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Usefulness of ultrasound-computer-craniocorpography in different vestibular disorders

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Abstract

Introduction: Vertigo is one of the most unpleasant symptoms. Two of the main points of the examinations are the vestibulospinal tests (Romberg test and Unterberger- Fukuda test) can be measured objectively by the ultrasound-computer-craniocorpography. **Objectives:** Using ultrasound-markers on head and shoulders, the ultrasound-computer craniocorpography can measure and analyze the numerical data of statokinetic tests. The study is comparing the parameters of the vestibulospinal tests in different vestibular disorders. **Patients and methods:** 84 patients were examined. The main parameters in the standing test are the longitudinal and sway, the torticollis angle, and the forehead covering. In the stepping test the main parameters were the longitudinal deviation, the lateral sway, the angular deviation, and the self-spin degree. The patients were divided on normal, unilateral and bilateral peripheral lesion and central lesion groups. **Results:** The data of the longitudinal and lateral sway and the forehead covering in Romberg test are quite different in the normal and dizzy patients. **Conclusions:** Ultrasound-computer-craniocorpography is a useful method in the examination of the balance system disorders. The differential diagnostic value is not sufficient alone, we needs other investigations for the topical diagnosis of the vestibular system.

Keywords: central vestibular dysfunction, bilateral peripheral vestibular dysfunction, standing and stepping, unilateral peripheral, US-COMP-CCG.

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INTRODUCTION

Vertigo is one of the most frightening symptoms of the human's life. Vertigo is a border line problem of otolaryngology, neurology, psychiatry, and other specialties. Basically vertigo maybe defined as a mismatch in input from the sensory pathways, which define our position in space.

Four main sensory mechanisms contribute to our sense of balance and orientation are the visual afferentation; the vestibular afferentation, including accelerative and gravitational forces as monitored by our vestibular organ; the proprioceptive afferentation, including muscle and joint receptors; and the acoustic receptors.

Data from these sensory mechanisms are taken up by the brainstem, compared and integrated into a total spatial image. The central nystagmus generator is in the brainstem, especially in the mesencephalon, which is related to the neck muscle monitoring nuclei via the medial longitudinal fasciculus. Vestibular ataxia is related to an inappropriate activation of the polysynaptic vestibulospinal pathways[1].

For establishing necessary topodiagnostic procedure we are using a special neurootological history scheme, the computer based electronystagmography with caloric and optokinetic tests. Vestibular spinal testing is objectively recorded through cranio-corpo-graphy (CCG). Additionally we are evaluating audiometry and evoked responses. The complete evaluation battery of vertigo contains ophthalmological and neurological examinations and MRI scans. Thus modern equilibriometric examinations have to analyze the clinical vertigo profile, the vestibular spinal functions, the vestibulo-ocular functions as well as the optokinetic functions.

A modern neurootological differential diagnosis is the basis for planning the acute and also the supportive treatment[2].

Objectives

Cranio-corpo-graphy was designed firstly as a non-electronic, simple office recording procedure for head and body movements. The regular cranio-corpography procedure combines a stepping test (Unterberger, Fukuda) with a standing test (Romberg).

Through a local positioning system a very precise localization of ultrasound markers is possible. Sound is moving through air with an average velocity of 330 m per sec. By means of 3 microphones in fixed arrangement in space the sound signal can be precisely located according to its source. This is based on a mathematical analysis. This principle is installed into the ZEBRIS Coordinate Measurement System® (CMS).

For analyzing head- and body movements under the strain of different test profiles we apply the following voluntary tests which must be performed by the patient when being instructed by an investigator. The PC contains a program, which releases impulses of ultrasound through the markers of the test person. It also arranges the collection of the sound signals from the microphones.

The patient is carrying a helmet with 2 ultrasound markers and a shoulder fixation with two other ultrasound markers. A computer unit is triggering the ultrasound impulses. Backwardly and above the patient is the ultrasound receiver unit, containing several ultrasound microphones and data processors receiving the sound traces from the head and from the shoulders. The signals received are triggered by as well as sent to the computer unit. The computer unit calculates the spatial position of all the 4 ultrasound markers.

The PC software shows online the results obtained in each test. In normal patients there were no significant differences in ultrasound-computer-craniocorpography (US-COMP-CCG) results compared with other statokinetic balance tests. In patients with somatosensory disturbances the lateral sway in stepping test, and the longitudinal sway and forehead covering area were significantly pathological. In vestibular disorders the stepping test parameters, the lateral sway and self-spin degrees were significantly pathological. In visual-cortical inhibition the forehead covering area could be pathological[3].

Using ultrasound-markers on head and shoulders the computer can measure and analyze the numerical data of statokinetic tests of the patients suffering of vertigo or balance disorders. The main parameters for evaluating the standing test are the longitudinal sway in cm, the lateral sway in cm, the torticollis angle in degree, and the forehead covering area in cm^2.

The normal values in the longitudinal sway are 1.75 cm-10.53 cm, in the lateral sway is 1.74 cm to 7.06 cm. The forehead covering parameter has several types based on the shape of the curves.

In the stepping test the normal values of the longitudinal displacement are between 30.03 cm and 113.35 cm, of the lateral sway are between 5.17 cm and 16.15 cm. The mean value of the angular deviation is 55.13 degree to the right and 48.37 degree to the left. The body spin mean value is 82.21 degree to the right and 82.89 degree to the left[4].

The aim of our study is to compare the parameters of the vestibulospinal test in different vestibular disorders.

