

# Role of dynamic posturography (Equitest) in the identification of feigned balance disturbances

## *Ruolo dell'Equitest (posturografia dinamica) nell'identificazione dei disturbi dell'equilibrio simulati*

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### Key words

Dizziness • Diagnosis • Dynamic posturography • Simulation

### Parole chiave

Vertigini • Diagnosi • Stabilometria dinamica • Simulazione

### Summary

Clinico-instrumental criteria to reliably detect simulated vertigo remain to be defined. Computed dynamic posturography (Equitest) has been used to identify additional factors to distinguish simulated, from real vertigo. The present study population comprised 23 normal subjects and 16 patients with documented vestibular impairment. Normal subjects were also studied during a state of simulated vertigo. In malingerers, the Equilibrium Score and the Composite Equilibrium Score showed a statistically significant reduction in all test conditions as compared to normal subjects, patients and "non-malingerers". Upon Sensory Analysis, statistically significant differences were found for the somatosensory component between malingerers and "non-malingerers". In 20/23 cases, Strategy Score values recorded in malingerers were 2 Standard Deviations lower than the mean obtained in "non-malingerers" in at least one of the six test conditions. By combining the latter observation with Goebel's 1<sup>st</sup> criterion it was possible to differentiate malingerers from non-malingerers with 86.9% sensitivity and 89.7% specificity. The Equitest, therefore, in combination with conventional methods, provides the clinician with an important tool, in the identification of a state of simulated vertigo.

### Riassunto

*Criteria clinico-strumentali in grado di individuare con assoluta certezza una vertigine simulata non sono ancora disponibili. La Posturografia Dinamica Computerizzata (Equitest) è stata utilizzata in questo lavoro per individuare ulteriori elementi utili a distinguere la vertigine simulata da quella reale. Sono stati studiati con l'Equitest 23 soggetti normali e 16 con accertato danno vestibolare. I soggetti normali sono stati studiati anche durante la simulazione di uno stato di vertigine. Nei simulatori l'Equilibrium Score ed il Composite Equilibrium Score hanno evidenziato una riduzione statisticamente significativa in tutte le condizioni di esame rispetto al gruppo dei normali, dei patologici e dei "non simulatori". Alla Sensory Analysis differenze statisticamente significative sono state riscontrate per la componente somatosensoriale tra simulatori e "non simulatori". In 20/23 casi i valori di Strategy Score registrati nei simulatori sono inferiori di 2 DS alla media ottenuta nei "non simulatori" in almeno una delle sei condizioni del test. La combinazione di questa osservazione con 1° criterio di Gobel permette di discriminare lo stato di simulazione dalla non simulazione con una sensibilità dell'86,9 ed una specificità dell'89,7%. L'Equitest quindi può fornire al clinico un contributo importante in associazione con le metodiche tradizionali per individuare la vertigine simulata.*

## Introduction

The identification of criteria able to exclude that a vestibular disorder is, to some extent, simulated, is still a matter of debate.

Those patients who consciously and voluntarily complain of postural unsteadiness, for the purpose of economic gain, can be defined as "malingerers".

Conventional methods currently available (electro-nystagmography, caloric test, rotation test, spontaneous tests) to define the various forms of vertigo evaluate only the labyrinthine component of balance while computed dynamic posturography (Equitest)

provides information on visual and somatosensory conditions<sup>1-3</sup>.

Aim of the present study was to identify patterns, by means of dynamic posturography, useful to distinguish non-organic or apphysiologic from real vertigo.

## Patients and methods

A group of 23 normal volunteers (13 male, 10 female, age range 17-60 years) and 16 patients (10 male, 6 female, age range 18-60 years) with documented peripheral (4 Ménière syndromes, 2 Benign Paroxysmal

Vertigo, 2 Chronic Otitis Media) or central vestibular impairment (3 neurinomas of 8<sup>th</sup> cranial nerve, 2 cases of multiple sclerosis, 3 cases of vertebrobasilar insufficiency) entered the study. All participants underwent computed dynamic posturography (Equitest, Neurocom Int. Inc., Clackamas, Oregon, USA). Normal subjects were also studied during simulated postural unsteadiness.

