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The Value of the YGTSS Scale and Somatosensory Evoked Potentials in Assessing Tic Disorder

Yu Zhiyu*, Xu Lei, Wang Xia, Shi Jianhong, Li Yi, Tang Feng, Zhang Kemin, Pu Zhaoxia, Yi Yuan, Li Xiaoling, Deng Junyang

Chengdu Gaoxin Southwest Children's Rehabilitation Hospital, Chengdu, Sichuan, 610000, China
**Corresponding author*

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Abstract: This study examines the theoretical basis of assessing abnormalities in the somatosensory-motor cortex using Somatosensory Evoked Potentials (SEP) and explores the correlation between SEP and the Yale Global Tic Severity Scale (YGTSS) for clinically evaluating the severity of Tic Disorder (TD) Forty-one children with TD who met the inclusion criteria in our department of developmental behavior in 2024 were selected. Their SEPs were recorded using a somatosensory evoked potential recorder, focusing on the P_{22} latency period, while their YGTSS scores were evaluated through clinical observation. There was a significant positive correlation between the P_{22} latency period and YGTSS scores ($r = 0.44$, $p < 0.01$). Children with moderate to severe TD had significantly longer P_{22} latency periods compared to those with mild TD ($t = 2.75$, $p < 0.001$, $d = 0.96$). Abnormalities in somatosensory evoked potentials are present in children with TD, supporting the existence of a consistent deficit in the cortical-striatal-thalamic-cortical loop. SEP holds promise as an objective indicator for the clinical assessment of TD severity.

1. Introduction

Tic Disorder (TD) is a neuropsychiatric condition that begins in childhood, characterized by sudden, purposeless, and rapid motor or vocal tics, such as blinking, shrugging, throat clearing, shouting, or using obscene language [1]. Meta-analyses indicate that the global prevalence of TD is about 0.5% [2], with a prevalence rate of 2.68% among children in China [3]. Tic behaviors can cause severe psychological harm to children, affecting their education and peer relationships. Moreover, TD is a chronic condition, with symptoms persisting in adolescence or even adulthood for some individuals [1]. Regular monitoring and assessment of tic symptoms and treatment efficacy are crucial components of disease management. However, there are currently no specific diagnostic markers for TD; diagnoses primarily rely on the clinical criteria set forth in the fifth edition of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [4]. Thus, exploring more objective and convenient tools for symptom assessment in clinical settings is essential.

In recent years, with the advancement of brain science technologies, the technique of measuring neurophysiological activity through Somatosensory Evoked Potentials (SEP) has gained attention.

The exact pathogenesis of TD is still unclear, but many scholars believe it involves abnormalities in the striatal-thalamic-cortical (STC) neural circuit [5]. SEP can record the sensory evoked potentials of the central nervous system and has been used as an auxiliary examination for central nervous system disorders. Abnormalities in SEP latency periods may indicate disruptions in the STC circuit [6], suggesting that SEP could become an objective tool for assessing Tic Disorder.

Currently, clinical research on SEP is relatively scarce, and its value in the clinical diagnosis and assessment of TD needs further verification. Therefore, this study primarily explores the value of SEP in assessing TD symptoms and its correlation with the Yale Global Tic Severity Scale (YGTSS) used in clinical applications.

2. Materials and Methods

2.1 General Information

Sample Size Calculation: Based on previous literature [7], the effect size for somatosensory evoked potentials in assessing Tic Disorder is considered large (r = 0.67). This study utilized G-power software to calculate the required sample size, setting the effect size at a large level (r = 0.5), with an alpha of 0.05 (two-tailed) and a statistical power of 0.9. Calculations determined that at least 34 patients were needed for this study.

From June to October 2024, patients diagnosed or awaiting diagnosis with TD who visited the Southwest Children's Rehabilitation Hospital in Chengdu High-Tech West and met the inclusion criteria were selected. After applying the exclusion criteria, the study ultimately included assessment data from 41 patients.

