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Comparative Results of Craniocorpography and the Test of Balance in Tinnitus and Vertigo Patients

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Abstract: Many authors have reported different useful studies in evaluating vestibular function through vestibular, somatosensory, and visuocortical systems using the test of balance and in assessing vestibular function through the vestibulospinal system using craniocorpography. We researched 100 patients suffering from tinnitus and vertigo (36 men and 64 women). Diagnoses of vestibular dysfunction can be improved if modern physicians correlate the background, clinical description, and vestibular test results of patients suffering from tinnitus and vertigo. In this study, we report on the evaluation of vestibular function through craniocorpography and the test of balance in order to determine a better vestibular diagnosis.

Key Words: craniocorpography; test of balance; tinnitus; vertigo

PATIENTS AND METHODS

We reviewed the clinical charts of all patients (N = 100) who had a diagnosis of vertigo and were seen at our neurophysiology-otology clinic in Mexico City in 2004. We recorded gender, age, reason for consultation, and results of the audiological and otoneurological studies.

A detailed questionnaire—Neurootological Data Evaluation–Claussen (NODEC) IV (Germany) was administered to and a neurophysiology-otoophthalmological ear, nose, and throat examination (Argentina) was performed on each patient. We also recorded the electronystagmography results and possible neurootological symptoms and their collateral characteristics in all cases. This patient history takes into account the complaints and disorders from other cranial nerves and the background of underlying diseases—in this case, tinnitus and vertigo.

In all patients, we performed the test of balance (TOB), consisting of a static platform measuring 50 × 50 cm, whereon a patient stands. The platform has four pressure sensors, one in each corner, each with a range of force from 0 to 100 kg. Each sensor produces a small voltage proportional to the pressure supported.

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The platform holds the necessary electronics to amplify these signals, convert them to digital format, and send the information to a computer using the serial port. The computer receives the information from each pressure sensor. The special software running in the PC under Windows permits a complete center-of-gravity calculation and further analysis (Fig. 1).

The four patient conditions that define each 30-second test are

1. eyes open, stable surface (EOS), complete equilibrium information;
2. eyes closed, stable surface (ECS), somatosensory and vestibular information;
3. eyes open, unstable surface (EOU), visual and vestibular information; and
4. eyes closed, unstable surface (ECU), vestibular information only.

The unstable condition (tactile information suppressed or very attenuated) is performed using a thick foam cushion over the platform.

Performing Craniocorpography

This study pointed out the importance of a short but significant vestibulospinal equilibrium test, which is recorded by Claussen craniocorpography (CCG). The stepping test was first described by Unterberger and colleagues in 1963. In 1978, Claussen described the photo-

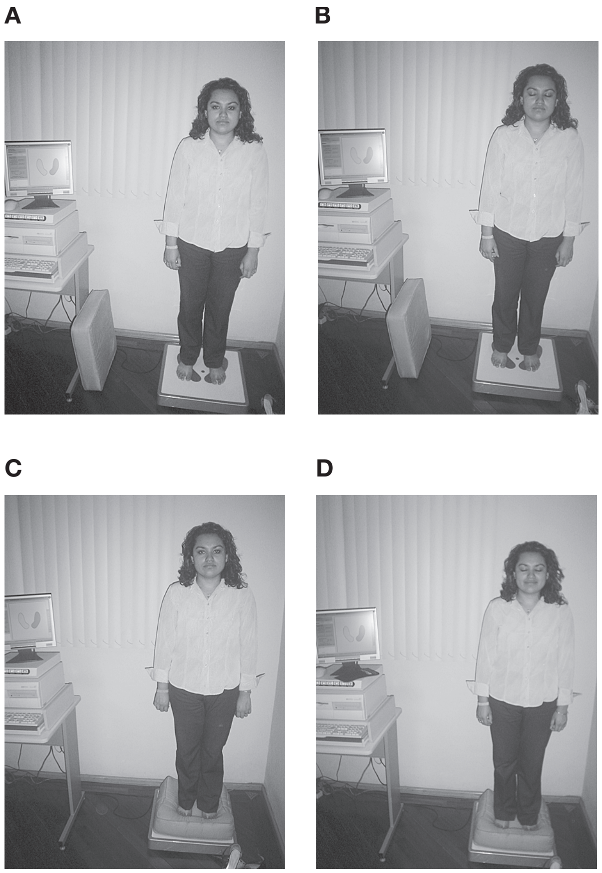

Figure 1. Test of balance, performed with a device consisting of a static platform whereon a patient stands. The four patient conditions that define each 30-second test are (A) eyes open, stable surface, complete equilibrium information; (B) eyes closed, stable surface, somatosensory and vestibular information; (C) eyes open, unstable surface, visual and vestibular information; and (D) eyes closed, unstable surface, vestibular information only. The unstable condition (tactile information suppressed or very attenuated) is performed using a thick foam cushion over the platform.

graphic technique for recording results of the stepping test, which he called the *craniocorpography test*. It was performed as described here. The CCG uses light markers placed on the forehead, the occiput, and both shoulders of a patient. Such lights are reflected through a mirror system on the ceiling into a recording video camera and on to an IBM computer that receives, analyzes, and prints the signal.