The Sensory Organization Test (SOT) which evaluates the contribution of the different sensory inputs in the maintenance of posture and the Motor Control Test (MCT) which studies motor reflexes triggered by abrupt platform motion were performed by positioning the patient on a platform surrounded by a background. Six different conditions for balance system stimulation were studied:

- I. eyes open, fixed platform surface and background;
- II. eyes closed, fixed platform surface and background;
- III. eyes open, moving background (directly proportional to patient antero-posterior sway);
- IV. eyes open, moving platform surface (directly proportional to patient antero-posterior sway);
- V. eyes closed, moving platform surface;
- VI. eyes open, moving platform and background.

Equilibrium scores (ES) and strategy scores (SS) were obtained by repeating the trials in each condition three times to achieve reliable results.

ES, which indicates the amplitude of sway angle based on maximum displacement of gravity centre, was calculated using the formula:

$$ES = [12.5^\circ - (\theta_{\max} - \theta_{\min})] \times 100 / 12.5^\circ$$

where  $12.5^\circ$  is the normal limit of antero-posterior sway and  $\theta$  is the angle between the vertical line passing from the platform centre and that which links it to the patient gravity centre<sup>4</sup>.

The Composite Equilibrium Score (CES) was obtained for each patient: this represents the overall evaluation of all trials, the maximum value of which is 100.

The SS which considers the ankle and/or hip strategy used by the patient to maintain balance during trials, was calculated with the formula:

$$[1 - (\text{SH max} - \text{SH min}) / 25] \times 100$$

where 25 indicates the difference measured between the maximum and minimum tangential force generated by normal subjects who use only the hip to maintain the balance on a limited surface.

A score close to 100 indicates that the patient applies mainly an ankle strategy to maintain balance, while a score close to 0 indicates preferential use of the hip strategy.

The Sensory Analysis (SA) was then considered. Based on average balance scores in specific pairs of sensory trials, SA classifies sensory dysfunction and/or the abnormal sensory preference in somatosensory (ratio between conditions II and I), visual (IV/I), vestibular (V/I) and visual preference (III+VI/II+V) dysfunction.

SA and SS results were evaluated in terms of sensitivity and specificity. Comparison was made in relation to single groups (malingerers, normal subjects, patients) as well as considering normal subjects and patients as a single group defined of "non-malingerers". The results obtained were associated with Goebel's first criterion (1997): *in all malingerers, SOT I scores are lower than standard*<sup>5</sup>.

The results obtained were expressed as mean  $\pm$  Standard Deviation (SD) and the statistical significance was evaluated using the Mann-Whitney test, with  $p \leq 0.05$  being considered statistically significant.

## Results

### EQUILIBRIUM SCORE (ES) AND COMPOSITE EQUILIBRIUM SCORE (CES)

ES and CES, in the group of patients, were shown to be markedly decreased compared to values in normal

**Table I.** Equilibrium Score (ES) and Composite Equilibrium Score (CES) of groups studied [Mean (M)  $\pm$  SD]\*.

*	Controls	Patients	Malingerers	Non-malingerers (Control+Patients)	Significance Malingerers/ Controls	Significance Malingerers/ Patients	Significance Controls/ Malingerers
SOT 1	92,8 $\pm$ 2,6	90,4 $\pm$ 4	57,4 $\pm$ 19,6	91,8 $\pm$ 3,4	$P \leq 0,001$	$P \leq 0,001$	$P \leq 0,001$
SOT 2	92,3 $\pm$ 3	89,3 $\pm$ 5	51,9 $\pm$ 18,4	91,1 $\pm$ 4,2	$P \leq 0,001$	$P \leq 0,001$	$P \leq 0,001$
SOT 3	91,7 $\pm$ 2,7	86,1 $\pm$ 5,9	48 $\pm$ 18,4	89,4 $\pm$ 5	$P \leq 0,001$	$P \leq 0,001$	$P \leq 0,001$
SOT 4	83 $\pm$ 5,6	62,3 $\pm$ 11,4	41,9 $\pm$ 13,4	74,4 $\pm$ 13,2	$P \leq 0,001$	$P \leq 0,001$	$P \leq 0,001$
SOT 5	70,8 $\pm$ 8,3	29,8 $\pm$ 14	36,9 $\pm$ 12,4	54 $\pm$ 23,1	$P \leq 0,001$	$P \leq 0,05$	$P \leq 0,05$
SOT 6	63 $\pm$ 9	25,25 $\pm$ 18	33,3 $\pm$ 11,4	47,5 $\pm$ 23	$P \leq 0,001$	$P \leq 0,05$	$P \leq 0,05$
COMP	79,6 $\pm$ 4,1	57 $\pm$ 6,2	42,4 $\pm$ 12,4	70,36 $\pm$ 12,3	$P \leq 0,001$	$P \leq 0,001$	$P \leq 0,001$