This research is retrospective and did not involve any intervention in the diagnosis or treatment of the children; it received approval from the Ethics Committee of the Southwest Children’s Rehabilitation Hospital in Chengdu (approval number 202401), and the requirement for signed informed consent was waived.

Inclusion Criteria: 1) Children whose parents actively requested and voluntarily consented to participate; 2) Children who cooperated in completing the YGTSS scale evaluation and somatosensory evoked potential assessment; 3) Children aged 0-18 years, regardless of gender; 4) Children with a total IQ greater than 70 on the fourth edition of the Wechsler Intelligence Scale for Children.

Exclusion Criteria: 1) Children with visual or hearing impairments and severe physical illnesses; 2) Children with autism spectrum disorders, intellectual developmental disorders, motor disorders, or other psychiatric conditions; 3) Children in poor mental state or uncooperative; unable to complete the examination and assessment.

2.2 Assessment Tools

Yale Global Tic Severity Scale (YGTSS): The scale comprises three parts: 1) Evaluation of motor tic symptoms, assessing the severity across five dimensions: frequency, intensity, interference, and complexity; 2) Evaluation of vocal tic symptoms using the same scoring method; 3) Assessment of the impact on the child's self-esteem, learning, and social interactions. The combined score from these components represents the total severity of TD, with the total possible score being 100. Scores under 25 are considered mild, 25-50 moderate, and above 50 severe.

Somatosensory Evoked Potentials (SEP): Measurements are conducted using the MEB-9400C electromyography/evoked potential system from Nihon Kohden, Japan. Participants lie supine with eyes closed and body relaxed, and recording electrodes are placed according to the international 10-20 system. The stimulation electrode, a saddle-shaped electrode with a 1.5 cm distance between

points and 0.8 cm diameter, is positioned over the median nerve at the wrist. Stimulation is delivered via a constant current square wave pulse at 8 mA intensity, sufficient to cause visible slight hand muscle contractions. Each limb undergoes two SEP tests, each with 100-200 superimpositions; the results are averaged to record latency periods of wave components like N20, P22, and N30.

2.3 Statistical Analysis

Statistical analyses were conducted using SPSS software version 21.0. Descriptive statistics, regression, and t-tests were performed on the YGTSS and SEP data of children with TD, with a significance level set at alpha = 0.05.

3. Results

Baseline Characteristics of the Study Subjects: The study collected assessment data from 41 children with TD, aged between 3 and 16 years, with an average age of 9.02 years. There were 32 boys and 9 girls.

Descriptive Statistical Analysis: Descriptive statistical results for the YGTSS and SEP assessments of children with TD in this study are presented in Table 1.

Table 1: Descriptive Statistics for YGTSS and Somatosensory Evoked Potentials

Statistic	Motor Tics	Vocal Tics	Total Impairment	Total Tic Score	P_{22}	N_{20}	N_{30}
M	13.51	5.54	10.73	29.78	22.90	17.41	30.22
SD	5.34	5.98	4.11	10.33	0.90	1.13	1.07

From Table 1, it can be observed that the average tic severity for children in this study, as measured by the YGTSS, is moderate, with an average score of 29.78 (SD = 10.33). The average latency period for the SEP P22 is 22.90 ms (SD = 0.90), which exceeds 22 ms.

Correlation Analysis: A correlation analysis was conducted between the YGTSS scores and SEP assessments for children with TD. The results are shown in Table 2.

Table 2: Correlation Analysis between YGTSS and Somatosensory Evoked Potentials

	Motor Tics	Vocal Tics	Total Impairment	Total Tic Score
P_{22}	0.30	0.21	0.42^{**}	0.44^{**}
N_{20}	0.13	0.05	0.16	0.16
N_{30}	0.19	-0.01	-0.11	0.05

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

From Table 2, there is a significant positive correlation between the SEP P22 latency period and the total impairment score on the YGTSS, with a correlation coefficient (r) of 0.42 and a p-value < 0.01. There is also a significant positive correlation between the SEP P22 latency period and the total tic score on the YGTSS, with r = 0.44 and p < 0.01, indicating that longer P22 latency periods are associated with more severe tic severity in children with TD.

