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Evaluation of Balance Disorders After Minor Head and Whiplash Injuries

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The increased use of automobile transportation and lack of awareness of safety measures at work have resulted in many accidents, which have caused head and neck injuries. Direct blow to the head may result in minor brain injury, such as postconcussion syndrome. Flexion-extension or whiplash injury is a very common sequel of indirect trauma to the neck. Many patients suffering from these syndromes complain of dizziness and disorders of equilibrium.

The vestibular symptoms of postconcussion syndrome may be due to brain concussion in regions involved in maintaining balance or to concussion of the labyrinth. However, the etiology of vertigo after whiplash injury is less well understood, and several major theories have been proposed: (1) cervical sympathetic irritation, (2) abnormal neck reflex, (3) vertebrobasilar artery insufficiency, and (4) cerebral or labyrinthine concussion. In fact, some have suggested that balance impairments often are attributed to psychological or emotional problems [1].

The most common test of the vestibular system is electronystagmography (ENG). This test assesses the response of the horizontal semicircular canal as manifested by the vestibuloocular reflex. Posturography, on the other hand, is considered as a test of the functional integrity of the sensory input of the three systems involved in maintaining balance (i.e., the visual, the somatosensory, and the vestibular systems). This test can validate ENG findings. In addition, it can detect vestibular malfunction that cannot be detected by conventional ENG (e.g., pathology involving the vertical semicircular canal, otolithic organs, central vestibular pathways, extravestibular central nervous system regions, and the adaptive state of the patient).

Lehmann et al. [2] suggested that patients who have experienced a traumatic brain injury without apparent orthopedic or physical involvement exhibit deficits in their postural control mechanism.

The posturography test is divided into two parts: the sensory organization test (SOT) and the motor control test (MCT). Postural sensory selection responses are scored under six different conditions during which visual and proprioceptive inputs are altered statically and dynamically. Conditions 1 and 2 evaluate static sensory selection (eye open and eye closed, similar to the Romberg test), whereas conditions 3–6 evaluate dynamic sensory selection. In conditions 3–6, visual and proprioceptive inputs are sway-referenced independently (conditions 3–5) or simultaneously (condition 6). In the MCT, the response latency is defined as the time between the onset of forceplate translation and initiation of the active force response in a leg.

The purpose of this preliminary study was to examine the balance abilities of individuals who had expressed subjective complaints of dizziness after minor head trauma or whiplash injury and to characterize the types of deficits seen in these individuals.

PATIENTS AND METHODS

The patients included in this study suffered whiplash or minor head injury at least 1 year prior to referral. All patients complained of dizziness and were referred for evaluation of the balance system. Patients with history of previous ear disease were excluded.

Computed dynamic posturography records of 121 patients were evaluated. Fifty-six were males, and sixty-five were females (average age, 40 years). The average time between accident and referral was 32 months.

Seventy-seven patients suffered from whiplash (29 males and 48 females; average age, 40 years). Forty-

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Table 1. Sensory Organization Test Patterns in all Patients (N = 121)

SOT Patterns	No. of Patients (%)
N	43 (35.5)
MSD	23 (19.1)
VLP	4 (3.3)
F	51 (42.1)
Total	121 (100)

SOT = sensory organization test; N = normal; MSD = multisensory dysfunction; VLP = vestibular loss pattern; F = functional.

four patients suffered from head trauma (27 males and 17 females; average age, 39 years).

The results of the SOT were grouped into four major patterns based on studies by Hamid et al. [3] and Nashner and Peters [4]: (1) normal (N; good performance on all conditions compared to the normative data provided by the manufacturers [NeuroCom, Clackamas, OR]); (2) functional, nonorganic, aphysiological (F; low scores in the easier conditions [1 and 2] compared to the scores of the more difficult conditions [5 and 6]); (3) vestibular loss pattern (VLP; decreased scores on conditions 5 and 6); and (4) multisensory dysfunction (MSD). This last pattern is divided further into three groups: (1) sensory dependence on vision, typically characterized by decreased score on conditions 2, 3, 5, and 6; (2) sensory dependence on support, typically characterized by decreased scores on conditions 4, 5, and 6; and (3) sensory deficit pattern, characterized by decreased scores on conditions 3–6.