**Table II.** Sensory Analysis of groups studied (M ± SD) †.

†	Controls	Patients	Malingeringers	Non-malingeringers (Control+Patients)	Significance Malingeringers/ Controls	Significance Malingeringers/ Patients	Significance Controls/ Malingeringers
Som	99,5±3	98,7±4,4	91,6±20,5	99,2±3,6	P≤0,05	P≤0,05	P=0,001
Vis	89,2±6	68,9±12,1	76,3±27,8	80,9±13,5	NS.	NS.	NS
Vest	76,5±10,5	33,2±15,8	72,3±41,3	58,7±25	NS.	P≤0,001	NS
Pref	94,9±6,4	93,4±9,8	91,4±13	94,3±7,9	NS	NS	NS

subjects, especially in the last three conditions which are the most difficult to perform (Table I).

In malingeringers, ES and CES showed a statistically significant decrease in all conditions, as compared to normal subjects, patients and non-malingeringers (Table I).

#### SENSORY ANALYSIS (SA)

In malingeringers, high SD from mean values and statistically significant differences in the somatosensory components were observed compared to those in normal subjects, patients and non-malingeringers (Table II). In 8/23 malingeringers (34.7%), values of one or more components of the balance system (somatosensory, visual, vestibular systems and of visual preference) were 2 SD higher than the mean obtained in non-malingeringers.

The Strategy Score (SS) showed statistically significant differences in all six conditions in the comparison between malingeringers/normal subjects and malingeringers/non-malingeringers, but only in the first 4 conditions, in the comparison between malingeringers and patients (Table III).

SS values 2 SDs lower than mean values in normal subjects, in at least one of the six conditions, allowed us to distinguish malingeringers from normal subjects with 100% sensitivity and 82.6% specificity (Table IV).

SS values 2 SDs lower than mean values of patients in at least one of the six conditions allowed us to distinguish malingeringers with respect to patients with 95.6% sensitivity and 87.5% specificity (Table IV).

SS values 2 SDs lower than mean values of non-malingeringers in at least one of the six conditions allowed us to distinguish malingeringers with respect to non-malingeringers with 86.9% sensitivity and 82.% specificity.

In 20/23 cases, SS values recorded in malingeringers were 2 SDs lower than the mean obtained in non-malingeringers, in at least one of the six conditions.

Applying Goebel's first criterion (1997)<sup>5</sup> to the latter results, malingeringers could be distinguished from non-malingeringers with 86.9% sensitivity and 89.7% specificity (Table V).

#### Discussion

The need to better establish the possible disease state of the patient and to identify attempted malingering is a situation that is frequently found in clinical practice. While the validity of dynamic posturography is stressed by many, its potentialities have been exploited in a limited number of studies.

Hamid et al., in 1990<sup>6</sup>, indicated as valid criteria, in the identification of malingering, the recording, in the six conditions of the trial, of extremely high or relatively low scores of significantly different patterns when the trial was repeated and of an evident voluntary postural control expressed by increased sway and motor latencies. The aphysiologic pattern may be present independently of, or in association with, real disorders and this distinction is significant for the choice of therapy<sup>6,7</sup>.

In 1995, Cevette et al. comparing the performances of 22 patients showing an aphysiologic pattern with the same number of patients affected by vestibular dysfunction and with normal subjects, identified the following criteria of distinction<sup>8</sup>:

1. a considerable variability in trials of the same condition in aphysiologic patients, a criterion the authors themselves judged as not significant;
2. the finding in malingeringers of performances better than those observed in patients with vestibular dysfunction ascertained two conditions (V and VI) (more difficult to perform), and of lower scores in the first two.

