

# Rethinking the neurological examination I

## Static balance assessment

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### ABSTRACT

The authors advocate a modernization of the neurologic exam with regard to the evaluation of static equilibrium through the application of some easily performed and interpreted bedside maneuvers like the Clinical Test of Sensory Integration and Balance - modified and the Functional Reach Test. The authors also believe that these and other assessments, such as that of the risk of falling for elderly patients, should be incorporated into the routine neurological examination.

**Key words:** neurological examination, static balance, Romberg sign, clinical test for sensory integration in balance - modified, functional reach test, risk of falling.

### Repensando o exame neurológico I: avaliação do equilíbrio estático

### RESUMO

Os autores advogam a modernização do exame neurológico no que diz respeito à pesquisa do equilíbrio estático, por meio da aplicação de algumas manobras de beira-deleito fáceis de serem executadas e interpretadas, tais como o Teste Clínico de Integração Sensorial e Equilíbrio-modificado e o Teste do Alcance Funcional. Os autores também acreditam que estes e outros testes visando avaliação de risco de queda em pacientes idosos devem fazer parte do exame neurológico de rotina.

**Palavras-Chave:** exame neurológico, equilíbrio estático, sinal de Romberg, teste clínico de integração sensorial e equilíbrio - modificado, teste do alcance funcional, risco de queda.

The neurological examination (NE) is the main instrument for diagnosing central and peripheral nervous systems diseases<sup>1</sup> and is a science that remains in constant evolution<sup>2</sup>. Its practice continues to grow using simple and creative maneuvers such as: clapping hands<sup>3</sup>, rolling a coin between fingers<sup>4</sup>, tapping foot<sup>5</sup>, walking foot - forefoot<sup>6</sup>, or simply extending the hands forward, or rolling fingers<sup>7</sup>. Currently the great advance in imaging and other diagnostic techniques have revolutionized all areas of medical knowledge but the NE is still critical because of its accuracy and ability to locate neuro-anatomic dysfunctions. Over time some old tricks

and signs are no longer used because they are devoid of practical importance<sup>8</sup>, but new tests and signs with proven sensitivity and specificity replace them<sup>7</sup>.

In a regular neurological consultation, after the interview the examinees are usually submitted to general clinical and NE and, depending on the examinee's complaint, to a more specific focal evaluation. For practical and didactic purposes the NE is subdivided in several parts, which limits are not precise, that can provide the neurologist with 94 different aspects<sup>9</sup>. Although the experienced neurologist may be able to perform an adequate exam in few minutes<sup>10</sup>, the "complete" NE is tough,

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complex, and impractical. In fact, the NE needs always be adapted to a specific circumstance<sup>1</sup>.

Regarding the static balance examination, we believe that based on current knowledge, one cannot justify the use of the same semiotic resources employed by Charcot and his disciples in the XIX century<sup>11,12</sup>. In addition to looking for the Romberg sign we can also use several tests often used in neuro-otology, neuro-geriatrics and vestibular rehabilitation fields, which enrich the neurological assessment and should be part of a routine NE.

The aim of this article is to propose modernize the practice and teaching of NE introducing some already validated maneuvers in relation to static balance evaluation, stressing a more suitable approach to the vestibular system, and emphasizing the need for the neurologist to routinely assess the risk of fall in older examinees.

### Romberg sign

The German neurologist Moritz Heinrich Romberg (1795-1873) maybe worried about losing the merit of pioneering the description of his sign – loss of postural control in darkness of a patient with severely compromised proprioception was already been described by Marshall Hall (1836) and possibly by Bernardus Brach (1840) but, without highlight a clinical practical significance<sup>13-15</sup> – noted in the second edition of his book *Lehrbuch Nervenkrankheiten der den Menschen* (1851):

“... be arranged that (the patient) close your eyes in the upright position, he begins swaying and rocking from side to side; the insecurity of his gait is exhibited more in the dark. It is now ten years since I called attention to this pathognomonic sign ...” (ie, c1840. Author’s note)<sup>14</sup>. Only thirty-seven years later, William Gowers (1845-1915) in his classic book, *Handbook of Disease of the Nervous System* (1888) provided a clear contribution to research on the Romberg Sign, suggesting that the examinee should take a narrower base, putting his feet together as part of the test<sup>13,14</sup>. This is how the test is performed nowadays.

