International Tinnitus Journal, Vol. 5, No. 1, 57–59 (1999)

Experiences with a Computer-Based Electronystagmography System in Examining Totally Deaf Patients

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Although the computer-based electronystagmography (ENG) system's analytic routines offer refinements available only in research laboratories, the system is very useful also in everyday practice. The computer-based ENG system contains a stimulator for saccadic and sinusoidal eye movements and for optokinetic eye movements, both of which are connected to the registration program. The system contains software for the numerical analysis of nystagmus, especially slow-phase velocity. When stimulation begins, registration also starts automatically. The system can save patient data.

Connected to the computer system is an air caloric stimulator used by the authors for the examination of caloric nystagmus. With this stimulator, caloric irrigation is safe also in cases of a perforated eardrum or even in ears that have been operated on. The timing of irrigation and the temperature of the air can be defined. The caloric stimulator is shaped similarly to an otoscope; using it is very easy.

The advantages of the computer-based ENG system are evident: A quantitative and qualitative analysis of nystagmus parameters can be made. Patient data can be saved for the control examinations, so the changes in the vestibular status can be monitored. Finally, the system is available for scientific analysis of nystagmus.

Every method also has disadvantages: Examination by computer-based ENG requires hardware and software, so it is very expensive. A complete examination takes perhaps an hour, and the cooperation of the patient is essential. The system cannot register every symptom and sign (e.g., pure rotatory nystagmus), so it cannot substitute for the traditional examination with Frenzel glasses.

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This article was presented at the Twenty-Fifth Ordinary Congress of the Neurootological and Equilibriometric Society, March 19–22, 1998, Bad Kissingen, Germany.

PATIENTS AND METHODS

Since 1985, in the Ear, Nose, and Throat Department of Semmelweis University, Hungary, cochlear implantation has been a routine operation in cases of total deafness. The authors have placed cochlear implants in 50 patients, all of whom had previous vestibular examination. Of these 50 implant patients, 26 were male and 24 were female. All were operated on by the senior author. The mean age of the patients was 30 years (range, 5–59 years).

The causes of total deafness in this group were as follows: 13 perinatal lesions, resulting in prelingual deafness; 6 cases of purulent meningitis and 4 skull-base fractures, resulting in postlingual deafness; 8 cases of ototoxic drug administration (especially streptomycin and gentamicin); 7 viral infections; and 12 cases of total deafness of unknown origin.

Most of the implantations (32 patients) were of the intracochlear type. Extracochlear implantation was performed in nine patients, and round-window electrodes were implanted also in the other nine patients.

During selection of the patients, in every case the vestibular system was examined before implantation. Before 1989, the authors had no method by which to register nystagmus. From 1989 to 1996, traditional ENG could be used, with bithermal caloric irrigation (44°C and 30°C water) by Cawthorne-Fitzgerald-Hallpike [1]. Therefore, most of the examinations were made with a traditional ENG and manual analysis.

Our patients were examined for 1 year with an ICS Medical Corporation computer-based ENG system. The ears were stimulated with 50°C and 25°C air for 40 seconds. Patients indicated a preference for 50°C air, claiming that it was more pleasant than was the 44°C water in the Cawthorne-Fitzgerald-Hallpike method, which was used previously by the authors.

RESULTS

A normal vestibular system was found in 13 patients, whereas bilateral loss of function was found in most (27) of the patients. Unilateral canal paresis was registered in six patients, and directional preponderance, characteristic of a central vestibular lesion, was found in only four cases.

The authors also examined whether cochlear implantation could change vestibular function after the operation. After implantation, patients were examined with the computer-based ENG system and with the air caloric stimulator. Postoperatively, stimulation is safer with warm and cool air than with the bithermal caloric test using water, because of the possibility of otitis externa with the latter method. A postoperative vestibular examination was performed in 39 patients. The other 11 patients also were contacted to participate in the control examination, but several are living far from Budapest, and the others did not want to undergo the vestibular examination because of the unpleasant feeling of vertigo.

Immediately after the operation, only four patients had vertigo lasting for 3–4 days [2]. Some time after the operation, the authors checked the vestibular system. In 17 patients, the function of the labyrinth on the operated side was the same as was registered preoperatively. In 10 patients, the irritability of the labyrinth became worse. This finding suggests that in the preoperative, normally functioning labyrinth, a canal paresis was present. In 12 patients the postoperative vestibular function improved, suggesting that the preoperative labyrinth anesthesia changed and normal (or almost normal) caloric reaction was registered in the operated ear.

CASE HISTORIES

Patient 1

In the first of three interesting cases, the patient was a 56-year-old woman who had hypoesthesia of the left side and vestibular anesthesia of the right side preoperatively. In a 1996 operation, the patient received an intracochlear implant in the left ear. The postoperative vestibular function on the operated ear was improved. The right side evinced a hypesthesia (as preoperatively), but the operated left ear, wherein anesthesia was registered preoperatively, exhibited very good vestibular function (hyperesthesia) postoperatively.

Patient 2

The second case is an example of impairment of vestibular function. In patient 2, vestibular examination was made by a computer-based ENG system before and after implantation. The patient was a 31-year-old man, who had a 56% caloric weakness in the right ear preoperatively and a 40% directional preponderance in the left. This case is very interesting because this patient became deaf after an ototoxic drug treatment. Before the vestibular examination, a pure peripheral lesion was suspected. Surprisingly, the patient has directional preponderance, which indicates a central vestibular lesion. The patient had an intracochlear implantation in the left ear. After the implantation, the patient had a 61% caloric weakness in the left ear and a 14% directional preponderance in the right. In this case, the impairment of vestibular function of the operated ear can be seen.

Patient 3

Patient 3 is a 55-year-old, prelingually deaf man, who had bilateral anesthesia preoperatively. An extracochlear implantation was performed in 1986 on the right side. Ten years after the operation, vestibular function has returned. Postoperatively, the authors found a 38% caloric weakness on the left side and normal vestibular function on the right (operated) side.

CONCLUSIONS

In the authors' cases, labyrinth function remained unchanged in 17 patients and worsened in 10 patients. Surprisingly, in 12 patients, vestibular function improved on the operated ear. The authors cannot identify the reason for the improvement of vestibular function. In one of the patients, vestibular function improved not only in the operated ear but in the contralateral ear. Possibly this change can be incited by the long-time electrical impulses in the labyrinth. Perhaps the electrodes of the cochlear implant have a stimulating effect on the labyrinth. The authors plan further investigations to resolve this issue.

SUMMARY

The computer-based ENG system's analytic routines offer refinements available only in research laboratories. This system contains a stimulator for the examination of saccadic and tracking, and optokinetic eye-movements, and an air-caloric stimulator, both of them connected to the registration program. The system also contains software for the numerical analysis of the nystagmus, thereby saving patient data.

The vestibular system of patients with total deafness was examined by the authors before and after cochlear implantation. The computer-based ENG system proved to be a useful diagnostic method, not only in the selection of the patients for cochlear implantation but in the diagnosis and treatment of dizzy patients. In a few cases,

improvement of vestibular function can be seen in the operated ear.

ACKNOWLEDGMENT

This work was supported by a grant of the National Scientific Research Council (OTKA) of Hungary No T-025231.

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