The patient is blindfolded by means of a sleeping mask, cutting off visual stimuli, and the patient loses contact with the ground while stepping; hence the proprioceptive stimuli are also gradual (Fig. 2). The patient now will maintain balance only through the stimuli received from both vestibular systems. Any deviation, rotation, or sway beyond the normal range will indicate the involvement of the peripheral or central systems. The

Figure 2. In craniocorpography, the patient is blindfolded by means of a sleeping mask, cutting off visual stimuli, and the patient loses contact with the ground while stepping; hence the proprioceptive stimuli are also gradual.

test procedures applied are generally the Romberg standing test and the Unterberger-Fukuda stepping test.

Unterberger-Fukuda Test

The Unterberger-Fukuda test requires a patient to step at least 80 steps on the spot. The test evaluates longitudinal displacement from the starting point to the end point; lateral sway, which is the width of the head movement curves; angular deviation, which is the angle between the directions at the starting point and at the end point; and body spin, which is the rotation around the body axis.

Claussen et al. [1] reported that the parameters obtained through the CCG and the TOB are significant for the final diagnosis. Each variable of CCG and TOB was analyzed using statistical tools, such as Pearson's *r*. The statistical analysis methods were Pearson's for the independent variables and Spearman's correlation for association.

RESULTS

At our neurophysiology-otology clinic in Mexico City, 100 neurootological patients (36 men, average age 50.88 years; 64 women, average age 47.98 years) underwent a thorough neurootological examination, including medical history (NODEC IV) and neurophysiology;

Table 1. Results of Craniocorpography

		No. of Patients		
Variables	**Tolerances**	**Normal**	**Abnormal**	**Total**
Side-to-side sway	0–14.23 cm	22	78	100
Linear displacement	0–104.80 cm	17	83	100
Lateral deviation				
Right	0–36.72 deg	16		
Left	0–32.20 deg	14		
Total		30	70	100
Lateral angulation				
Right	0–56.50 deg	26		
Left	0–51.90 deg	7		
Total		33		
Romberg		33	67	100

ear, nose, and throat examination; and CCG and TOB. The average age for the entire patient group studied was 50 years and, of these patients, 42.94% had tinnitus and 100% complained of vertigo. The most frequent symptom of vertigo reported was lift sensation (59.05%), followed by a tilting and falling sensation (51.04%) and feeling sick (39.02%).

Patient histories showed us hyperacusis in 54.58%. Tinnitus was reported in 42.94%. Neurological symptoms, such as double vision, were reported in 6%, and headache was reported in 36%, data that may mirror the habits and cultures of the groups represented by the patients studied.

Vascular findings included hypertension (24.20%), hypotension (16.60%), insufficient heart (0.67%), neurological disease (7.15%), and kidney disease, (9.95%), data that, again, may be reflective of the various habits and cultures of the groups represented by the patients studied. Diabetes was present in 9.75% of the patient population.

The purpose of this investigation was to compare CCG (side-to-side sway, linear displacement, right and left lateral deviation, right and left lateral angulation, and Romberg; Table1) and the TOB (average velocity, total displacement, equilibrium area, and Romberg; Tables 2–5). Our aim was to describe the results obtained from the vertigo patients in our clinic.

Table 2. Results of Test of Balance: Average Velocity

	No. of Patients
Stable	
OA < .40	1
OA > 1.13	19
Total	20
OC < .94	49
OC > 1.53	22
Total	71
Abnormal	91
Normal	9
Total	100
Unstable	
OA < .69	5
OA > 2.13	14
Total	19
OC < 1.61	41
OC > 3.64	8
Total	49
Abnormal	68
Normal	32
Total	100

Table 3. Results of Test of Balance: Total Displacement

	No. of Patients
Stable	
OA < 15.5	1
OA > 44.5	22
Total	23
OC < 33.9	36
OC > 60.3	17
Total	53
Abnormal	76
Normal	34
Total	100
Unstable	
OA < 26.3	7
OA > 86.4	11
Total	18
OC < 63.0	39
OC > 143.7	5
Total	44
Abnormal	62
Normal	38
Total	100

Table 4. Results of Test of Balance: Equilibrium Area

	No. of Patients
Stable	
OA < .82	7
OA > 2.50	47
Total	54
OC < 1.93	26
OC > 7.09	10
Total	36
Abnormal	90
Normal	10
Total	100
Unstable	
OA < .78	1
OA > 4.68	48
Total	49
OC < 4.91	31
OC > 20.13	11
Total	42
Abnormal	91
Normal	9
Total	100

Table 5. Results of Test of Balance: Romberg

	No. of Patients
Stable	
OA < 244	88
OA > 443	12
Total	100
Abnormal	47
Normal	3
Total	50
Unstable	
OA < 89	99
OA > 99	1
Total	100
Abnormal	49
Normal	1
Total	50

