INTER-SESSION CONFIDENCE OF BALANCE ASSESSMENT WITH TOBTRAINER^{MR}

ORIGINAL ARTICLE

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ABSTRACT

Introduction: A new device for assessing and training dynamic balance, the TOBtrainer^{MR}, has been recently developed. Objective: To assess the inter-session reliability of balance assessment using the TOBtrainer^{MR}. The study has also the purpose of giving error scores so that true changes in performance can be identified. Methods: Thirty healthy sedentary subjects (nine males, 21 females, age = 27.9 ± 2.9 years) participated in this study. The TOBtrainer^{MR} was used to assess balance in the medial-lateral plane with eyes open (MLEO) and with eyes closed (MLEC), and in the anterior-posterior plane with eyes open (APEO) and with eyes closed (APEC). Subjects were instructed to be in a double-limb standing position with the hands at their sides trying to maintain platform stability. All the data were registered with the TOBT software. Results: The samples were correlated, t-tests assessed, learning effects and Intraclass Correlation Coefficients assessed in their reliability. Standard Errors of Measurement and Smallest Detectable Differences were calculated to assess measurement error. No significant differences between the first and the second session measurements were found. The Intraclass Correlation Coefficients, the Standard Errors of Measurement and the Smallest Detectable Differences for the four modalities measured ranged from 0.71 to 0.83, 0.32º to 0.80º and 0.90º to 2.22º, respectively. Conclusions: Inter-session reliability for balance assessment using the TOBtrainer^{MR} was good. Future researchers have now reference data to evaluate whether differences in two different scores are real or due to measurement error and what changes are needed in a subject's score to be sure that a real change has occurred.

Keywords: balance, postural control, Intraclass correlation coefficient.

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INTRODUCTION

Balance is a basic human need which allows keeping the body weight center on the support basis[1-3]. Balance control is generally defined as a complex motor ability which involves the integration of sensory responses, elaboration of a response of the central nervous system and the motor capacity to perform this response so that the posture goals can be reached[1,3]. Balance disorders in the elderly have been widely studied[1-8]. Moreover, there are many studies about balance in the active and sports population which establish relations with injury prevention and recovery[9-12].

Statically speaking, balance may be defined as the ability to keep a support basis with minimum movement, while dynamically speaking, it can be the ability to perform a task during the maintenance of a stable position[13,14]. Many tests have been developed to assess static and dynamic balance. Some of them are especially used with the elderly and have proved to be useful in prevention of falls. Examples of these tests are the Romberg test, the Tinetti test, the Stand Up and Run test, Functional reach test and the Bestest test[15-20]. Some others, such as the Cartwheel test[12,16] are used with a more active population. There are also more sophisticated systems which assess balance quantitative and qualitatively, such as the *AMTI AccuSway Plus* Force Platform, the NeuroCom EquiTest, the Biodex Stability test, the Trainer 2000 Kinestetic Ability and the Balance Master[20-26].

Dynamic balance conditions have been investigated with the use of some of these systems, such as the Biodex Stability System, generating instability through the instrument itself[13]. In this flow of thinking, a new instrument for dynamics balance assessment and training, the TOBtrainer^{MR}, has been developed and patented by Pablo de Olavide at the University of Seville, Spain. The TOBtrainer^{MR} is at least three times less costly than the majority of the instruments previously mentioned here, besides being easy to be carried (it weighs only 7 kg).

The aim of the present study is to assess inter-session confidence of balance assessment using the TOBtrainer^{MR}. The evaluator's participation limited to providing instructions to the subjects, which makes the evaluation almost independent from the evaluator. Moreover, the authors have the aim to offer error scores so that the actual performance alterations can be identified.

METHODS

Subjects

Thirty healthy subjects (nine men, 21 women, age = 27.9 ± 2.9 years) with no involvement in physical activity over two times per week and absence of history of having been considered elite athletes, participated in this study. None of them have reported lower extremity or spine injury in the last previous six months. None of them have suffered central nervous, visual or vestibular systems disorder or have ingested any drug which could alter balance. All subjects provided written consent for participation in the study, according to the Declaration of Helsinki Revised in 2008.

Instruments

The TOBtrainer^{MR} is a 40-cm fiberglass platform with 12 levels of unidirectional inclination, which can be medial-lateral um (ML) or anteroposterior um (AP), depending on the subject's position on the platform. It has three radius of curvature (25 cm, 15 cm and 10 cm) for increase of the difficulty level and can also evaluate balance in any position.

The TOBtrainer^{MR} has an accelerometer (ADXL105) which may be connected to two microcomputers, PIC16F877A or PIC16F876A. The first has a sampling rate of 20 Hz, is used without a computer, has two modalities (assessment and training) and presents the information on the instrument's display (figure 1). The second one is only used for assessment, has a sampling rate of 40 Hz and needs a computer attached to it. Both micro-controllers can be used with a visual reference to aid the subject improve his/her balance.

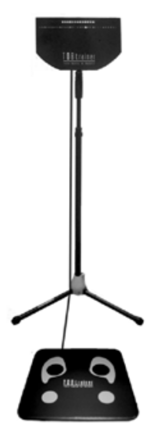

Figure 1. TOBTrainer^{MR} used without a computer.

Testing procedure

The test protocol consisted of two sessions separated by a time interval of three weeks. Each session consisted of three 20-second tests for each modality, using a radius of curvature of 15 cm (medium difficulty level). The four modalities were medial-lateral with eyes open (MLEO), medial-lateral with eyes closed (MLEC), anteroposterior with eyes open (APEO) and anteroposterior with eyes closed (APOF). The tests were performed in the following order: MLEO, MLEC, APEO and APEC.

