Evaluation of Autonomic Nervous System Function with Tilt Table Testing in Young Adults with Persistent Developmental Stuttering

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ÖZET:
İrsarı gelişimsel kekemeliği olan genç yetişkinlerde otonom sinir sistemi ile dovgedirilmesi


YÖNTEM: Çalışmaya irsarı gelişimsel kekemeliği olan 27 hasta ile uyarak gelen 22 normal konu-san sağlıklı hasta ile efllefltirilmifl 22 normal konuflan sa§l›kl› Klinik Psikofarmakoloji Bülteni 2010;20:45-49

RESULTS: In the stutterers, the mean onset of stuttering was 7.4±3.75 years (range of 3 to17). Eighteen stutterers (66.7%) showed a positive TT response, whereas 2 normal speakers (9.1%) had a positive TT response (p< 0.01). Although mean pulses, systolic and diastolic blood pressures at the rest did not differ significantly between the two groups, stutterers had lower systolic and diastolic blood pressure values than those of normal controls (p=0.001 and p=0.003) at the end of TT testing.

Discussion: We conclude that a positive TT response is observed more often in the stutterers. The findings of the present study support the results of our previous report indicating that the stutterers have an autonomic nervous system dysregulation.

Key words: Stuttering, autonomic nervous system, tilt table testing

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INTRODUCTION

Stuttering is a developmental speech disorder in which sounds, syllables, or words are repeated or prolonged, disrupting the normal flow of speech. Persistent developmental stuttering affects one percent of adults, and it may impair social and occupational functioning (1). Over the years, numerous theories have been proposed to explain the etiology of stuttering, but mechanisms behind the distribution in speech flow are still not clear. Etiology has been traditionally defined in terms of predisposing, precipitating and perpetuating factors (2).

Autonomic nervous system (ANS) directly and/or indirectly plays a key role on motor speech and its regulation (2,3). Therefore, some studies have been suggested that ANS dysregulation may be involved in persistent developmental stuttering. Peters and Hulstijn (4) and Weber and Smith (5) proposed that anticipation of a spontaneous speech task was associated with autonomic co-activation in the persons who stuttered, whereas Caruso et al. found that the mean heart rate of the persons with stuttering was significantly lower than that of the
persons without stuttering, with increasing difference as
the task became more stressful during the tasks (6).

Previously, our group studied by the 24-hour Holter
monitorization for heart rate variability to evaluate whether
ANS dysregulation is responsible for persistent
developmental stuttering in young adults (7). The results of
our previous study suggested that sympatho-vagal imbalance
might render the person prone to speech dysfluencies. In the
present study, we aimed to confirm and extend our
preliminary findings by using the tilt table test (TT) in young
adults with persistent developmental stuttering.

MATERIALS AND METHODS

Subjects

This case-control study was performed in
 collaboration with the departments of Psychiatry and
Cardiology at the Hospital of Gulhane Military Medical
School between July 2008 and April 2009. We studied 27
patients with persistent development stuttering and 22
age-matched normal speakers as healthy controls. The
study comprised men who were between the ages of 19
and 25 years. The patients had received no treatment
before the study was conducted. Developmental stuttering
was diagnosed according to DSM-IV criteria (8) by a
psychiatrist. After then a speech-language specialist
evaluated speech and stuttering severity.

Subjects with a history of convulsions, central nervous
system infections, cerebrovascular diseases, cranial
trauma, endocrine and metabolic diseases, or any chronic
drug use and those who have mental retardation and
severe psychiatric disorders were excluded from this
study. No study subject had autonomic symptoms such as
fatigue, syncope, dizziness etc. and did not recive any drug
(psychotropics, sympathomimetics, parasympatholytics
etc.) before and during the study period. All participants
were asked to refrain from heavy smoking and excessive
eating during the study period.

All participants gave written consent to a protocol
approved by the Ethics Committee of the Gulhane
Military Medical School.

Study Procedure

In first phase of the study, a psychiatrist initially
carried out a semi-structured socio-demographic
information form and the Structured Clinical Interview
for DSM-IV Axis-I Disorders (SCID-I) (9,10). After that,
all patients were evaluated by the speech-language
specialist using the Stuttering Severity Instrument for
Children and Adults-Third Edition (SSI-3). In the second
phase, all subjects were administered the TT test.