Simple Linear Regression Analysis: A simple linear regression model was established using the SEP P22 latency period as the independent variable and the YGTSS total tic score as the dependent variable to explore the clinical impact of the P22 latency period on the severity of tics. The results are presented in Table 3.

From Table 3, it is evident that the regression equation using P22 latency as the predictor and total tic score as the outcome variable shows a significant fit, $F(1, 39) = 9.78$, $p < 0.01$. The P22

latency period can positively predict the total tic score, with $\beta = 0.44$ and $t(39) = 4.58$, $p < 0.01$.

Table 3: Regression Analysis of Total Tic Score on P22 Latency Period

Regression Equation		Overall Fit Index			Significance of Regression Coefficients	
Dependent Variable	Predictor Variable	R	R^2	$F(df_1/df_2)$	β	t
Total Tic Score	P_{22} Latency Period	0.44	0.20	9.78(1/39)	0.44	3.12^{**}

Differences in SEP by Severity of Tics: According to the total score on the YGTSS, children with TD are categorized into mild (total score < 25) and moderate-to-severe (total score ≥ 25) tic severity. An independent samples t-test was conducted on the P22 latency period based on tic severity. Results indicate that children with moderate-to-severe TD (M = 23.12, SD = 0.82) have significantly longer P22 latency periods compared to those with mild TD (M = 22.30, SD = 0.87), $t(39) = 2.75$, $p < 0.001$, Cohen's d = 0.96.

4. Discussion

Tic Disorder (TD) is a neuropsychiatric disorder that begins in childhood. It is estimated that 10 million children and adolescents in China suffer from TD, with a male-to-female ratio of approximately 3~4:1 [1]. Studies have shown that Tic Disorder can also lead to long-term health consequences, such as increased risks of immune system diseases, cardiovascular diseases, allergies, and respiratory disorders [8]. The course of TD is relatively stable, with 50% of affected children experiencing persistent symptoms, necessitating long-term prognosis assessments. Therefore, convenient, affordable, and objective assessment tools are essential in the clinical monitoring and evaluation of TD.

Somatosensory Evoked Potentials (SEP) have always been a crucial index for assessing the somatosensory pathways. SEPs involve the electrical stimulation of sensory nerves and the recording of electrical signals along the large fiber somatosensory pathways to identify pathological abnormalities [6]. SEPs are short-latency potentials, and in this study, the upper limb SEPs were recorded within 30 ms.

TD is a sensorimotor disorder, not merely a motor disease. The sensory system also plays a role in its pathophysiological mechanism, with sensory disturbances being common among TD patients. These disturbances include premonitory urges and sensory hypersensitivity [9]. Premonitory sensations refer to uncomfortable feelings in specific body parts prior to a tic, or a strong impulse to move. Clinically, premonitory sensations usually correlate with tic severity, and previous research has shown a direct correlation between the two [10]. Kimura and others [11] confirmed the presence of premonitory impulse disorders in TD patients using SEP, showing abnormal N30 wave amplitudes compared to healthy individuals. Sensory hypersensitivity is a potentially distinct clinical phenomenon, and research on sensory hypersensitivity using SEP is still relatively limited [12][13]. Sensory hypersensitivity involves a continuous heightened awareness of internal or external stimuli, with at least 80% of TD patients experiencing it [12]. The SEP P22 latency period, indicative of heightened excitability and reactivity in somatosensory processing neural activities, suggests potential sensory hypersensitivity [14][15]. An extended P22 latency period indicates functional abnormalities in the motor area IV and supplementary motor area, potentially pointing to abnormalities in the Cortical-Striatal-Thalamic-Cortical (CSTC) loop [7].

5. Conclusion

This study supports the presence of SEP abnormalities in patients with TD, suggesting potential disturbances in the CSTC regulatory loop. It also provides further clinical evidence for the potential of SEP to become an objective indicator for assessing Tic Disorder.

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