The original description of this test was opportune as a reliable way to determine the healthiness of the posterior column spinal pathways since tabes dorsalis was very common in Europe at that time<sup>14</sup>.

Good balance depends on good motor control abilities but also on feedback inputs regarding body position and velocity at any time. These inputs come from three systems: vision, proprioception, and vestibular sensation<sup>16</sup>.

In normal individuals, these systems share the task of maintaining standing on a firm surface as follows: proprioceptive system (70%), vestibular system (20%), and visual system (10%)<sup>17</sup>. It can be concluded that the research of traditional Romberg sign better discerns proprioceptive problems than vestibular affections.

As surface becomes unstable, balance control shifts to: 70% vestibular system, 20% visual system and only 10% proprioceptive system<sup>18</sup>. Interestingly, some authors consider that upon closing the eyes, normal individuals suffer severe loss of postural control, with a reduction of up to 50-65% compared to previous status with eyes open<sup>19</sup>. By other way, Black et al. recordings of Romberg tests performed by 132 normal subjects demonstrated no statistically significant sex or age effect on adults aged 20 through 49 years, and there was a strong stabilizing influence of vision upon postural control in most, but not all normal subjects<sup>20</sup>.

Over time, some questions arose about how to elicit the Romberg sign and interpret their responses. For example, should the examinee remove his shoes? What should be considered a positive test? Just swinging or taking a step sideways, or down? How should the examinee position his arms? Forward along the body or keeping them crossed on the chest? What kind of maneuver can the examiner use as an adjuvant? Pulling or pushing the examinee slightly forward, backward, or sideways? Is placing the examinee’s feet in a straight line an appropriate technique?<sup>13,14</sup>

The Romberg sign is supposed to be observed while the examinee is standing, without shoes, with his feet place together and crossed arms on the chest. Initially the examinee should have his eyes open (EO), and the examiner should set the vision at a point far away 1 meter, thus remaining at 30 seconds. Next, the same position, with eyes closed (EC) for 30s. Observe the examinee’s ability to maintain this position, with no falls, little oscillations at most, and what resources are used to circumvent any difficulties<sup>21</sup>. Normal individuals over the age of 79 may stand with their EC and without falling, at least for 30 seconds.

If, for some reason the examinee can’t stand by him to be examined, the test should be performed by observing his ability to remain seated at the bedside, supported with hanging legs<sup>22</sup>.

The Romberg sign is present if the examinee moves his feet away from the initial position, uncrosses his arms, or opens his eyes with the intention to remain in balance. In such cases, it is indicative of the loss the ascending proprioceptive function of the lower limbs. The sign may be observed in patients with peripheral neuropathy and proprioceptive changes as well in acute vestibular disorders<sup>23</sup>.

Using values obtained in the stabilometry platform the Romberg sign can be quantified by Romberg index (RI) which is the proportion or balance (sway) rate with EC to the balance rate with EO (RI=EC sway/EO sway)<sup>24</sup>. Index >1 indicates that the oscillation increases with the EC, while index <1 indicate reduced sway with EC.

Significant imbalance with EO and EC (in other words, RI=1), or a predominant characteristic sway in the anteroposterior direction indicate cerebellar sign<sup>24</sup>.

When the examinee sways exaggerated and stereotypically, this points to a somatization or conversive disorder. In this case, distracting the examinee with another task, for example, recognition of a coin by touch (stereognosis) or asking him to do the finger-nose test (coordination) will abolish the excessive swing and eliminate the false response<sup>25</sup>.

Although some authors<sup>8,26</sup> consider the existence of the “vestibular Romberg sign”, the conventional method to elicit is not best suited to assess the vestibular system, especially in cases of examinee with unilateral vestibular dysfunction compensated.

Uncompensated unilateral vestibular lesions can promote the body’s tendency to shift and fall to the side of the slower phase of nystagmus (to the same side of the lesion). However, examinees with true peripheral unilateral vestibular dysfunction (compensated or not) and bilateral lesions do not necessarily present the Romberg sign<sup>24</sup>.

