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# Portable Posturography: Validation of Variables in People Without Posture and Balance Disorders. A Pilot Study

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### Abstract

Posturography has become a useful element in evaluating patients with balance disorders, although the equipment used is not available in the doctor's office. In the present study, we used a portable posturograph in healthy people with the intention of validating the normal values of the variables collected by the device. Ten healthy individuals were studied, values of stability limit, visual dependence, somatosensory dependence, visual preference, vestibular dysfunction and a physiologic pattern were obtained. Portable posturography can become a useful element to evaluate patients with balance disorders in the doctor's office, once validated in different populations.

***Keywords:*** *Dynamic Posturography; Portable Posturography; Healthy Adults; Validation Study; Reference Values*

## Introduction

Postural control has been defined as "controlling the position of the body in space, with the dual purpose of stability and orientation" [1,2] or as "the ability to maintain a proper relationship between the body segments and the environment to perform a task" [3,4].

There are 3 basic elements that, interacting, constructs, maintains and changes the posture: individual factors, the task to be done and the environment5. Within the individual factors, we can find sensory, motor and cognitive elements. At the same time, within the sensory elements, the visual, somatosensorial and vestibular contributions are the ones that play the main role for the correct postural control, allowing to feel the changes in the corporal segments and in that way to make the motor corrections necessary for maintain posture.

Since the Romberg test [6] was used to assess postural control, more objective tests have been sought for evaluation of posture. Dynamic posturography has been developed for this purpose. It is a quantitative method for the evaluation of disorders of postural control, being also useful for the planning of a treatment for them [7-9]. It has become the reference method for the study of postural control [10]. The American Academy of Neurology (AAN) [11] and the American Academy of Otorhinolaryngology - Head and Neck Surgery (AAO-HNS) [12] have highlighted it as a clinically useful method for studying human balance, which isolates and quantifies the sensory and motor components that contribute to the maintenance of postural control and allow the assessment of sensorimotor integration in healthy individuals as well as those with deficit of balance.

Since PD is currently performed with large and expensive equipments, that makes it difficult to use in a regular consultation, we have developed a portable posturograph, which can be used anywhere with minimal elements. This study is done to establish the limits of normality of the variables that are obtained with the new equipment.

## Material and Methods

Data were prospectively collected from 10 healthy individuals without complaint of loss of balance and who did not show alteration in conventional dynamic posturography, for which the Balance Rehabilitation Unit (BRU) was used. Subsequently, the portable posturography equipment was used.

The device (Figure 1) used consists of an accelerometer and a 3-axis gyroscope (MPU-6050) connected to an 8-bit Atmega 324 micro controller that processes the information overturned by the sensors. With the combination of acceleration and angular velocity measurement, the representation of the position of the sensors is achieved in angular values that are transmitted to a PC through a USB port or a BlueTooth connection. These values represent the position of the body in a certain period of time and in different conditions. The software in the PC is responsible for taking these values and represent them graphically, showing the maximum and minimum angular movements in the X and Y axes and an area based on these measurements. Sway or patient oscillations per second and per minute are also calculated (Sway/s and Sway/m, respectively). (See Figure 2 and 3 for a comparison of how the data presented between the portable posturograph and the BRU).

The individuals were placed on a firm surface, with an intermalleolar separation of 8 cm, same distance as that used in the foam pillow; The portable posturograph was placed immediately above the inner malleolus of the right ankle. The tests that are done with the equipment are five:

1. Limit of Stability (LOS)
2. Firm Platform with Open Eyes (FPOE)
3. Firm Platform with Closed Eyes (FPCO)
4. Open-Eye Foam Pillow (OEFP)
5. Foam pillow with closed eyes (FPCE)

The individual being 60 seconds in each test. Each of these tests are identified in the graphic interface with a double letter, where LOS = LL, FPOE = AA, FPCE = BB, OEFP = CC, CEFP = DD.

