International Tinnitus Journal, Vol. 6, No. 2, 182–184 (2000)

Neurootological Aspects of Medical Expertise in Whiplash-Associated Disorders

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Abstract: After summarizing the neurophysiological aspects of whiplash injury, the author proposes a guide for neurootological evaluation in relation to the pathophysiology of the injury.

Key Words: guide for neurootological approach; medicolegal aspects; whiplash injury

The legal redress for bodily injury goes back to the very ancient concept of "an eye for an eye and a tooth for a tooth." It is really a kind of revenge fee for bodily damage. Financial compensation is a civilized way to restore justice. The need for a referee to avoid excess compensation has appeared quickly. This referee is the expert: He or she must be neutral and must detail the extent of the lesions.

When it comes to evaluating bodily injury, not only are the same terms concerning invalidity, incapacity, and the like not used throughout the various countries but the same terms (e.g., invalidity) have a different connotation from one country to another. The laws and their interpretations also differ from country to country. Hence, our purpose is not to define a disability scale but to determine whether we believe that a common approach to the medicolegal problem is necessary. We must establish the following points:

- An objective evaluation of the sequelae
- A demonstration of the causality bonds
- A relation to a preexisting state
- A study of the evolution of the subject lesions
- A quantitative evaluation of the subject injury

We suggest a guide for the neurootological approach to patients suffering from whiplash injury.

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Presented at the Twenty-Seventh International Congress of the Neurootological and Equilibriometric Society, Bad Kissingen, Germany, March 23–26, 2000.

NEUROPHYSIOLOGY

Whiplash-associated disorders (WAD) should be distinguished from sprained neck, traumatic disk protrusion, and damage to cord and nerve roots. WAD can be associated with central nervous system lesions, such as postconcussion syndrome.

The so-called posterior cervical sympathetic syndrome of Barré is a disputed cause of vertigo arising from cervical lesions. Barré [1] proposed that cervical lesions might irritate the sympathetic vertebral plexus and result in a decreased blood flow to the labyrinth, owing to constriction of the internal auditory artery. Although numerous clinical reports of Barré syndrome have been published, few objective data exist to support an association between episodic vertigo and cervical sympathetic dysfunction. Because intracranial circulation is autoregulated independently of cervical sympathetic control, lesions in the vertebrosympathetic plexus are unlikely to produce focal constriction of the vasculature to the inner ear.

Hinoki (first in 1971 and then in detail in 1985) [2, 3] proposed a hypothesis in which the hypothalamus occupied a fundamental place to explain vertigo due to whiplash injury. According to Hinoki [2], patients with whiplash injury present with a hypertonicity of the soft supporting tissues of the neck, owing to the overexcitation of the cervical proprioceptors. The condition is caused by an excitation of sympathetic beta-receptors in the muscle spindles. Hinoki [2] has demonstrated the development of granular vesicles at the end of unmyelinated nerve fibers near motor nerve endings of these spindles.

Abnormal centripetal impulses arising from the injured cervical soft tissues may ascend along the spino-

reticular tract to the brainstem. Among the ascending pathways from the cervical and lumbar proprioceptors to the brainstem, the spinoreticular tract seems to be the most important, as most of its fibers ascend along the lateral fasciculus and the anterior column and terminate in the reticular formation of both the medulla oblongata and the pons. However, some fibers of this tract ascend directly to the midbrain and are connected to Deiter's nucleus.

Furthermore, this tract changes neurons in the medulla oblongata, the pons, and the midbrain and terminates in the superior colliculus. Generally accepted is that the reticular formation of these parts of the brain and of Deiter's nucleus and the superior colliculus are active in both ocular and spinal reflexes related to body equilibrium. Among the descending paths from the brainstem, the median longitudinal fasciculus is important in cases of vertigo, because this tract originates in the brainstem and is connected to both the oculomotor nuclei and the somatomotor cells in the ventral column.

The reticulospinal tract also originates in the brainstem reticular formation of both the medulla oblongata and the pons and is connected to the somatomotor cells in the ventral column. As previously mentioned, this tract is thought to have a close relationship with the spinoreticular tract. Thus, the median longitudinal fasciculus and the reticulospinal tract seem especially important in the development of disequilibrium because of whiplash injury. The hypothalamus also must play an important role in producing vertigo due to whiplash injury, as most of Hinoki's patients [3] who had vertigo after whiplash injury had various autonomic symptoms, such as lacrimation, abnormal sweating, and palpitation. The cerebellum is, of course, involved in the development of this type of vertigo, as it is connected closely to the proprioceptors of the cervical and lumbar regions and to the brainstem (Fig. 1).

