Non-vestibular dizziness and static posturography *

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Abstract. In patients complaining of dizziness attributable neither to vestibular disorders nor to any neurological cause, static posturographic recordings can reveal signs consistent with the symptoms. These posturographic abnormalities are a sign, not of impairment of some other input of the fine-postural system, but of faulty integration of the multimodal sensory information that contributes to the control of orthostatic posture.

Introduction

Patients who complain of symptoms but show no clinical or paraclinical signs to indicate the cause or the course of the disorder can be very perplexing. They complain of dizziness, but tests of their labyrinthine function show that it is within normal limits and neurological evaluation reveals no signs of any disease that can cause dizziness.

In such patients, postural investigations can reveal signs consistent with the symptoms: the patients complain of unsteadiness, and indeed their recordings show that they are not steady relative to their environment. These posturographic abnormalities are signs not of the failure of some other sensor of the fine-postural system (1), but of faulty integration of the multiple inputs that contribute to the control of orthostatic posture.

These facts are crucial in the treatment of these patients, because they invite us to try all means of taking advantage of the plasticity of sensory integration to relieve the dizziness. At least, this is how we interpret the simultaneous regression of the signs and symptoms of these patients after postural treatment.

The posturographic signs

Posturographic technique

Patients data were recorded on a static posturographic platform conforming to the standards published by members of the International Society of Posturography (2). The subjects stood upright and still, trying to keep steady on a firm, rigid, stationary platform. Any elasticity of the material underfoot alters the information received by the plantar sensors and so must be avoided. Movable platforms destabilize the subjects, who thus have to adopt a strategy to counteract this destabilization; the observed responses would therefore integrate cognitive factors, which we prefer to eliminate. The platform was set on only three strain gauges, since three points determine a plane; with four gauges the platform plane is hyperstable and the signal is quite different, at least if the gauge-and-platform setup is not prestressed.

The subjects stood in standardized surroundings (3), with the visual target on the axis of gaze in the primary position 90 centimetres away from the subject's eyes.

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and, for assessment of peripheral vision, with the walls of the posturographic booth 50 centimetres away on each side.

All the patients were recorded in the eyes-open and the eyes-closed condition.

The analogue signal from the three gauges, digitalized at a sampling frequency of 5 Hertz, was used on line to calculate the successive positions of the centre-of-pressure, whose coordinates were fed into a disk before being used off line.

**Signal analysis**

From the data provided by the signal analysis we shall present only:
- the area of the statokinesigram,
- the Romberg's quotient, and
- the correlation functions.

The area of the confidence ellipse containing 90% of the centre-of-pressure positions sampled is a statistical measure of the spread of these positions (4). Thus this area measures how accurately the subject keeps steady within his environment. The theoretical normal distribution of this parameter on a standardized platform in the eyes-open and eyes-closed conditions was established from three series of measurements, each in a different cohort of healthy subjects. In the eyes-open condition its mean was 90 mm and its upper 95% confidence limit was 210 mm² (Fig. 1). Therefore subjects whose area value was more than 210 mm², in the eyes-open condition, may be considered unsteady, statistically speaking.

Romberg's quotient is calculated from the values of the area observed in the eyes-open and eyes-closed conditions, by the formula:

\[
\text{RQ} = \left( \frac{A_{ec}}{A_{eo}} \right) \times 100.
\]

The theoretical normal mean value of this quotient is 250: that is, the fine-postural system is 250% as accurate in the eyes-open condition as in the eyes-closed condition. A Romberg's quotient of 100 means that the subject is no steadier with his eyes open than with them closed. Such a person does not use vision to keep steady, but behaves as if he were blind, as far as posture is concerned.

Oscillations of the centre-of-pressure along the forward-backward and the left-right axis, or "postural sway", can be analyzed according to their frequency. It was noticed long ago that the frequencies of oscillations in the two planes were independent (5). No correlation can be found between the frequency of sway on the two axes; their intercorrelation function is random (Fig. 2).

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**Fig. 1**

*Theoretical normal distribution of the area parameter in the eyes-open condition.*

The bar graph shows the distribution of areas in a cohort of 100 normal subjects, recorded in the eyes-open condition. The Gaussian curve represents the theoretical normal distribution of this parameter in the eyes-open condition, based on results from three cohorts of normal subjects [N (men + women) ; age in years ± SD; age range] :

1. 100 (50 + 50) ; 33 ± 10 ; 19-57 years;
2. 40 (40 + 0) ; 23 ± 4 ; 19-27 years ;
3. 110 (55 + 55) ; 35 ± 11 ; 18-59 years.