For each of the tests the values of Sway / s and Sway / m were obtained in the anteroposterior axis (X axis) and lateral (Y axis) and area, and with these values obtained in the different tests were calculated LOS, Visual dependency (VISD), somatosensory dependence (SomD), visual preference (VP), vestibular dysfunction (VD) and the aphysiological pattern (AP). The limit of stability of a person may be defined as the distance he or she is willing and able to move without losing balance and taking a step [13]. The visual dependence refers to the results being better in the tests where there is visual information, revealing an abnormality in the use of vestibular and somatosensory information [14]. The somatosensory dependence shows the difficulty in the management of visual and vestibular information, they are usually patients with alterations of the central nervous system, with great disability, since they depend on a firm and regular floor to maintain an optimal balance [14]. In relation to the vestibular dysfunction, there are alterations in the use of the vestibular information, being able to correspond to peripheral or central lesions [14]. The visual preference does not identify a disease, they are usually patients with instability in situations of great visual conflict, on large avenues or commercial surfaces [14]. Finally, the physiological pattern refers to the presence of incongruity between the tests, that is, better values are obtained in simple tests than in the more complex ones, suggesting that the patient somehow exaggerates their symptoms, either deliberately or due to an anxious personality [14].

The calculation of each of these variables was done by the software in the following way:

```
VD = ((d) / (a + b + c + d) * 100);                // Calculating Vestibular Dysfunction
VP = ((b + d) / (a + b + c + d)) * 100;            // Calculate Visual Preference
SomD = ((c + d) / (a + b + c + d)) * 100;          // Calculate Somatosensory Dependency
VISD = ((b + c + d) / (a + b + c + d)) * 100;      // Calculate Visual Dependency
AP = ((a) / (a + b + c + d)) * 100;                // Calculate Aphysiological Pattern,
```

Where the letters are replaced by the value of the "area" obtained in the tests identified with homonymous letters. For example, the letter "D" refers to the area calculated in the "closed-foamed foam pillow" (CEFP) test identified on the interface as "DD".

For each variable the mean value, standard deviation (SD), minimum and maximum values were calculated. Statistical analysis was performed using the statistical package SPPS version 21.

## Results

Of the 10 individuals evaluated, 50% were women. The mean age was 35.66 years (SD ± 11.48). The average height was 169 cm (SD ± 9.98).

LOS had an average value of 92,04 (SD ± 36,33, with a maximum value of 161.83 and a minimum of 60.6, Table 1). The rest of the values obtained in the different tests can be seen in Table 1.

| | LOS | FPOE | FPCE | OEFP | CEFP |
|---|---|---|---|---|---|
| Sway/s X | 1,83 (SD ± 0,41) | 1 (SD ± 0,63) | 1,17 (SD ± 0,75) | 1,17 (SD ± 0,41) | 1,33 (SD ± 0,52) |
| Sway/m X | 140,33 (SD ± 31,33) | 85,67 (SD ± 26,45) | 96 (SD ± 39,41) | 104 (SD ± 23,43) | 111 (SD ± 16,62) |
| Sway/s Y | 1,5 (SD ± 0,84) | 1,17 (SD ± 0,41) | 1,17 (SD ± 0,41) | 1,83 (SD ± 0,41) | 1,5 (SD ± 0,55) |
| Sway/m Y | 129,67 (SD ± 41,52) | 95 (SD ± 13,13) | 98,33 (SD ± 8,98) | 135,67 (SD ± 24,96) | 128 (SD ± 25,01) |
| Área | 92,04 (SD ± 36,33) | 2,5 (SD ± 3,49) | 1,74 (SD ± 1,7) | 3,56 (SD ± 1,79) | 4,02 (SD ± 4) |

*LOS: Limit of Stability; FPOE: Firm Platform Open Eyes; FPCE: Firm Platform Eyes Closed; OEFP: Open Eye Foam Pillow; CEFP: Foam Pillow Closed Eyes; Sway / s: Sway Per Second; Sway / m: Sway by Minutes; X: Anteroposterior Axis; Y: Lateral Axis; SD: Standard Deviation*

The visual preference, visual dependence, somatosensory dependence, vestibular dysfunction and the aphysiological pattern were calculated using the data obtained from the different tests. These values can be seen in Table 2.

| | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|
| LOS | 92,04 | 36,33 | 60,6 | 161,83 |
| Vestibular disfunction | 34,16 | 9,15 | 23,2 | 48,74 |
| Visual preference | 44,25 | 11,67 | 23,2 | 58,29 |
| Visual dependency | 81,32 | 7,67 | 73,56 | 87,4 |
| Somatosensory dependency | 74,74 | 14,01 | 59,2 | 87,4 |
| Aphysiologic pattern | 18,66 | 7,65 | 6,79 | 26,43 |

*LOS: Limit of Stability; SD: Stándard Deviation*

## Discussion

Posturography quantifies the impact of the sensory and motor disability of the patient and the ability to perform the balance and mobility strategies required for an effective and safe function in the activities of daily living. It has been considered by the AAO-HNS as "the gold standard" in the diagnosis of patients with vertigo and alterations of the balance of known or unknown etiology, considering it appropriate for the evaluation or treatment of patients with acute or chronic balance alterations bodily" [15,16].