PATIENTS AND METHODS

The US-COMP-CCG examination of 84 patients was performed at the Otoneurological Department of

the Semmelweis University. The diagnoses were based on the detailed case history, the results of the computer based electronystagmography and the clinical findings of the Romberg's test and blind walking test. Under those conditions two vestibulo-spinal tests are performed: Unterberger's and Fukuda's march test and Romberg's test. In the standing test the patient is requested to stand still with feet together, hands outstretched and eyes closed for a period of approximately 1 minute. The stepping test is based upon a series of steps on the spot during one minute.

The patients were divided into 4 groups according to the condition of their vestibular system: normal vestibular system, unilateral and bilateral peripheral vestibular lesion, central vestibular lesion. The diagnosis was based on the clinical findings and electronystagmographical results.

Statistical analysis were made by ANOVA (Kruskal-Wallis test), significance level was $p < 0.05$.

RESULTS

Analyzing the patients' results, the distribution of the patients was the following: 8 patients have normal and 9 have bilateral loss of vestibular function. Twenty-two patients suffered from central vestibular lesion, while most of the patients suffered from unilateral peripheral lesion (n = 45). Seventy-six patients with vertigo had vestibular disorders of various types (90.5%).

Most of the patients with vertigo were female, only one quarter of patients was male. The mean age of the patients was 55.8 years. The mean age of the pathological patients and of the normal patients was 55.7 and 56.8 years, respectively.

Analyzing the results of the standing test, we compared the 4 parameters (Table 1). The four parameters of the US-COMP-USCCG tests are significantly different from each other.

Table 1. Standing test

	Longitudinal sway	Lateral sway	Forehead covering	Torticollis angle abs*
Normal vestibular system	4.7	4.3	19	18.3
Unilateral peripheral	8.8	5.1	65.5	12.1
Bilateral peripheral	9.2	5.1	62.3	13
Central lesion	8.4	6.3	81.7	16.7
All pathological patients	8.7	5.5	69.8	13.6
All patients	8.3	5.2	57.1	14.1

* Torticollis angle results were given in absolute value, without direction.

In the longitudinal sway the normal value is substantially different from the pathological values, but there were no significant differences among the values of various vestibular functions. In the lateral sway the normal patients value is not significantly differ from the others. The forehead covering value is significantly higher in the different vestibular dysfunction than in the normal patients, and the highest difference can be found in central vestibular lesions. The torticollis angle parameter showed higher value in normal vestibular system patients than in the pathological patients but the difference is not significant statistically. The mean values of the standing (Romberg) test results are shown in the Table 1.

Comparing the parameters of the stepping test, we were analyzing the results of 4 parameters, the longitudinal deviation, the lateral sway, the angular deviation, and the self-spin (Table 2). They are significantly different parameters from each other.

Table 2. Stepping test

	Longitudinal deviation	Lateral sway	Angular deviation. abs**	Self spin degree abs**
Normal vestibular system	45.6	11.0	150.4	44.2
Unilateral peripheral	58.4	14.0	149	53
Bilateral peripheral	51.6	16.0	162.6	47.7
Central lesion	42.6	18.0	136.0	47.1
All pathological patients	53	15.4	147.0	50.7
All patients	52.3	14.9	149.5	48.7

** Angular deviation and self-spin results were given in absolute value, without direction.

The longitudinal deviation value is substantially lower in normal vestibular patients, than in pathological peripheral vestibular status. In the lateral sway parameter the central lesion result was higher than normal values, but it was also in the normal range. Angular deviation and self-spin degree have no diagnostic values; the normal results are not significantly different from the pathological states. The mean values of the stepping test parameters are shown in the Table 2.

CONCLUSIONS

Vertigo is a frightening symptom. The diagnostic procedure is sometimes long, and to evaluate the subjective complaints of the patients we needs objective methods. Clinical neurootology is depending much upon its sensory motor tests. The neurootometric tool box

contains several sensory motor pathway analyses, i.e. vestibular ocular nystagmus, retino- ocular nystagmus, cervico- ocular nystagmus, vestibular spinal head and neck movements[5].

One of these objective methods could be the ultrasound-computer- craniocorpography.

The US-COMP-CCG, developed by Claussen, is a simple, reliable, quantifiable and reproducible method for statokinetic test investigation of vertigo victims. It consists of optically monitoring the patient's head and body movements as he performs the classical Romberg's and Unterberger's tests. The results of the investigation are available very shortly after performing the test. It is nearly an on-line procedure.

Our experiences show that ultrasound-computer-craniocorpography is useful test in the examination of patients. Although the differences in the parameters of the stepping and standing tests between several diagnostic groups (central, unilateral and bilateral peripheral) are statistically not significant, the differences between normal and pathological values shows that the US-COMP-CCG could be available for the screening of the patients with vertigo; whether the vertigo is originated from the balance system or not. Our opinion is that the US-COMP-CCG alone is not capable of broadly differentiating cases into central, peripheral, combined and undifferentiated pathologies. According to Said and Izita's data[6] the correlation between the CCG and the caloric test were statistically significant, indicating that there is an important association between these two tests ($p < 0.001$). These results suggest that performing the CCG before the caloric test may be an easy examination, and it could be helpful in the preliminary diagnosis. Sometimes, when the vestibulo-ocular and vestibulo-spinal systems are seen not to run hand in hand and this probably accounts for the difference in topodiagnostic data arrived at using electronystagmography and cranio-corpo-graphy together. The parameters must be further investigation, but it could be useful for the follow -up of the patients with vertigo and is could be available for the monitoring of the treatment.

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