We found statistical significance when we correlated average velocity (TOB) and lateral deviation–lateral angulation (CCG) (Fig. 3); total displacement (TOB) and linear displacement (CCG) (Fig. 4); equilibrium area (TOB) and side-to-side displacement (CCG) (Fig. 5); and equilibrium area (TOB) and side-to-side and linear displacement (CCG) (Fig. 6). The Pearson's test proved to be independent of these variables: "No-correlation"

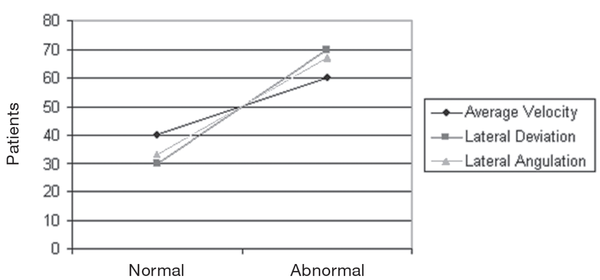

Figure 3. Statistically significant results were found in vertigo patients in our clinic when we correlated average velocity (test of balance) and lateral deviation–lateral angulation (craniocorpography).

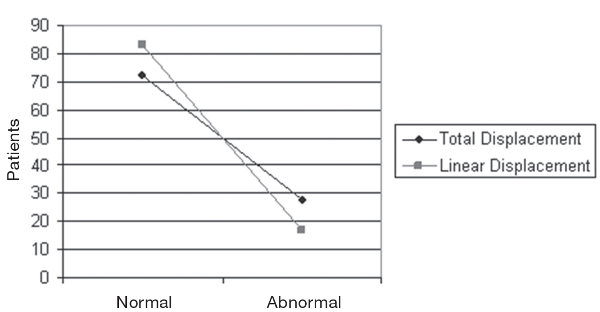

Figure 4. Statistically significant results were found in vertigo patients in our clinic when we correlated total displacement (test of balance) and linear displacement (craniocorpography).

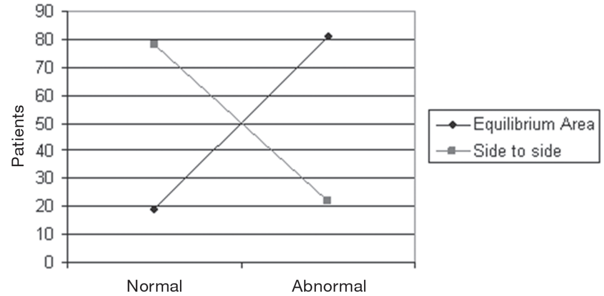

Figure 5. Statistically significant results were found in vertigo patients in our clinic when we correlated equilibrium area (test of balance) and side-to-side displacement (craniocorpography).

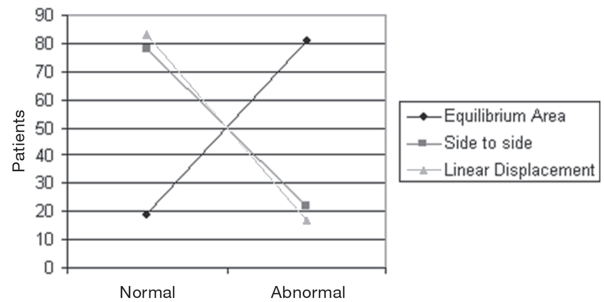

Figure 6. Statistically significant results were found in vertigo patients in our clinic when we correlated equilibrium area (TOB) and side-to-side and linear displacement (CCG).

would be perfect (–1) if the intersected values were linear, whereas the *r* correlation could take values –1.

DISCUSSION

Our 100 neurootological patients were examined for tinnitus and vertigo problems and for hearing problems. We administered clinical examination and laboratory tests and performed audiometry and equilibriometry. Our results reveal that the CCG and TOB are helpful in the preliminary diagnosis of vestibular dysfunction.

CCG is a diagnostic tool useful in the study of vestibular reflex pathways [1,2]. The TOB evaluates a patient's equilibrium in static condition and is the study of the center-of-gravity projection over the standing surface that evaluates visual, somatosensory, and vestibular contributions to stability or sensory equilibrium organization [1,3–5]. These studies stress the importance of studying vestibular function through the vestibular system.

The variables CCG and TOB were revealed statistically to be independent of one another ($p < 1$), as there was not correlation between these two tests. These results suggest that performing CCG and TOB before the caloric test may be easier, as they are rapid and noninvasive.

The incidence of normal subjects, the parameters, and their average about the CCG and TOB in this study as compared to other published studies may be similar.

CONCLUSIONS

CCG and the TOB are useful techniques for investigating vestibular function in cases of vertigo. CCG and the TOB are significant tests for scrutinizing peripheral, central, and combined lesions in cases of vertigo. Vestibular functions can be tested simultaneously on both sides. These tests can be easily performed in the outpatient department and are not time-consuming or expensive.

The correlation between CCG and the TOB test are statistically significant according to Pearson's r ($p < 1$). There is, however, no correlation between the two tests; they are independent of one another.

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