GUIDE FOR A NEUROOTOLOGICAL APPROACH TO WAD

Equilibrium Tests

Tests of equilibrium in WAD should include an oculomotricity study. Such a study would consist of saccadic tests—measures of accuracy, hypermetry, hypometry, latency, amplitude, duration, and peak velocity. Additional tests would be pursuit tests (accuracy and gain) and optokinetic tests.

A vestibuloocular reflex study entailing various assessments also should be undertaken. A spontaneous nystagmus test would include analysis of eyes open in several directions of gaze and eyes closed and evaluated via electronystagmography (ENG) or videonystagmography (VNG). A positional nystagmus test would assess with VNG a patient's assumption of sitting, ly-

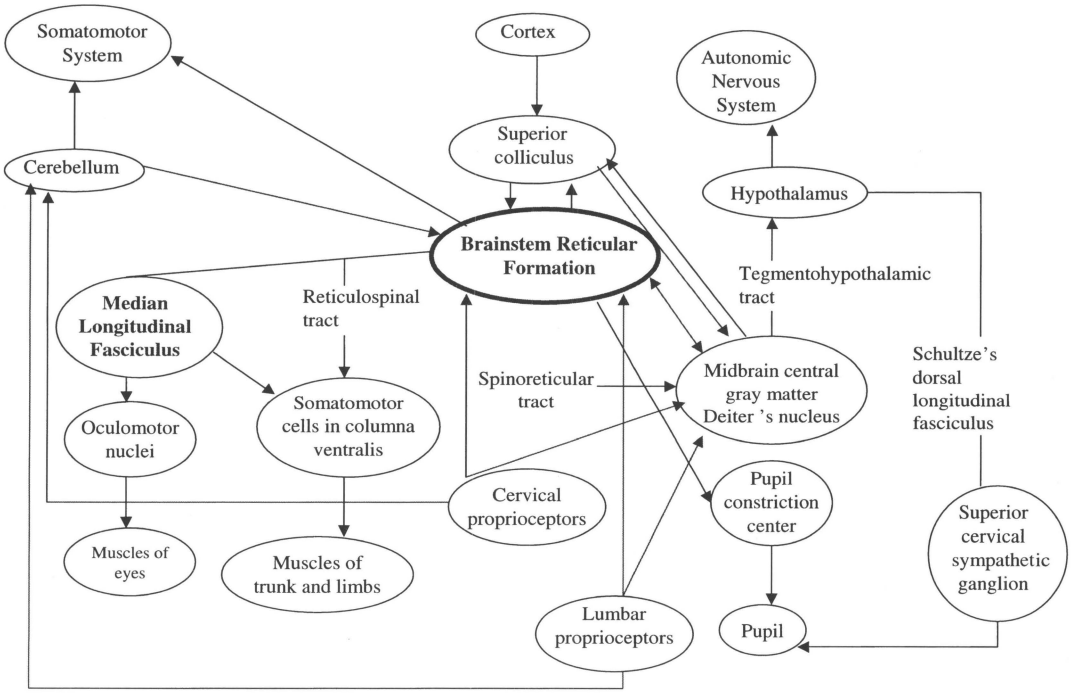

Figure 1. Anatomical pathways possibly involved in neurootological aspects of whiplash-associated disorders.

ing, and lateral left and right decubitus positions. Positional nystagmus mainly would involve Hallpike and Rose [4, 5] positions with or without VNG. The vestibuloocular reflex study also would cover head-shaking nystagmus, rotatory tests with ENG or VNG, and caloric analysis according to Dix and Hallpike [4], with ENG and VNG, including the measure of the ocular fixation index as described first by Demanez [6].

Posture tests can be used to examine static or dynamic posturography (or both); several systems exist. Gait tests, among others, are effective in vegetative disturbance analysis and in testing corticoequilibrium.

Audiological Tests

Another area of inquiry is audiological testing. Such testing would include tonal audiometry, suprathreshold and speech audiometry, and tests for malingering. Evoked potentials are part of audiological assessment and entail brainstem evoked response audiometry, middle latency response audiometry, and cortical audiometry. Tympanography and stapedius reflex and acoustic otoemissions also are essential.

Cranial Nerve Examinations

Cranial nerve examinations must be performed. Such testing would include gustometry, olfactometry, and assessment of the facial nerves.

CONCLUSION

As we have written in the report of the first meeting of the European Federation of Otorhinolaryngologic Societies [7], a great discordance exists not only between the members of the medical profession but between the rules and laws concerning disability throughout Europe. We hope that in the near future a European disability scale will be defined clearly. Our proposal for a standard battery of tests will be the first step in the right direction. For further information on the subject, we recommend particularly a book, *Whiplash Injuries: Diagnosis and Treatment*, written by several members of our society.

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