ORIGINAL ARTICLE

Is It Possible to Shorten Examination Time in Posture Control Studies?☆

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Received 7 May 2014; accepted 30 July 2014

Abstract

Introduction and objectives: The sensory organisation test (SOT) is the gold-standard test for the study of postural control with posturographic platforms. Three registers of Conditions 3, 4, 5 and 6 are conducted to find an arithmetic mean of the 3, with the time that this entails. The aim of this study was to determine whether a single record for each SOT condition would give us the same information as the arithmetic mean of the 3 recordings used until now.

Materials and methods: 100 healthy individuals who performed a sensory organisation test in the Smart Balance Master® Neurocom platform. For the statistical analysis we used the Wilcoxon test for nonparametric variables and dependent t-student for paired samples for parametric variables (P<.05).

Results: When comparing the scores on the first record with the average of the 3 records, we found statistically significant differences for the 4 conditions (P<.05). Comparing the first record to the second record also yielded statistically significant differences in the 4 conditions (P<.05). Upon comparing the second record with the third, however, we found differences in only Condition 5, with the significance being borderline (P=.04). Finally, comparing the average of the first and second record with the average of the 3 records, we also found statistically significant differences for the 4 conditions (P<.05).

Conclusion: Using only 1 or 2 records from each of the conditions on the SOT does not give us the same information as the arithmetic average of the 3 records used until now.

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☆ Please cite this article as: Faraldo García A, Soto Varela A, Santos Pérez S. ¿Es posible reducir el tiempo de exploración en los estudios posturográficos? Acta Otorrinolaringol Esp. 2015;66:154–158.

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Introduction

Balance is an important and essential function for performing many activities in daily life, and its assessment is consequently of great interest. Anamnestic and physical examination are essential for patient diagnosis, but are very variable since they depend, among other factors, on the physician’s experience, the patient’s ability to express him or herself and the time employed.  

Instrumental evaluation techniques do exist at present, such as posturography, which enables balance to be analysed in an objective and quantifiable manner.  

Computerised dynamic posturography (CDP) was conceived and developed by Nasher, studied clinically in collaboration with Black and Nasher and marketed in 1986 as Equitest by Neurocom® Inc.  

It enables assessment of the static and dynamic stability of the patient, and the patient’s skill in using vestibular, visual and somatosensory data, the relative contribution of each of these data in overall balance, determining the patient’s capacity to carry out voluntary movements of the centre of gravity through the use of visual feed-back (voluntary control tests of the shifts from the centre of gravity), and his or her ability to adapt to conflicting sensorial situations. The functional status of the patient is also assessed in order to guide the correct medical or rehabilitation treatment, by identifying sensory dysfunctions.  

The sensory organisation test (SOT) is the gold standard for the study of postural control with posturographic platforms.  

The centre of gravity sway is traced in this test, with the patient in the Romberg position, in 6 conditions:  

- Condition 1: eyes open, fixed visual environment and fixed platform.  
- Condition 2: eyes closed, fixed platform.  
- Condition 3: eyes open, mobile visual environment and fixed platform.  
- Condition 4: eyes open, fixed visual environment and mobile platform.  
- Condition 5: eyes closed and mobile platform.  
- Condition 6: eyes open, mobile visual environment and mobile platform.  

Tracing each of these conditions takes 20 s, and 3 tracings are made for the most sensorially complex conditions (conditions 3, 4, 5 and 6) to obtain an arithmetic mean of the 3, using as much time as necessary for this procedure.  

The aim of this article is to determine whether a single tracing of each SOT provides us with the same information as the arithmetic mean of the 3 tracings used up until now.

Material and Methods

Human Material

This study was carried out in a tertiary level hospital, approved by the relevant ethics committee and developed
according to the Tokyo amendments to the Declaration of Helsinki.

We selected a sample of 100 healthy individuals (50 males and 50 females), with a homogeneous spread of age groups, and a mean age of 48.1 (range between 15 and 83 years of age).

