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Typical sensory organization test findings and clinical implication in acute vestibular neuritis

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ABSTRACT

Objective: Sensory organization test (SOT) is used to evaluate postural instability. We wanted to characterize the SOT findings in patients with acute vestibular neuritis (VN).
Methods: Eighty-seven patients with VN were enrolled. The bithermal caloric and SOT were performed, and the results were compared with those from the dizziness handicap inventory (DHI). Abnormal SOT patterns were classified: severe, visual vestibular, vestibular, inconsistent, or normal patterns. The results were also analyzed by sensory analysis (somatosensory, visual, vestibular, and visual preference) and composite scores.
Results: Sixty-one patients (70%) showed abnormal findings for conditions 5 and/or 6 (vestibular pattern), and half (30 of 61, 49%) of them showed additional abnormal results in more than conditions 5 and 6. In pattern analysis, the vestibular pattern (abnormal in conditions 5 and 6) was the most common pattern (36%), and the visual vestibular pattern (abnormal in conditions 4, 5, and 6) was the second most common (24%). In sensory analysis, vestibular dysfunction was observed in 59 patients (68%), visual dysfunction in 37 (43%), visual preference in 17 (20%), and somatosensory dysfunction in 5 (6%). Composite scores of SOT showed a significant correlation with the DHI scores, though no correlation was observed between DHI and caloric results ($p < 0.05$).
Conclusion: VN can adversely influence on postural instability, with more severe patterns as well as classical vestibular patterns, indicating that abnormal vestibular inputs can influence postural stability in all SOT conditions and subjective symptom in patients with acute VN is more closely associated with the postural instability rather than canal dysfunction.

1. Introduction

Acute vestibular neuritis (VN) is characterized by an acute onset of long-lasting vertigo, spontaneous unilateral nystagmus toward the contralesional side, and ipsilesional canal paresis. Patients with VN also have difficulty standing and walking, and have a tendency to veer toward the affected side [1]. Vestibular function tests, including caloric, rotary chair, and vestibular-evoked myogenic potential tests, have been used to assess the integrity of the vestibulo-ocular reflex (VOR) and the vestibulo-colic reflex (VCR). Posturography is used to quantify the relative contributions of sensory systems to postural control in the upright stance under either static or dynamic conditions, and can provide insight into the presence of postural instability and help identify which sensory system is involved, although it does not provide a topographic diagnosis [2–5]. Postural control is closely related to integration of the sensory systems, especially

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the visual, somatosensory, and vestibular systems. The sensory organization test (SOT) is a form of posturography and a commonly used clinical protocol to selectively disrupt the somatosensory and/or the visual input to measure the patient's ability to use the remaining sensory inputs for postural control [2,3]. Thus, the SOT determines which sensory inputs (vestibular, visual, or somatosensory) the patient relies upon most to maintain postural stability. The four ratios reflect the functional conditions: somatosensory (SOM), visual (VIS), vestibular (VEST) and visual preference (PREF) [6,7].

Several studies have used posturography to measure postural control [7–10]. Most authors have studied a variety of vestibular disorders rather than individual diseases using these instruments [8,9,11–13]. Although patients with vestibular disorders reveal abnormalities in SOT conditions 5 and/or 6 [14–17], typical SOT findings in patients with acute VN, which is a typical vestibular disorder, have not been studied thoroughly. Therefore, we investigated typical SOT findings in patients with acute VN and identified their clinical relationship between SOT and the severity of dizziness using the dizziness handicap inventory (DHI).

2. Materials and methods

2.1. Ethical considerations

This study was approved by Institutional review board of the participating institutes.

2.2. Patients

We retrospectively analyzed data collected at two dizziness clinics from March 2010 to August 2012. The subjects included patients who had been diagnosed with VN. The diagnostic criteria were as follows: a history of acute onset of severe prolonged vertigo lasting >24 h; a spontaneous horizontal unidirectional nystagmus on clinical examination, without hearing loss or middle ear pathology; and caloric irrigation showing a lack of responsiveness in the affected ear (canal paresis $\geq 20\%$). No additional positive findings were found on the neurological examination, magnetic resonance imaging, or blood tests. We performed all vestibular tests on the same day and within 7 days (mean 2.0 ± 1.8 days) after the onset of vertigo.

2.3. Dizziness handicap inventory (DHI)

All subjects completed the DHI during their initial visit. The DHI is a validated self-reported questionnaire composed of 25 items that include three steps: nine questions on function, seven on physical aspects, and nine on emotional issues, with 100 points as the total score. Each question provides three answer options: (1) No (0 points), (2) sometimes (2 points), or (3) yes (4 points).

2.4. Sensory organization test (SOT)

All subjects were evaluated by the SOT of CDP (Equitest System, NeuroCom International, Clackamas, OR, USA). The SOT protocol includes six test conditions that reflect the visual, vestibular, and proprioceptive senses, which are responsible for maintaining posture (Table 1). Six SOT test conditions were as follows: (1) eyes open with fixed surroundings and platform (SOT 1); (2) eyes closed with a fixed platform (SOT 2); (3) sway-referenced surroundings with a fixed platform (SOT 3); (4) eyes open with fixed surroundings and a sway-referenced platform (SOT 4); (5) eyes closed with a sway-referenced platform (SOT 5); (6) sway-referenced surroundings and a platform (SOT 6). Three trials were conducted under each condition, for a total of 18 trials. After each test, anterior to posterior center of gravity (COG) displacement was automatically measured and an equilibrium score was calculated by comparing the angular difference between the patient's maximum anterior to posterior COG displacement to the theoretical limits of stability (approximately 12.5°) [7]. The equilibrium score ranging between 0% (fall) and 100% (did not sway at all) was obtained. Additionally, the composite score was calculated by independently averaging the equilibrium scores for condition SOT1 and SOT2, adding these two scores to the equilibrium scores from each three trial of condition SOT 3 through to SOT 6, and dividing the sum by total performed trials. The composite score is the first step to interpreting SOT results because it provides an overall determination of normal versus abnormal performance in postural stability.

2.5. Abnormal SOT patterns

Equilibrium scores $\geq 95\%$ confidence interval of the age-specific normative data from the CDP manufacturer were considered abnormal for each SOT condition trial. When more than two abnormal findings were detected in the three trials for each SOT condition, the result was considered "abnormal". Conditions 2, 4, and 5 examined the influence of the abnormal sensory inputs (somatosensory, visual, and vestibular inputs) on postural stability (Table 1). Vestibular pattern (abnormal in conditions 5 and 6) indicates difficulty using vestibular information alone for postural stability. Visual vestibular pattern (abnormal in conditions 4, 5, and 6) indicates difficulty using visual and vestibular information or vestibular information alone for postural stability. A severe pattern (abnormal in conditions on 4, 5, and 6 and more) indicates difficulty using visual, vestibular, and/or somatosensory information. A pattern was considered inconsistent when the findings were normal in conditions 5 and 6, but abnormal on other conditions. In the interpretation of composite score, the composite score below age-matched normative performance values was considered as abnormal.

2.6. Sensory analysis

The CDP system computes sensory ratios between the mean equilibrium scores on specific pairs of sensory test conditions to assist the clinician in describing the findings to the patient. The sensory analysis aims to interpret the functional compensations in each sensory system. The detailed descriptions of sensory ratios are as follows.

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