RESULTS

VLP is more indicative of peripheral vestibular dysfunction. The multisensory dysfunction group is indicative of central dysfunction and, to a lesser degree, a mixed-system dysfunction.

Tables 1 and 2 display the SOT patterns of the patients. Only 27 (22.3%) patients showed abnormal patterns. Four patients (3.3%) showed a VLP pattern, and 23 patients (19.1%) showed an MSD pattern and were suspected of having central pathology [4]. These findings were supported by Rubin et al. [5] who described higher movement displacement during conditions 1, 2, 3, and 6 in patients with head injury. Normal patterns were found in 43 patients (35.5%), and 51 patients (42.1%) were suspected of having functional patterns. The majority of the patients (some 75%) had normal balance function, because most of the functional cases actually are normal.

Table 2. Subgroups of the Multisensory Dysfunction Pattern

MSD Subgroups	No. of Patients (%)
SDP	15 (65.2)
SDS	6 (26.1)
SDV	2 (8.7)
Total	23 (100)

MSD = multisensory dysfunction; SDP = sensory deficit pattern; SDS = sensory dependence on support; SDV = sensory dependence on vision.

Table 3. Sensory Organization Test Patterns in Patients with Minor Head Injury (N = 42) and Whiplash Injury (N = 77)

SOT Patterns	No. of Head Injury Patients (%)	No. of Whiplash Injury Patients (%)
N	11 (27.3)	31 (40.3)
MSD	9 (20.5)	14 (18.1)
VLP	2 (4.5)	2 (2.6)
F	20 (47.7)	30 (39.0)
Total	42 (100)	77 (100)

SOT = sensory organization test; N = normal; MSD = multisensory dysfunction; VLP = vestibular loss pattern; F = functional.

In the SOT, very little difference was noted between the minor injury and the whiplash injury groups (Table 3).

The average MCT latency (automatic postural response) was 127 milliseconds. Seven patients had prolonged MCT latencies, and all had abnormal SOT patterns, as displayed in Table 4. MCT latency was normal in patients with VLP, and only one patient with this pattern had prolonged MCT latency. Abnormal latency was observed mainly in patients with MSD patterns (central abnormality). Similar findings were described by Hamid et al. [3].

Center-of-gravity (COG) alignment during the SOT was off-center in 40% of the patients, 31% kept their COG over the center, and 29% showed a scattered pattern. The center pattern was associated with approximately 66% of the patients with normal SOT performance, the off-center pattern with approximately 69% of the abnormal SOT patterns, and the scattered pattern with nearly 86% of the functional cases (Table 5).

Table 4. SOT Patterns of the Patients with Abnormal Motor Control Test Latencies

SOT patterns	No. of Patients
SDP	5
SDV	1
VLP	1
Total	7

SOT = sensory organization test; SDP = sensory deficit pattern; SDV = sensory dependence on vision; VLP = vestibular loss pattern.

Table 5. Types of Center of Gravity Alignment

SOT patterns	Off-Center (%)	Center (%)	Scattered (%)
Normal	15 (30.6)	24 (65.8)	5 (14.3)
Abnormal	34 (69.4)	13 (34.2)	30 (85.7)
	49 (100)	37 (100)	35 (100)
	(40)	(31)	(29)

SOT = sensory organization test.

CONCLUSIONS

In contrast to ENG and rotational tests, computed dynamic posturography offers a quantitative measure of the functional integrity of the three systems involved in postural stability. The majority of the patients displayed normal or functional patterns. Only 22% had an impaired balance system.

The MSD pattern was more frequent than was that of theVLP. Thus, central lesions are implied as the major cause for balance disorders, and abnormal postural latency is indicative of a central lesion.

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