Inclusion criteria of the sample study were: absence of any known illnesses affecting balance (pathology of the skeletal muscular system, neurological or vestibular pathology), non-use of medication affecting CNS or balance and coordination, absence of clinical history of imbalance, clinical history suggestive of vestibular pathology or neurological conditions, absence of psychological conditions (including depression), absence of a clinical history of unexplained falls in the last 6 months and normal vision (or compensated by the wearing of glasses).

A detailed clinical history was prepared for each patient (demographic and clinical data) and a physical examination was made where height and weight were traced. A basic otoneurological examination was also made (otoscopy, examination of strength, sensitivity, cranial nerves, Bárany indexes, cerebellous testing, confirmation of the absence of spontaneous or induced nystagmus with the cephalic agitation test, absence of saccadic movements using the Halmagyi test, Romberg test and Unterberger test) and a postural study.

### Postural Study

For the postural study a posturographic platform model Neurocom® Smart Balance Master platform was used. A SOT was performed. To carry out this study, the patient was positioned on a platform in the Romberg position, without shoes (but provided with socks), and with a safety harness. Three measurements were taken for conditions 3, 4, 5, and 6, aimed at averaging the results obtained in each measurement. The time spent in each condition was 20 s.

### Variables

SOT facilitates the study of balance percentage for each condition, the mean overall balance, sensory analysis and strategic analysis. In this work we focused on the study of the behaviour of the balance percentage of conditions 3, 4, 5, and 6. We analysed the differences in balance percentage obtained during the first tracing with the arithmetic mean of the 3 tracings. The balance percentage of the first tracing with the third tracing, and the mean of the first and second tracing, with the mean of the 3 tracings.

### Statistical Study

We used the SPSS version 16.0, statistical package. For contrasting normality we used the Kolmogorov-Smirnov test. For the statistical study we used the Wilcoxon test for non parametric variables and the T-student test for samples relating to parametric variables. The significance considered was 5% (p<.05).

![Graph showing balance percentage for conditions 3, 4, 5, and 6](image)

Figure 1 Overall mean balance (%) during the first, second and third tracing and the arithmetic mean of the 3 tracings in conditions 3, 4, 5, and 6 of the sensory organisation test.

### Results

Analysis of the balance percentage obtained for each of the 100 patients during the first tracing (first attempt) showed a score below the arithmetic mean of the 3 tracings. The balance percentage in the first tracing of Condition 3 is 91%, compared with the arithmetic mean of the 3 tracings which was 92%, this difference is statistically significant (p<.01). In the first tracing of Condition 4, 81% was obtained compared with 85% in the mean of the 3 tracings, also a statistically significant difference (p<.01). In Condition 5 we observed 57% in the first tracing compared with 64% in the mean of the 3 tracings (p<.01). And in Condition 6, we also found statistically significant differences, 60% in the first tracing versus 70% in the mean (p<.01) (Fig. 1).

If we compare the balance percentage of the first tracing with that of the second tracing we also observe that the percentage is lower in the first tracing. In Condition 3: 91% in the first tracing compared with 92% in the second tracing, in Condition 4: 81% compared with 86%, in Condition 5: 57% compared with 66%, and in Condition 6: 60% compared with 74%. These differences are statistically significant in the 4 conditions (Table 1).

On comparing the second tracing with the third, however, we only find statistically significant differences in Condition 5, the balance percentage being 66% in the second tracing.

<table>
<thead>
<tr>
<th>Table 1 Comparison Between the Balance Percentage of the First Tracing With the Second Tracing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st tracing</td>
</tr>
<tr>
<td>Condition 3</td>
</tr>
<tr>
<td>Condition 4</td>
</tr>
<tr>
<td>Condition 5</td>
</tr>
<tr>
<td>Condition 6</td>
</tr>
</tbody>
</table>
Table 2 Comparison Between the Balance Percentage of the Second Tracing With the Third Tracing.