#### Clinical Test for Sensory Integration in Balance - modified (CTSIB-m)

The CTSIB was developed by Anne Shumway-Cook<sup>27</sup>, Horak and Nashner<sup>28</sup> in 1986, and was introduced as a tool for clinical evaluation by the first author in 1987.

In the original description the examinee was tested in six positions, two of them with visual conflict<sup>24</sup>. The



Fig 1. CTSIB position 4.

CTSIB-m suppressed the visual conflict without losing the test sensitivity and specificity<sup>23</sup>. The situations 1 and 2 are the same used to elicit Romberg’s sign. Soon after, in situations 3 and 4, the examinee repeats the same positions, but now on foam with proper density (Fig 1).

The examiner needs to protect the examinee from falling whereas the foam prevents the perception of the deep sensation that ascends through the lower limbs.

We believe that CTSIB-m should be part of the static balance assessment (Table 1), because, besides considering proprioception, it also measures the contribution of vestibular afference to static balance/posture.

The result must take into consideration the period standing in each position for 30 seconds, and also quantify the balance, which can be graded as follows: 1=minimum imbalance; 2=mild imbalance; 3=moderate imbalance; and 4=loss of balance. The test should be repeated three times<sup>23</sup>.

Previous studies have shown that inability to remain standing on the foam with eyes closed indicate a vestibular dysfunction with 90% sensitivity and 95% specificity<sup>29</sup>.

In a national survey involving US adults (n=5086) aged 40 years and older, Agrawal et al.<sup>30</sup> demonstrated that patients with vestibular dysfunction (ie, reported of dizziness) and failed to be examined on the foam with their eyes closed, had a 12-fold increase in the odds of falling.

The CTSIB-m exhibited a high degree of concordance (90%) with the Sensory Organization Test (SOT) of Computerized Dynamic Posturography (CDP)<sup>29</sup>.

The CDP, a method created from a series of studies of basic research regarding the control of human movement developed by the National Institutes of Health and NASA in 60’ and 70’ years, was defined by the American Academy of Otolaryngology-Head and Neck Surgery and the American Academy of Neurology as a tool that quantifies the contribution of sensory and motor control of balance in people with sensory-motor skills during normal and abnormal<sup>31</sup>. In 1982, Nasher et al.<sup>32</sup> were the first to describe the CDP system as a clinical tool, and four years later, the technique became commercially available<sup>33</sup>.

Table 1. Clinical Test For Sensory Integration in Balance-modified.

- Place the foam near a wall (preferably angled walls)
- Examinee standing with feet together, without shoes, and arms crossed in front of the chest
- In the hard surface: first with eyes open (looking away) and then with eyes closed
- Thirty seconds in each position
- In the foam: staying in the same positions during the same time
- Repeat each test three times and consider the lowest score
- Quantify both the degree of imbalance (1, 2, 3 or 4) and the time spent in each position
- Protect the examinee standing - without holding - next to him

### Romberg tandem

The Romberg tandem also called the Romberg sharpened, is performed as follows: the examinee should be barefoot, arms crossed in front of the chest, stare at a point approximately one meter away, stand with heel to toe (the foot that is behind most regulates the balance in this position). His feet should be perfectly aligned so to not form an angle. The test time is the same as the Romberg test; thirty seconds of EO and another 30 seconds of EC. This test will exacerbate any subtle changes in static balance and showed different according to examinee's age. The test unveils the same conditions as conventional Romberg test and is 49-60% sensitive and 95% specific for static imbalance<sup>21,23</sup>.

### Single leg stance

This test rarely is employed during NE. It is difficult for older adults to perform, but provides information on the possibility to walk in relative safety when climbing stairs or in the dark<sup>23,34</sup>.

**Method** – The examinee should be barefoot, arms crossed in front of the chest. He should then fix his eyesight on a point about one meter away, standing on one foot for 30 seconds only, first EO and then EC. Standard data from this event has been established according to age. Those aged between 20 and 39 can stay on only one foot for 30 seconds. Individuals between 60-69 years remaining  $22.5 \pm 8.6$  seconds with EO, and  $10.2 \pm 8.6$  seconds with EC with no significant difference between the dominant or non dominant leg. In the age group of 70-79 years the values are: with EO =  $14.2 \pm 9.3$ , and  $4.3 \pm 3.0$  seconds with EC<sup>34,35</sup>.