Currently, the equipment used to carry out the study needs a large room and is expensive. In this study, we set out to evaluate people without alterations in their balance with a portable device, which can be used in the professional's office, with the intention of calculating the reference values of the variables and standardizing their use, to apply it in future studies with different populations.

The device calculates its variables in different conditions that vary according to the sensory information to which the subject can access (Table 3). These data are used by the software to express in numbers the different patterns that we can find in a person who inquires for disturbances of the balance: vestibular dysfunction, visual preference, visual dependence, somatosensory dependence and aphysiological pattern.

| | FPOE | FPCE | OEFP | CEFP |
|---|---|---|---|---|
| Precise sensory information | Visual Somatosensorial Vestibular | Somatosensorial Vestibular | Visual Vestibular | Vestibular |
| Missing Sensory Information | Ninguna | Visual | Somatosensorial | Visual Somatosensorial |

*FPOE: Firm Platform Open Eyes; FPCE: Firm Platform Eyes Closed; OEFP: Open Eye Foam Pillow; CEFP: Foam Pillow Closed Eyes*

One limitation was the small sample that was used, but we believe that, as a pilot study, it was enough to protocolize the use of the device. New trials are required, with a larger population for more accurate data. We believe that once validated, the device can become a useful element when studying patients who present with complaints about their balance.

## Conclusions

The portable posturography can become a useful element for the examination of the patient with balance disorders once the corresponding validations have been made in different populations.

## Conflict of Interest

None to be disclosed.

## Bibliography

1. Shumway-Cook A., *et al*. “Motor control: translating research into practice”. Baltimore: Lippincott Wilkins and Williams (2007).
2. Shumway-Cook A., *et al*. “Attentional demands and postural control: the effect of sensory context”. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences* 55.1 (2000): M10-M16.
3. Horak FB., *et al*. “Postural orientation and equilibrium”. In: Shepard J, Rowell I, eds. Handbook of physiology. Exercise: regulation and integration of multiple systems. New York: American Physiological Society (1996): 225-292.
4. Gallahue D., *et al*. “Understanding motor development: infants, children, adolescents, adults”. Boston: Mcgraw-Hill (2006).
5. Bernstein NA. “The co-ordination and regulation of movements”. Oxford: Pergamon Press (1967).
6. Romberg MH. “Manual of the nervous disease of man”. London: Syndenham (1853).
7. Qutubuddin AA., *et al*. “A comparison of computerized dynamic posturography therapy to standard balance physical therapy in individuals with Pakinson’s disease: a pilot study”. *NeuroRehabilitation* 22.4 (2007): 261-265.
8. Ondo W., *et al*. “Computerized posturography analysis of progressive supranuclear palsy”. *Archives of Neurology* 57.10 (2000): 1464-1469.
9. Berg KO., *et al*. “Measuring balance in the elderly: validation of an instrument”. *Canadian Journal of Public Health* 83.2 (1992): S7-S11.

10. Barona de Guzmán R. "Interés de la posturografía en el diagnóstico y tratamiento del vértigo y el desequilibrio en especialidades médico-quirúrgicas". *Rev Biomech* 1 (2003): 11-14.

11. Fife TD., *et al*. "Assessment: vestibular testing techniques in adults and children: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology". *Neurology* 55.10 (2000): 1431-1441.

12. American Academy of Otolaryngology - Head and Neck Surgery (AAO-HNS). "Posturography position statement" (2014).

13. Grzegorz J., *et al*. "Evaluation of the Limits of Stability (LOS) Balance Test". *Journal of Human Kinetics* 19.1 (2008): 39-52.

14. Alguacil Diego IM., *et al*. "Nuevos métodos de valoración del equilibrio y el control postural". En: Cano de la Cuerda y Collado Vázquez, eds. Neurorrehabilitación. Métodos específicos de valoración y tratamiento. Madrid: Editorial médica panamericana (2012): 173-181.

15. Furman J., *et al*. "Assessment: posturography. Report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology". *Neurology* 43.6 (1993): 1261-1264.

16. Sanz Fernandez R., *et al*. "Posturografía dinámica computarizada". En: Rossi Izquierdo M, Soto Varela A, Santos Perez S, eds. Rehabilitación vestibular. Ponencia Sociedad Gallega de Otorrinolaringología (2016): 136-151.

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