<table>
<thead>
<tr>
<th>Condition</th>
<th>2nd tracing</th>
<th>3rd tracing</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>92</td>
<td>93</td>
<td>(p=.085)</td>
</tr>
<tr>
<td>4</td>
<td>86</td>
<td>86</td>
<td>(p=.0734)</td>
</tr>
<tr>
<td>5</td>
<td>66</td>
<td>70</td>
<td>(p=.044)</td>
</tr>
<tr>
<td>6</td>
<td>74</td>
<td>76</td>
<td>(p=.369)</td>
</tr>
</tbody>
</table>

Table 3 Comparison Between the Balance Percentage Mean of the First and Second Tracing Compared With the Mean of the 3 Tracings.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean of the 1st and 2nd tracing</th>
<th>Mean of the 3rd tracing</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>91.5</td>
<td>92</td>
<td>(p=.01)</td>
</tr>
<tr>
<td>4</td>
<td>83.5</td>
<td>85</td>
<td>(p=.002)</td>
</tr>
<tr>
<td>5</td>
<td>61.5</td>
<td>64</td>
<td>(p=.01)</td>
</tr>
<tr>
<td>6</td>
<td>67</td>
<td>70</td>
<td>(p=.01)</td>
</tr>
</tbody>
</table>

compared with 70% in the third tracing, with significance being at the limit (\(p=.04\)) (Table 2).

If we compare the arithmetic mean of the balance percentage of the first and second tracing with the mean of the 3 tracings, we observe that the mean of the 2 tracings is below that obtained in the 3 tracings. In Condition 3 we find 91.5% in the mean of the 2 first tracings compared with 92% of the 3 tracings; in Condition 4: 83.5% compared with 85%; in Condition 5: 61.5% compared with 64% and in Condition 6: 67% compared with 70%. The differences for the 4 conditions were statistically significant (Table 3).

Discussion

In recent years we have been permanently subjected to increased pressure on healthcare, leading us to seek strategies for savings in costs and time.

SOT of computerised dynamic posturography is currently the gold standard in instrumental balance evaluation testing. The scores given to each of the 6 conditions, especially those more sensorially complex ones, are determined using the arithmetic mean of the value attained in the 3 successive tracings in each Condition. Where there are 3 (in 1,2, or 7, for example) convention rules so as not to leave everything to chance in a single tracing per condition and not to excessively prolong the test.\(^5\)\(^6\)\(^7\)

However, our results question this convention, at least in conditions 3, 4, 5, and 6. The balance percentage of the first tracing is not comparable to the arithmetic mean of the balance percentage of the 3 tracings. This may be due to the surprise factor, since although the posturographic systems attempt to emulate everyday situations, the Neurocom\(^\circ\) Smart Balance Master type posturographic platforms differ greatly from the sensory situations in which the patients find themselves in their daily lives, a fact which is frequently manifest during the test. This may explain why the second tracing is significantly different (better balance percentage) to the first or, as the difference between the first and second tracing is so significant, its mean continues to be significantly below the mean of the 3 tracings.\(^11\)\(^12\) Knowledge of the test methodology justifies to us both the significant improvement from the first to the second tracing, and the improvement of the balance percentage from the second tracing to the third not being statistically significant.\(^13\)

These findings clearly show that we must not waste time in carrying out posturographic tracings. Given that the reproducibility of the test is only obtained with the second and third tracing, we propose that the first tracing be rejected (without analysis) and that the score of each condition be calculated as the mean of the 2 following ones.

Conclusions

Based on these results, several considerations may be addressed:

- Firstly, a single tracing per test is not reliable. In this case, we would probably be assigning the patients significantly worse scores to those corresponding to their clinical condition.
- The agreement between the results of the second and third tracing suggest that further attempts are not necessary for each condition, the scores obtained in these attempts being the real ones for the patient.
- It seems sensible to make a third tracing and not just be satisfied with the second. The precise coincidence of both is what provides consistency to the scores obtained.

Conflict of Interests

The authors have no conflict of interests to declare.

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