity rate for the tilt-table test and only 20% of positivity in the passive period. Using the same protocol in 66 patients with mean age of 13.6 years, Berkowitz et al¹⁶ reported a 65% (43 patients) positivity in the passive period with an addition of 12% in 20 of the 23 patients later undergoing the sensitizing test with isoproterenol. In this same study, the false-positive rate was 52% in the passive test. On the other hand, when sensitization with isoproterenol was used, no increase in the false-positive rate was observed. The results led the authors to

question the specificity of the test, and, at the same time, to recommend tests lasting up to 20min to minimize the incidence of false-positive results.

In studies performed with no sensitizing agents, the results showed a lower positivity rate. Lerman-Sagle et al¹⁷, in a study with 15 patients (mean age of 14.4 years) and 10 controls, performed the tilt-table test at 60° for 60min and obtained a 43% positivity rate with 100% specificity. Fouad et al¹⁸ provoked a vasovagal response in 25 out of 45 patients (57%), and in 3 out of 18 controls (17%). In addition to the tilt-table test, some investigators have used the orthostatic test based on the same principle as the tilt-table test for assessing syncope. Ross et al¹⁹, using a protocol in which the patients, after a resting period, remained in the orthostatic position at 90° without any support for 12min, obtained syncope in 44% of 104 patients (mean age = 13 years). Oslizlok et al²⁰, however, with the same tilting angulation but for 15min, reported a positivity rate of 58% in 209 patients, whose ages ranged from 1.8 to 18 years.

Specificity in regard to different tilting angles was the objective of the study by Lewis et al²¹. In this study, the controls, whose ages ranged from 12 to 18 years, underwent the passive tilt-table test with angles of 60°, 70°, and 80°, and a duration of 30min, which resulted in specificities of 69%, 71%, and 40%, respectively. On the basis of the results obtained, the authors recommended the use of angles of 60° or 70° for no longer than 10min. In another study with controls, whose ages ranged from 6 to 16 years, Van Steenwijk et al²² used the orthostatic test and the tilt-table test with a tilting angle of 70°. Of the 68 controls, 29 (40%) had a false-positive result, which was attributed to the associated intravascular procedure. Despite data presented, it is worth noting that the tilt-table test identifies an excessive susceptibility to the vasovagal reflex, to which all human beings are vulnerable, depending on the stimulus. Therefore, specificity of the tilt-table test may have been actually underestimated. In our study, the patients did not undergo intravascular procedures aiming to minimize false-positive results.

Most of the hemodynamic responses of the positive tests obtained in our study were mixed (66.6% in children and 62.0% in adolescents). In regard to this parameter, data in the literature vary. Mangru et al²³ and Müller et al²⁴, studying patients whose mean ages were 14 and 13 years, respectively, reported results similar to ours, in which the mixed response predominated with 50% and 71.4%, respectively. On the other hand, Alehan et al¹³ reported a vasodepressive response in 67% of patients, mixed in 27%, and cardioinhibitory in 6%. In regard to duration of exposure to the orthostatic decubitus position for a positive test, the results reported ranged from 8.5min to 48min. No study separately analyzing children and adolescents has been reported. In a previous study carried out in our service and cited above, with patients whose mean age was 34.2 years, the time elapsed between tilting and the appearance of symptoms ranged from 3 to 40min, with a mean of 18 min and 25s. In the present study, the means obtained (11.0min for children and 18.4min for adolescents) were similar to most data in the

literature, with earlier responses for children as compared with those for adolescents.

In conclusion, the tilt-table test is a useful method for assessing unexplained syncope in children, and no difference

was observed in the positivity rates for children and adolescents. The predominant hemodynamic response of the positive tests was mixed in both groups. Children had earlier positive responses as compared with those of adolescents.

