International Tinnitus Journal, Vol. 10, No. 1, 39–41 (2004)

Therapeutic Advances in Neurootology

Wallace Rubin

Department of Otorhinolaryngology, Head & Neck Surgery and Biocommunication, Louisiana State University School of Medicine, New Orleans, LA

Abstract: Biochemical evaluations have been extremely rewarding in the search for etiological mechanisms in neurootological patients. They have been diagnostically confirmatory in 72% of our patients. In these patients, the treatment results are gratifying when the instructions are followed. This method of etiological diagnosis and treatment has significantly reduced the necessity of using long-term antivertiginous symptomatic medication.

Key Words: biochemical metabolic evaluations; electronystagmography; etiological mechanism; harmonic acceleration testing; neurotransmitter; site of lesion; vestibular function test

The biochemical, metabolic, hormonal, and neurotransmitter influences as they relate to hearing and balance problems have just begun to be explored. The inner ear is, in fact, an internal body organ. The diagnostic and therapeutic direction for the evaluation of the patient with neurootological symptoms should be oriented to confirm an etiological mechanism. This can be accomplished only if our testing modalities are used in a way that is topographically diagnostic. This approach would then logically culminate in a systematic etiological investigation.

The questions to be answered by a neurootological evaluation are numerous. What neurootological tests can be used for confirming site of lesion? Which biochemical, metabolic, and hormonal tests are indicated? What modalities of therapy can then be efficacious? Do we perform biochemical, metabolic, and hormonal screens? Which tests do we use for this? How do we make these decisions? Answering these questions is the challenge.

Mechanical energy signals that are processed and interpreted as sound originate in the environment. Other mechanical energy signals occur as a result of body movements. These mechanical energy signals must be converted to electrical energy to be transmitted to the appropriate areas of the brain via the eighth cranial nerve. This conversion or transduction takes place in the inner ear. The transduction process is accomplished by the chemicals within the inner-ear fluids.

The process of chemical conversion of energy within the inner ear identifies the inner ear as an internal body organ and therefore relates the inner ear to other internal body organs, such as the kidney, liver, and thyroid. The functions of sugar and fat metabolism, of hormonal control, and of the immune and stress systems are involved in the chemical control of inner-ear biochemistry. The source of the chemicals involved in all these processes is the food that each of us eats.

The processing of the chemicals that originate in our food and the transport of these chemicals to the inner-ear fluids involve bypassing three blocks. These obstacles are the gastrointestinal wall, the blood-brain barrier, and the endolymphatic sac and duct. At each step along the way, differential absorption allows passage only of the necessary chemicals at the proper concentration for efficient inner-ear function.

Can any question remain, then, about the significance of proper nutrition? Is not supplementing our diet with necessary nutrients important? How much better to incorporate nutritional management than to use drugs without therapeutic effect and with many side effects.

METHODS

What, then, are the tests that we need to perform to determine the proper therapeutic regimen? After a complete history and physical examination are concluded, the confirmatory tests fall into several groups.

Audiological Evaluation

The tests within the audiological area that are necessary are pure-tone air and bone conduction audiometry;

Reprint requests: Dr. Wallace Rubin, 3434 Houma Boulevard., No. 201, Metairie, LA 70006. Phone: 504-888-8800; Fax: 504-455-6796; E-mail: wrubinmd@bellsouth.net

speech reception thresholds and discrimination tests; tympanometry and stapedial reflex tests; auditory brainstem-evoked responses, including middle and late latency function tests; and tinnitus matching and suppression tests.

These audiological tests are those most useful for site-of-lesion identification. The results from this group of tests will be helpful to physicians in correlating with vestibular function testing.

Vestibular Function Testing

The site-of-lesion vestibular function tests that are available include conventional electronystagmography (ENG) with the alternate binaural-bithermal stimulation test of Hallpike; the simultaneous binaural-bithermal test; and the rotation tests performed with computer capability (harmonic acceleration [HA] testing). These tests permit the evaluation of the integrity of the three functional components of the vestibular system: the vestibular end organ, the vestibular nuclei, and the central vestibular connections.

The vestibular nuclei are the sites of coordination of the input signals from the two vestibular end organs. The vestibular brainstem nuclei are additionally the sites of the origin of switching and relay for signals to the muscles of the eyes, the limb muscles, and the gastrointestinal tract. These connections are responsible for the symptoms that accompany dizziness.

The central controls are in such areas as the reticular formation, the thalamus, and other unidentified higher centers responsible for such phenomena as altering, habituation, and compensation. These controls, like mechanical governors, are involved when ENG testing difficulties occur in some patients. These phenomena and pathways are also responsible when drug actions affect ENG. The central controls are also responsible for spontaneous remission of vestibular complaints. This is accomplished by way of the process of compensation and habituation.

Clinical testing techniques presently available measure the function of these identified levels of vestibular input and control. The alternate binaural-bithermal caloric test (conventional Hallpike) measures primarily the integrity of the peripheral linear accelerator systems. The simultaneous binaural-bithermal caloric test evaluates the ability of the right and left linear accelerator systems to work synchronously or, if not, to measure the asymmetry of their input to the higher centers. The HA tests phase lag and symmetry, and the Bode plots are the result of the input from both accelerometers, their control by the brainstem modulators, and the central compensation mechanisms. All these functions are controlled and influenced by the reticular formation, the thalamus, and the cerebellum. Further refinement and sophistication of vestibular evaluation capability for central lesions is likely possible when quantitative tests of visual ocular control (saccade, smooth pursuit, and optokinetic) are used with HA testing.