Measures

The Stuttering Severity Instrument for Children and
Adults-Third Edition (SSI-3). The SSI-3 was developed
by Riley (11). This instrument measures the stuttering
severity of both children and adults for clinical and
research use. The SSI-3 Test Record and Frequency
Computation Form is divided into four major areas:
frequency (converted to scale scores 0 through 18);
duration (converted to scale scores 0 through 18); physical
concomitants (rated by degree of distractibility 0 through
20); and severity conversion tables for preschool children
(ages 2-10 through 5-11), school-age children (ages 6-1 to
16-11), and adults (ages 17-0 and older). The levels of
severity equivalents of SSI-3 total overall scores for adults
are: (1) very mild (scores of 17 and below), (2) mild
(scores between 18 and 24), (3) moderate (scores between
25 and 31), (4) severe (scores between 32 and 36), and (5)
very severe (scores of 37 and higher) (11).

Tilt Table Testing (TT). One of the clinical
examinations performed to evaluate the ANS activity is the
TT, which consists in studying the cardiovascular response
to the change of a patient’s position from a supine to a head-
up position (12). The TT test is able to reveal the integrity
of the autonomic cardiovascular reflexes (early responses
occurring within 30-60 sec) by achieving changes in blood
pressure. A normal response is a brief, transient decrease in
blood pressure accompanied by an increase in heart rate.
There is a return to near-baseline rates and pressures, and
this is maintained throughout the period of tilting. In our TT
protocol, the testing was performed at approximately the
same time (between 9:00 AM and 11:00 AM) to minimize
variability. The subjects were comfortably restrained on a
motor-driven tilt table to prevent them from falling down in
case a syncope occurred. Electrocardiogram was monitored
continuously during the test, and arterial blood pressure
was monitored noninvasively by tonometry system.
Baseline heart rate and blood pressure were monitored for
10 minutes of the resting in the supine position. Once stable recordings were made at minute 1 and every 3 minutes, the head of the table was tilted up to 70°, and the heart rate and blood pressure were monitored for up to additional 30 minutes. If the baseline tilt result was negative, the subject was returned to the supine position and a fixed dose of 400 mg nitroglycerin spray sublingually administered in the upright position and monitored for 15 minutes. A drop in at least 25 mmHg of systolic blood pressure with production of any symptoms of pre-syncpe or syncpe was considered a positive test (with or without changes in heart rate). Presyncope was defined as experiencing the forewarning signs and symptoms of an imminent syncpe (e.g., dizziness, blurry vision, and severe weakness). Three types of responses were noted during the TT testing (13): vasodepressor response, cardioinhibitory response, and mixed response.

**Statistical Analysis**

Differences between both groups were determined using the Mann Whitney-U test for the data not normally distribution and continues variables and compared with Pearson chi-square test variables for categorical variables. The SPSS for Windows 11.0 (SPSS Inc., Chicago, IL) program was used in all analyses, and the level of significance was accepted as p<0.05.

**RESULTS**

The mean age of the stutterers was 20.89±1.43 years and that of the normal speakers was 21.69±1.64 years with no significant difference between the groups (p > 0.05). The mean onset of stuttering was 7.44 ± 3.75 years (range: 3 to 17). Mean stuttering severity score was 3.63 ± 1.35 (range: 1 to 5). Two of the subjects had very mild stuttering, 5 subjects exhibited mild stuttering, 6 subjects had moderate stuttering, and 5 subjects had severe stuttering. The remaining 9 subjects exhibited very severe stuttering.

In the stuttering group; 11 (40.7%) subjects had DSM-IV psychiatric Axis I diagnoses, with generalized anxiety disorder (n=1), anxiety disorder-not otherwise specified (n=7), adjustment disorder with anxiety (n=2), and social anxiety disorder (n=1).

Eighteen stutterers (66.7%) showed a positive TT response, whereas 2 normal speakers (9.1%) had a positive TT response. There was a statistically significant difference between both groups (X² = 16.635, p= 0.000) (Table 1). The stutterers with a positive TT response included 14 with a vasodepressor response, 3 with a mixed response, and 1 with a cardioinhibitory response, whereas the normal speakers with a positive TT response included 1 with a vasodepressor response, and 1 with a mixed response.