The test should be stopped if one leg touches the other, the foot moves excessively on the floor, or arms leave their initial positions.

### Functional Reach Test

The Functional Reach Test (FRT) is a clinical test which was devised by Duncan, Studenski et al. in 1990. The test assesses the voluntary limits of stability in the anterior direction by gauging the balance and functional reach considering the maximum distance that the arm can reach when leaning forward, maintaining a fixed base of support in the standing position<sup>36,37</sup>. The test is simple to perform and normalized, measures the stability margin at the beginning of the activity and predicts the relative fall risk in older adults<sup>34</sup>. The necessary material requires only one meter ruler fixed to the wall.

The examinee is placed standing parallel to a wall where a horizontal rule is fixed (by velcro) at shoulder height. The examinee elevates the upper limb nearest the wall to the horizontal position, with a fist holding a stylus (pen or pencil), which acts as a marker for the po-

sition, and bending the trunk forward trying to reach the greatest possible distance, without touching the arm or body to the wall. The distance reached is measured in centimeters. The subject could lift feet off the ground as long as they did not lose balance (Fig 2 A and B).

The FRT assesses the risk of falling and can be scored (Table 2). It can also be useful in the development of prospective elderly examinees<sup>23,37</sup>. It correlates well with the centers of pressure measured on a stabilometry platform and the simplicity with which it is performed, should be part of routine assessment of NE.

The examinee's age and height influences the response<sup>36</sup> and the test should be discontinued if the examinee touches the wall or give a step. Range test multidirectional (back and sides) has been developed, but still needs standardization<sup>23</sup>.

### Pull test

The Pull Test (PT) also called the Postural Stress Test (PST)<sup>34</sup>, has long been used in clinical movement disorders. It should be part of neurologic semiotic resources in the routine evaluation of examinees older than 65 years<sup>16</sup>.

The test is done with both – the examinee and the examiner – standing. The examiner stands behind the



**Fig 2.** Functional Reach Test . Gauging, in centimeters , the scope forward reaching as far as possible without losing the balance.

**Table 2.** Graduation of the Functional Reach Test.

Range $\geq 25$ cm	=	Normal (no risk of falling)
15 to 25 cm	=	2-fold IOF*
<15 cm	=	4-fold IOF
$\leq 2$ cm	=	8-fold IOF

\*IOF: increase in the odds of falling.

**Table 3.** Pull test.

0	No observable attempt to step; requires assist
1	Takes $\geq 2$ steps and requires assist
2	Takes $> 2$ steps but is able to restore balance independently
3	Takes 2 steps but is able to restore balance independently
4	Able to restore balance independently with only 1 step



examinee from a distance, gives a sudden pull backward by shoulders (or waist), with the force needed to cause imbalance. The examinee is told to maintain balance. The test is invalid if the examinee is leaning forward, anticipating that he will be pulled back. A variation of this method is to start from the same position, with the examinee anchoring his back in the examiner's hands. If the examiner notices that the center of mass of the examinee is behind the heels, quickly removes his hands and observes whether the examinee is able to regain the equilibrium. The maximum level of ability is deal with the perturbation using body movements without moving his feet. One compensatory step backward is considered normal<sup>16,25,34</sup>. The abnormal response is characterized by the inability to recover the balance and can be scored (Table 3). Grade zero corresponds to a functional dependence and assumes the need for assistance and supervision for walking. Whatever the technique, the examiner should always have a wall behind him, in case the examinee falls back into his arms<sup>38</sup>.

In conclusion, some simple-to-perform semiotic techniques must be part the routine of neurological examination turning it into a more sensitive, functional, dynamic, and even prospective assessment instrument.

The Clinical Test for Sensory Integration in Balance - modified, for instance, is a bedside method for evaluating the static contribution of proprioceptive and vestibular input for static balance.

We believe that the NE for examinees over 65 years should routinely include the Functional Reach Test and the Pull Test that, in addition of providing us with information about the static balance, it also assesses the risk of falling, a common cause of morbidity and mortality in this age group.

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