In 1997, Goebel et al. increased the criteria of evaluation to 7: however, only three of them, in their opinion, were indicative of malingering<sup>5</sup>.

- n. 1: in all malingeringers, scores in SOT1 were lower than standard;
- n. 6: in MCT, the range of responses evoked by low intensity stimuli was too broad;
- n. 7: in the different MCT trials, discordant responses were observed.

The aim of this study was to identify other elements indicative of malingering by SOT data or scores of somatosensory, visual vestibular components and of visual preference and used strategy.

**Table III.** Strategy Scores (SS) in the six conditions of the examination (M ± SD) †.

‡	Controls	Patients	Malingers	Non-malingers (Control+Patients)	Significance Malingers/ Controls	Significance Malingers/ Patients	Significance Non-malingers/ Malingers
SOT1	93,8±4,4	94,1±5,4	78,8±11,4	93,9±4,8	P≤0,001	P≤0,001	P≤0,001
SOT2	95,3±3,1	95,2±2,2	76,7±14,1	95,3±2,7	P≤0,001	P≤0,001	P≤0,001
SOT3	95±2,3	91,9±5,8	67,6±17,1	93,7±4,3	P≤0,001	P≤0,001	P≤0,001
SOT4	88,6±5,1	74,1±10,4	56,9±18,3	82,7±10,5	P≤0,001	P≤0,05	P≤0,001
SOT5	82,2±7,3	52,8±15,9	52,3±18	70,1±18,5	P≤0,001	NS.	P≤0,001
SOT6	78±8,1	53,3±23,8	44,6±20,1	67±20	P≤0,001	NS	P≤0,001

**Table IV.** Specificity and sensitivity §.

§	Malingers/Controls	Malingers/Patients	Malingers/Non-malingers (Di Nardo et al.)
Sensitivity	100%	95.6%	86.9%
Specificity	82.6%	87.5%	82%

Based on the results obtained, it seems evident that dynamic posturography is useful in the attempt to differentiate malingers from non-malingers.

It is interesting to observe that, in malingers, SS values were markedly decreased with a statistically significant difference in all six conditions with respect to normal subjects and non-malingers, in the first four conditions, as compared to patients.

Considering SS values 2 SD lower than the mean of values obtained in the various groups, in at least one of the 6 conditions, malinging was identified with 100% sensitivity and 82.6% specificity, as compared to normal subjects; with 95.6% sensitivity and 87.5% specificity as compared to patients; with 86.9% sensitivity and 82% specificity as compared to non-malingers (Table IV).

The criterion identified by the Authors (SS value in at least one of the 6 conditions, 2 SD lower than mean values obtained in the group of non-malingers) was shown to be more effective if associated with Goebel's first criterion<sup>5</sup>.

**Table VI.** Specificity and sensitivity using criterion identified by Authors in association with Goebel's first criterion.

	Malingers/Non-malingers (1 <sup>st</sup> Goebel; Di Nardo et al.)
Sensitivity	86.9%
Specificity	89.7%

In fact, this association discriminates the state of "malinging" as compared to "non-malinging" with a sensitivity of 86.9% and a specificity of 89.7% (Table V).

Another interesting finding was the particularly high significant difference found on SA between malingers and the other groups for the somatosensory component, not observed for the visual and vestibular component.

This difference might be explained by the malingers' need to excessively exploit the somatosensory component to change his/her physiologic balance.

## Conclusions

According to the results reported, the identification of SS values 2 SDs lower than mean values obtained in non-malingers allowed us to distinguish "malingers" with high sensitivity and specificity values, especially if associated with Goebel's first criterion<sup>5</sup>. Furthermore, the significant difference between malingers and non-malingers, for the somatosensory system, deserves attention and additional studies. It could imply the malingers' attempt to act on it to decrease postural stability.

Therefore, to perform the Equitest in cases of suspected malinging, in states of vertigo and/or postural instability, could provide valuable information which, integrated with more conventional methods of vestibular evaluation, may direct the clinician towards a correct diagnosis.

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