On the abscissa, area values are given in mm². CL: 95% confidence limits. Logarithmic scale.

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**Fig. 2**

*Random intercorrelation function.*

The correlation between forward-backward sway and left-right sway does not show any common periodicity.
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Patients

The statistical analysis presented here is based on recordings from 800 patients who complained of dizziness. All of them underwent a neurological and an otoneurological check-up that gave results within normal limits.

Results

The distribution of the area parameter for the patients was very significantly different from the theoretical normal distribution and most gave an area beyond the upper 95% confidence limit (Fig. 3).

Discussion

Critique of the results

The results of this study are at first glance so striking that they are difficult to believe. For instance it might be asked whether the instruction to "stand upright keeping steady" were interpreted in different ways by normal and by dizzy subjects. In fact, more detailed analysis of the results confirms that they are indeed not credible - at least not for all the patients.

Careful observation of the distribution of the areas of the confidence ellipses of these patients shows that it is bi-modal, with the intersection at about 2000 mm² (Fig. 3). Our group of patients therefore comprises two different populations: those whose areas are abnormal but less than 2000 mm² and those whose areas seen really huge - more than 2000 mm². The population of subjects with huge areas can be suspected of not having complied with the instruction to stand upright keeping steady, because it includes many subjects who are betrayed by their intercorrelation function. Their intercorrelation function (Fig. 4) is periodic; therefore it is mathematically certain that their forward-backward sway and left-right sway are no longer independent.

The oscillations are no longer governed by two different subsystems, but are governed by one single, unique centre, probably a higher centre (cortical? ...). Psychiatrists often call such subjects "oversimulators", as distinct from malingers (6). Not all patients with huge areas are malingers or "oversimulators", but these huge areas are suspect; they cannot be considered objective signs of impairment of the fine-postural system. In contrast we never found any periodic intercorrelation in the population with abnormal areas below 2000 mm², and in fact it is difficult to simulate such abnormal areas.
For these reasons, among others (7,8), only areas between 210 and 2000 mm$^2$ in the eye-open condition are taken as a posturographic sign of impairment of the fine-postural system. Within these limits posturographic abnormalities turn out to be reliable data indeed, and useful for the study of nonvestibular dizziness.

**Sensory integration**

These posturographic abnormalities are not a sign that some input of the fine-postural system other than the vestibular input is impaired. When an input is out of order, the system continues to stabilize the person’s body correctly in its environment, by making use of the other available sensory information; this fact has been noted by several authors (1, 9, 10, 11, 12);

On the contrary, these posturographic abnormalities are a sign of poor integration of the multimodal sensory information contributing to the control of orthostatic posture. This phenomenon is particularly obvious in the case of the integration of visual information.

The basic visual stimulus for controlling posture is the slipping of the image of the surroundings on the retina. But retinal slip is ambiguous: it may be due to movement of the body, or of the surroundings, or of the eyes. The postural significance of the retinal signal must be deciphered by comparing it with the signals from the other sensors of the fine-postural system. If one of these sensors is defective then the integration of visual input must be disturbed. And clinically that is precisely what we observe. Posturographic recordings evaluate the quality of the integration of visual input by means of Romberg's quotient, and this quotient is significantly modified when any other sensor of the fine-postural system is defective, as in vestibular neuritis (1) (Fig. 5), oculomotor dysequilibrium (13) and even low back pain; in this case not only is Romberg's quotient disturbed, but its return to normal in the course of the illness seems to be the first objective sign of the patient's return to normal (14).

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**Future prospects for treatment**

From a diagnostic point of view these stabilometric findings of disorders of sensory integration are disappointing, since they do not lead to any anatomo-clinical conclusions: they do not answer the question of where the problem is, anatomi-{}cally speaking.

On the other hand from a therapeutic point of view these findings are stimulating, because they point to a need for re-education of the sensory integration of these patients. This path is a hopeful one, on account of the plasticity of the central nervous system, and can be explored methodically now that we have not only symptoms, but also objective signs, to be used for the purpose.

**Conclusions**

The control of orthostatic posture is a complex phenomenon that can be studied more accurately now thanks to the development of electronics and of data processing. But one must be equipped not only with new material tools, such as a stabilometric platform, but above all with new conceptual tools that
change our way of thinking. We must recognize that we do not yet really understand all the nervous centres and pathways that contribute to postural control, and we must consent to consider them as a "black box" in a system whose transfer functions we are only beginning to study.

From this point of view any symptom, such as dizziness, that suggests a loss of the normal relations between a subject and his environment is an invitation to look carefully at the functioning of his fine-postural system.

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References


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Figure 1