**Table 1: TT response between the subjects who stutter (n=27) and the normal speakers (n=22)**

<table>
<thead>
<tr>
<th>Tilt Table Test</th>
<th>Stutterers (n=27)</th>
<th>Normal Speakers (n=22)</th>
<th>X²</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>18 (66.7%)</td>
<td>2 (9.1%)</td>
<td>16.635</td>
<td>&lt;0.001**</td>
</tr>
<tr>
<td>Negative</td>
<td>9 (33.3%)</td>
<td>20 (90.9%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: The comparison of mean pulses, systolic and diastolic blood pressures at rest and end of TT test**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Stutterers (n=27)</th>
<th>Normal Speakers (n=22)</th>
<th>Z</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP-rest (mmHg)</td>
<td>123.30±12.22</td>
<td>124.32±17.28</td>
<td>0.211</td>
<td>0.833</td>
</tr>
<tr>
<td>SBP-end</td>
<td>78.15±27.61</td>
<td>107.32±21.81</td>
<td>3.292</td>
<td>0.001**</td>
</tr>
<tr>
<td>DBP-rest (mmHg)</td>
<td>71.22±8.49</td>
<td>72.09±8.10</td>
<td>0.292</td>
<td>0.770</td>
</tr>
<tr>
<td>DBP-end</td>
<td>54.35±16.42</td>
<td>69.96±12.61</td>
<td>3.012</td>
<td>0.003*</td>
</tr>
<tr>
<td>Pulse-rest</td>
<td>70.26±10.16</td>
<td>70.36±11.15</td>
<td>0.161</td>
<td>0.872</td>
</tr>
<tr>
<td>Pulse-end</td>
<td>88.27±26.73</td>
<td>95.09±18.18</td>
<td>0.725</td>
<td>0.468</td>
</tr>
<tr>
<td>SBP-dif</td>
<td>49.50([-14]~[+90])</td>
<td>11([-5]~[+60])</td>
<td>3.435</td>
<td>0.001**</td>
</tr>
<tr>
<td>DBP-dif</td>
<td>14([-14]~[+46])</td>
<td>1.5([-11]~[+25])</td>
<td>3.250</td>
<td>0.001**</td>
</tr>
<tr>
<td>Pulse-dif</td>
<td>-27([-56]~[+63])</td>
<td>-26.5([-5]~[+13])</td>
<td>0.507</td>
<td>0.612</td>
</tr>
</tbody>
</table>

SBP: systolic blood pressure; DBP: diastolic blood pressure; dif: difference (median [min-max]); end: at the end of TT; **p<0.01
Despite mean pulses, systolic and diastolic blood pressures at the rest did not differ significantly between the stutterers and normal speakers, at the end of the TT testing, the stutterers had lower systolic and diastolic blood pressure values than those of normal speakers (p=0.001 and p=0.003 respectively). Stutterers showed a higher decrease in both systolic and diastolic blood pressures compared to normal speakers at the end of the TT testing (p=0.001). There were no statistically significant differences in mean pulses between both groups (Table 2).

**DISCUSSION**

The evaluation of ANS function comprises several diagnostic methods: Valsalva maneuver, the orthostatic test, assessment of heart rate variability, pupillometry, skin conductance, sudomotor axon reflex test, and thermoregulatory sweat test (14,15). In our previous study (7), we examined the heart rate variability (HRV), which is a particularly sensitive method used to evaluate autonomic dysfunction (16) and we suggest that general ANS imbalance with parasympathetic predominance might render the person to be prone to speech disfluencies (7). In the present study, we administered the TT test in order to replicate our previous report. In fact, ANS is strongly influenced by a change from supine to upright position. Both active and passive (TT) change to such position launches the process of complex neurohumoral regulation (14,17). The results of our present study showed that young adults with persistent developmental stuttering were significantly more likely to have a positive TT response, and evidence of significant blood pressure changes at the end of TT testing. Therefore, these findings are thought to be suggestive of a dysregulation of ANS in young adults with persistent developmental stuttering and support our previous report (7).

Alterations in its activity level and/or in the balance between the various autonomic branches may compromise the cardiovascular response to TT which can be defined by measuring the heart rate and blood pressure response during an orthostatic challenge. Normally, orthostatic stress produces an increase in heart rate, increase in diastolic and decrease in systolic BP accompanied by increase in plasma norepinephrine and muscle sympathetic activity. Thereafter a relative bradycardia follows due to vagal reflexes (18). In other words, TT reflects the integrity of the autonomic cardiovascular reflexes, and therefore a lower sympathetic responsiveness and a higher parasympathetic responsiveness may be associated with tilt-intolerant or positive TT response. In our study, evidence of more positive TT response in subjects who stutter might indicate an increase in parasympathetic tone.

As limitations in the present study, first, the design was cross-sectional and the sample size was not enough large. Further large-scale clinical studies are needed. Secondly, the TT testing is an indirect way of evaluating autonomic system function, and other tests for evaluation of ANS activity including pupillometry, skin conductance, and sudomotor axon reflex test should have been administered.

To the best of our knowledge, our study is the first evaluating general ANS activity by the TT test in young adult stutterers. In conclusion, it might be suggested that a positive response to TT is more often found in young adult stutterers than in healthy controls. Based on our previous and present results, we suggest that a sympatho-vagal imbalance may contribute to the speech difficulties in developmental stuttering. In addition, autonomic dysfunction might be of some importance in the pathogenesis of developmental stuttering, but further studies are needed to confirm these findings. If these findings are replicated, they might provide some contribution in developing rational treatment approaches for persistent developmental stuttering.

**References:**