All tests were performed in a closed room with good light. There were no visual or sound distractions. The subjects were then instructed to remain at standing position on the two limbs with hands along the body trying to maintain stability on the platform. Therefore, they were helped by a visual reference which consisted of a light signal which remained in the middle of the screen when the platform was at the horizontal plane. In case the subjects were not able to maintain bilateral position on the platform, the attempt was discarded.

Before the beginning of the tests, the protocol was explained to all subjects and they performed a 20-second familiarization test immediately before the test of each modality.

A PIC16F876 micro controller was used so that the sampling rate was set at 40 Hz. All data were recorded with the TOBT software. The mean value of the angle bias was admitted for each test and the best result out of the three used tests for each modality was applied. A 60-second interval was given between tests, while a five-minute one was given between modalities.

Statistical analysis

Statistical analysis used the SPSS program for *Windows*, version 17.0. The means and standard deviations of all variables have been measured. The Kolmogorov-Smirnov test was applied to verify normality of all variables, and as this condition was always verified, a *t* test for paired samples was used for comparison of the first and the second measurement with the aim to discard any systematic differences due to the learning effects. The significance level of the test was set at $p < 0.05$. A Two-way intraclass correlation coefficient model (2,1) (ICC) was used to evaluate confidence. The following criteria were established for the ICC values[27]:

- Bad: $ICC < 0.40$;
- Average: $0.40 \leq ICC < 0.70$;
- Good: $0.70 \leq ICC < 0.90$;
- Excellent: $ICC \geq 0.90$.

From the ICC values, we calculated the standard error measurement (SEM) and the smallest detectable difference (SDD) through the following formulas[28]:

$$SEM = SD \sqrt{1 - CCI}$$
$$SDD = SEM.\ 1.96.\ \sqrt{2}$$

Where SD is standard deviation of the scores of all subjects.

RESULTS

Table 1 presents the mean and standard deviation for the four modalities in both sessions. The *t* tests of related samples did not reveal differences between measurements from the first and second sessions ($p < 0.01$), evidencing hence that there were no differences between both sessions due to learning effects. The ICC values for confidence assessment between sessions 1 and 2 ranged between 0.71 (for MLEC) and 0.83 (for MLEO). Table 2 presents the ICC, SEM and SDD values for all the measured variables.

Table 1. Mean and standard deviation for the four modalitites in sessions 1 and 2.

Modalities	Session 1	Session 2
	Mean ± standard deviation	Mean ± standard deviation
MLEO	2.81 ± 0.74	2.81 ± 0.84
MLEC	9.31 ± 1.60	9.17 ± 1.39
APEO	2.67 ± 0.94	2.58 ± 0.77
APEC	8.80 ± 1.49	8.52 ± 1.45

MLEO: medial-lateral eyes open; MLEC: medial-lateral eyes closed; APEO: anterior-posterior eyes open; APEC: anterior-posterior eyes closed.

DISCUSSION

Concerning our dynamics balance assessment, the ICC values found for MLEO, MLEC, APEO and APEC ranged from 0.71 and 0.83, which means that confidence after three weeks of interval was good. Such results are according to the ones found by Mattacola

Table 2. Confidence and error measure for the four modalities.

Modalities	ICC	SEM	SDD
MLEO	0.83	0.32	0.90
MLEC	0.71	0.80	2.22
APEO	0.82	0.36	1.01
APEC	0.76	0.72	1.99

ICC: intra-class correlation coefficient; SEM: standard error of the measure; SDD: smallest detectable difference; MLEO: medial-lateral eyes open; MLEC: medial-lateral eyes closed; APEO: anterior-posterior eyes open; APEC: anterior-posterior eyes closed.

et al.[24], who obtained an ICC of 0.78 for the dynamics protocol of two limbs with eyes open and of 0.84 for the dynamic protocol of two limbs with eyes closed using the Chattecx Balance System. The SEM describes within which variation the actual score of a subject will lie as a result of an impossibility of confidence of the assessment, The SDD is an index which shows the necessary difference between scores separated of a subject so that the difference in these scores is considered real. The ICC is without an unit, but the SEM and the SDD present the same units of measure under interest, and we believe that these are more useful than the ICC itself. An important limitation of our study is that the quantity of tested conditions was very low. Balance assessment should also consider the way these balance strategies alter with support and sensory conditions, as well as limitations of the task. Moreover, these results were obtained from a healthy and young population and it is not clear whether the results would have been similar with an older population or another with balance disorders. Another possible limitation is the choice of the radius of curvature for the adjustment of the level of difficulty. Our subjects were not involved in physical activity more frequent than twice a week; therefore, it would have been possible to find higher ICC values using a radius of curvature of 25 cm. Some authors [29,30] reported good confidence when used a steady stability level with the Biodex, but Pereira *et al.*[25] state that the decreasing stability protocol could have been a better option for subjects who are engaged in sports, since it is difficult to choose which stability level better represent its reality. The use of a similar protocol with the TOBTrainer[MR] could also be the best way to assess balance in sports populations.

CONCLUSION

Although there is certain variability in the balance assessment using the TOBtrainer[MR], the ICC values found in our study present good confidence. Since there are no previous studies with the TOBtrainer[MR], there are no SEM and SDD values either. Future researchers would have, from now on, reference data to assess within which variation an actual score of a subject will lie and whether differences in two scores are real or due to an error in measurement.

All authors have declared there is not any potential conflict of interests concerning this article.

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ERRATUM

In volume 19, no. 5, September/October 2013, of the RBME, on page 376 – "Confiabilidade entre sessões de avaliação de equilíbrio com TOBtrainerMR" (Reliability between balance assessment sessions with TOBtrainerMR), the name of the author, Francisco José Berral de la Rosa (Physician)3, should have been included and the title of author Daniel Rojano Ortega should have stated (Physicist). The authors are therefore listed as follows:

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