Biochemical, Immunological, and Hormonal Testing

The biochemical metabolic evaluation of patients with neurootological disorders should include tests of cholesterol, triglyceride, thyroid, glucose tolerance response (ENG monitored), blood urea nitrogen, and serum glutamic-oxaloacetic transaminase. In addition, evaluation would encompass a complete blood count, analysis of fluorescent treponemal antibody absorption, prolactin level assessment (in women), uric acid, radioallergosorbent test immunological studies, and a test of fasting blood glucose [1–3].

Brain Mapping

Methods have been developed to analyze the electroencephalogram (EEG) quantitatively through spectral analysis. Much of the subjective aspect of EEG interpretation is removed, and features of the background EEG are revealed that are normally difficult to extract by visual examination. A much more sensitive approach to the evaluation of brain function has been accomplished by combining topographical displays of the EEG data, topographical displays of evoked potential data, and statistical comparisons of patient data with data from age-matched normal control groups (statistical probability mapping). This technique, which is known as *brain electrical activity mapping* (BEAM), has proved useful in detecting abnormalities consistent with organic dysfunction in many patients presenting with symptoms of vertigo but having otherwise normal results on conventional EEG testing. It is also extremely helpful in objectively documenting abnormal function in patients with learning disabilities, head trauma, and metabolic abnormalities.

DISCUSSION

The number of abnormal test results in patients with neurootological complaints has been greatest in fat metabolism, sugar metabolism, radioallergosorbent tests, and fluorescent treponemal antibody absorption tests. Abnormality has been found next most commonly in prolactin testing. Some abnormalities of liver and kidney function and an occasional abnormality in thyroid testing have been found as well.

In the fat metabolism area, triglyceride abnormality has been the most common finding. Management of these abnormalities is based on phenotype and low-density lipoprotein and high-density lipoprotein measurements. These assessments are performed before a routine of treatment and dietary instructions are given to affected patients [4–8].

Control of sugar metabolism abnormalities, both in the hyper- and hypoglycemic states, is accomplished by diet. A great number of patients with poor nutritional habits have been found and confirmed on the basis of an ENG-monitored glucose tolerance curve test (flat). Such patients respond to a dietary routine similar to that prescribed for patients with hypoglycemia (i.e., a diet low in noncomplex carbohydrate and with little refined sugar but high in proper proteins).

Both clinical and research findings have confirmed conventional allergy triggers as the cause of neurootological abnormalities. Inhalant allergies are by far less commonly responsible than are food and chemical triggers. The anecdotal reports of the past have been corroborated by research documentation. Immunological causes have been responsible for neurootological symptoms in 30% of my patient population. Also, in many more patients with neurootological symptoms, immunological triggers occur in combination with other biochemical or metabolic factors.

The abnormalities found on complete blood count studies have been anemias, polycythemias, and an occasional case of leukemia. Abnormalities of liver function with the glutamic-oxaloacetic transaminase test have been found primarily in alcoholics. (Most alcoholics do not admit that they are, in fact, alcoholics when their history is recorded.) The relationship between kidney abnormality and inner-ear abnormalities for both hearing and balance problems has been discussed in the medical literature for many years. We have found an occasional problem that fits into this category of abnormality.

The relationship between prolactin levels in women and neurological abnormalities has been described by Katsarkis. The most interesting relationship is seen in the fact that a deficiency in tryptophan in persons who have poor dietary intake—especially women—causes an elevation of the prolactin levels and, therefore, inner-ear abnormality. Such patients are easily controlled with change of diet and tryptophan supplementation. Tryptophan is involved in the serotonin cycle, and this may well be the neurotransmitter basis of the problem [9].

The high levels of zinc normally found in the choroid of the eye, the inner ear, and prostate has been described by a number of investigators, particularly Shambaugh [10]. We have just begun to evaluate patients for zinc and calcium levels. The use of zinc supplementation is a method of treating patients in whom the levels of zinc or calcium, or both, are low and may be the cause of tinnitus, hearing loss, or dizziness.

REFERENCES

1. Rubin W. Site of lesion vestibular function testing. *Laryngoscope* 94:386–390, 1985.
2. Boyles JH Jr. Food allergy diagnosis and treatment. *Otolaryngol Clin North Am* 18:775–785, 1985.
3. Harris JP. Immunopathology of the inner ear. Evidence of local antibody production. *Ann Otol Rhinol Laryngol* 93:157–162, 1984.
4. Wurtman RJ, Fernstrom JD. Nutrition and the brain. *Sci Am* 230:84–91, 1974.
5. Growdon JH, Wurtman RJ. Treatment of brain disease with dietary precursors of neurotransmitters. *Ann Intern Med* 86:337–339, 197..
6. Growdon JH. Neurotransmitter Precursors in the Diet: Their Use in the Treatment of Brain Diseases. In RJ Wurtman, JJ Wurtman (eds), *Nutrition and the Brain*, vol 3. New York: Raven Press, 1979:117–170..
7. Growdon JH, Wurtman RJ. Nutrients and neurotransmitters, contemporary nutrition. *N Y State J Med* 80:1638, 1980.
8. Moller SE. Tryptophan and tyrosine availability and oral contraceptives. *Lancet* 2:472, 1979.
9. Hall NR, Goldstein AL. Thinking well: The chemical links between emotions and health. *Science* 26:34–40, 1986.
10. Shambaugh G. Zinc and presbycusis. *Am J Otol* 6:116–117, 1985.