References

1. Prodinger RJ, Reisdorff EJ. Syncope in Children. *Emerg Med Clin North Am* 1998; 16: 617-26.
2. McHarg ML, Shinnar S, Rascoff H, Walsh CA. Syncope in childhood. *Pediatr Cardiol* 1997; 18: 367-71.
3. Driscoll DJ, Jacobsen SJ, Porter CJ, Wollan PC. Syncope in children and adolescents. *J Am Coll Cardiol* 1997; 29: 1039-45.
4. Lewis DA, Dhala A. Syncope in the pediatric patient. *Pediatr Clin North Am* 1999; 46: 205-19.
5. Benditt DG, Ferguson DW, Grubb BP, et al. Tilt table testing for assessing syncope. *J Am Coll Cardiol* 1996; 28: 263-75.
6. Tanel RE, Walsh EP. Syncope in the pediatrics patient. *Cardiol Clin* 1997; 15: 277-94.
7. Hachul D, Sosa EA, Consolim F, et al. Valor diagnóstico do teste de inclinação na avaliação da síncope de origem indeterminada. Resultados preliminares. *Arq Bras Cardiol* 1994; 62: 7-9.
8. Pavri BB, Ruskin JN, Brooks R. The yield of head-up tilt testing is not significantly increased by repeating the baseline test. *Clin Cardiol* 1996; 19: 494-6.
9. Linzer M, Yang EH, Mark Estes III NA, Wang P, Vorperian VR, Kapoor WN. Diagnosing syncope part 2: Unexplained syncope. *Ann Intern Med* 1997; 127: 76-86.
10. Kenny RA, Ingram A, Bayliss J, Sutton R. Head-up tilt: A useful test for investigating unexplained syncope. *Lancet* 1986; 11: 1352-4.
11. Pongiglione G, Fish FA, Strasburger JF, Benson W. Heart rate and blood pressure response to upright tilt in young patients with unexplained syncope. *J Am Coll Cardiol* 1990; 16: 165-70.
12. Thilenius OG, Quinones JA, Husayni TS, Novak J. Tilt test for diagnosis of unexplained syncope in pediatric patients. *Pediatrics* 1991; 87: 334-8.
13. Alehan D, Celiker A, Özme S. Head-up tilt test: a highly sensitive, specific test for children with unexplained syncope. *Pediatr Cardiol* 1996; 17: 86-90.
14. Alehan D, Lenk M, Özme S, Celiker A, Özer S. Comparison of sensitivity and specificity of tilt protocols with and without isoproterenol in children with unexplained syncope. *PACE* 1997; 20: 1769-76.
15. Grubb BP, Temesy-Armos P, Moore J, Wolfe D, Hahn H, Elliott L. The use of head-upright tilt table testing in the evaluation and management of syncope in children and adolescents. *PACE* 1992; 15: 742-8.
16. Berkowitz JB, Auld D, Hulse E, Campbell RM. Tilt table evaluation for control pediatric patient: Comparison with symptomatic patients. *Clin Cardiol* 1995; 18: 521-5.
17. Lerman-Sagle T, Rechavia E, Strasberg B, Sagie A, Blieden L, Mimouni M. Head-up tilt for the evaluation of syncope of unknown origin in children. *J Pediatr* 1991; 118: 676-9.
18. Fouad FM, Sithisook S, Vanerio G, et al. Sensitivity and specificity of the tilt table test in young patients with unexplained syncope. *PACE* 1993; 16: 394-400.
19. Ross BA, Hughes S, Anderson E, Gillette PC. Abnormal responses to orthostatic testing in children and adolescents with recurrent unexplained syncope. *Am Heart J* 1991; 122: 748-54.
20. Oslizlok P, Allen M, Griffin M, Gillette P. Clinical features and management of young patients with cardioinhibitory responses during orthostatic testing. *Am J Cardiol* 1992; 69: 1363-5.
21. Lewis DA, Zlotocha J, Henke L, Dhara A. Specificity of head-up tilt testing in adolescents: effect of various degrees of tilt challenge in normal control subjects. *J Am Coll Cardiol* 1997; 30: 1057-60.
22. Van Steenwijk CCEJV, Wieling W, Johannes JM, Harms MP, Kuis W, Wesseling KH. Incidence and hemodynamic characteristics of near-fainting in healthy 6- to 16-year old subjects. *J Am Coll Cardiol* 1995; 25: 1615-21.
23. Mangru NN, Young ML, Mas MS, Chandar JS, Pearse LA, Wolff GS. Usefulness of tilt table test with normal saline infusion in management of neurocardiac syncope in children. *Am Heart J* 1996; 131: 953-5.
24. Müller G, Deal BJ, Strasburger JF, Benson DW. Usefulness of metoprolol for unexplained syncope and positive response to tilt testing in young persons. *Am J Cardiol* 1993; 71: 592-5.