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Should the instructions issued to the subject in traditional static posturography be standardised?

M. Zok*, C. Mazzà, A. Cappozzo

Department of Human Movement and Sport Sciences, University Institute for Movement Science, Piazza Lauro de Bosis 6, 00194 Rome, Italy

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Abstract

The postural ability of a subject is usually evaluated through the observation of the centre of pressure parameters obtained through posturography. These parameters are known to be sensitive to various factors and standards have consequently been proposed for data acquisition and analysis. A factor usually not taken into due consideration but likely to influence the postural exam is the kind of standing posture (e.g. natural or immobile) a subject is instructed to maintain. This study aimed at investigating whether instructions issued in a traditional static posturographic test influence its outcome and hence should be considered in the standardisation of the posturography protocols. Two groups of young healthy subjects were each issued one of two common instructions, "stand quietly" or "stand as still as possible", by means of projected instructions. Differences between the two groups were investigated for commonly calculated centre of pressure parameters. All these parameters, but the mean frequency, were significantly different, with variations in the range between 8% (mean velocity) and 71% (confidence circle area). These results suggest that instructions given to the subjects strongly influence the outcome of posturography and should, hence, be standardised.

Keywords: Posture; Balance; Biomechanics; Stabilometry; Centre of pressure; Force platform; Experimental protocol

1. Introduction

Postural ability is typically evaluated using quantitative static posturography, which is based on body sway assessment through the observation of the centre of pressure (CoP) trajectory. Traditionally, subjects are asked to stand on a force platform and CoP related parameters (indicators of stability) are calculated from the ground reaction measures. Posturography outcome is known to be sensitive to various factors, which can be divided into three main groups: experimental setup, individual characteristics of the tested subjects, and experimental protocol.

Experimental setup refers to the acquisition chain and its settings. Its main characteristics consist of the data acquisition duration, the cut-off frequency of a commonly implemented low-pass filter, and the data sampling rate. These characteristics have been widely investigated previously and some standardisation guidelines have been provided in the literature. Regarding the data acquisition duration, an early comparison among the results obtained from trials where data was recorded for increasing durations, ranging between 10 and 60 s, revealed that at least 30 s of signals should be acquired to ensure data reliability [1]. This was later on contested, and a longer duration of 60 s was alternatively suggested [2], which has been recommended as well in further studies [3,4]. Concerning the cut-off frequency, the CoP parameters were shown not to vary at cut-off frequencies above 10 Hz [5]; such value is, hence, recommended. Finally, regarding the sampling rate, a value 100 samples/s is suggested both to allow for the limited selectivity of real filters and to exploit the improvements in digital signal acquisition techniques [5].

The importance of considering individual anthropometric measures of the subjects, such as mass and stature, and of taking into account for relative effects through normalization procedures has been pointed out in the literature [6]. Analogously, the use of an index that takes into consideration mass and stature of subjects for the evaluation of the data obtained in dynamic posturography has been proposed [7].

* Corresponding author. Tel.: +39 0636733506; fax: +39 0636733517.
E-mail address: mounir.zok@iusm.it (M. Zok).

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Experimental protocol deals with issues such as vision, subject positioning, and operator instructions. Previous studies demonstrated the sensitivity of posturography outcome to the variation of visual conditions [8] and feet positioning [9]. Other studies have shown that the subject's focus of attention can play a significant role in the performance of an upright posture motor task, especially for older adults [10]. This is a known issue in dual-task paradigm tests in which postural control, considered as a primary task, and a secondary task are performed together. During a traditional static posturography test, in which CoP related parameters are calculated to derive clues as to the stability of subjects situated on top of a force platform, there is only one task to be performed and the results related to the dual-task paradigms might be considered not relevant, especially for young adults [11]. However, a question might arise in spite of the above considerations: if not enough care is dedicated to the instructions issued to subjects during traditional static posturography, could its results be altered?

Instructions issued to subjects, when explicitly indicated (in some studies, such instructions are not indicated at all, e.g. [1]), belong arbitrarily to one of two sets: "stand quietly/naturally" (e.g. [12]) or "stand as still as possible" (e.g. [13]). In fact, the line distinguishing both sets seems subtle as is evident from a recent study in which subjects ". . . asked to stand quietly . . ." were instructed ". . . to stand as still as possible . . ." [14]. In light of what is observed above, this study aims at answering the following two questions: do the two commonly issued instructions "stand quietly" and "stand as still as possible" yield the same output in a traditional static posturography test? If not, what changes do they induce in the commonly used posture parameters?

An answer to these questions is expected to provide useful indications for a standardisation of the posturographic protocols and for the comparisons of the results reported in different studies.

2. Methods

Twenty-two young subjects who were physically active, who had no self-reported musculoskeletal or neurological disorders, and who had never undergone a static posturographic test previously were asked to stand barefoot on top of a six component strain gage force platform (Bertec Co.), hold their arms along the sides of their body, and follow the instructions that were projected on a 17 in. flat screen monitor, placed at a distance of 4 m and at eye level. The instructions were provided visually and not issued orally by an operator as not to introduce variables such as voice tone. Two groups of 11 subjects were randomly formed and each group was issued a unique instruction: "stand quietly" (QS—7 males and 4 females; age: range = 21–30 years, mean = 25 ± 3 years; mass: range = 52–79 kg, mean = 66 ± 9 kg; height: range = 158–183 cm, mean = 171 ± 8 cm) or "stand as still as possible" (SS—8 males and 3 females; age: range = 19–35 years, mean = 26 ± 5 years; mass: range = 57–99 kg, mean = 72 ± 12 kg; height: range = 163–191 cm, mean = 174 ± 7 cm). Each subject performed one trial in which the instructions were projected for 5 s prior to the beginning of data acquisition and were then substituted by a lightly illuminated 10 cm diameter circle, which the subjects had to fix throughout the trial duration (Fig. 1).

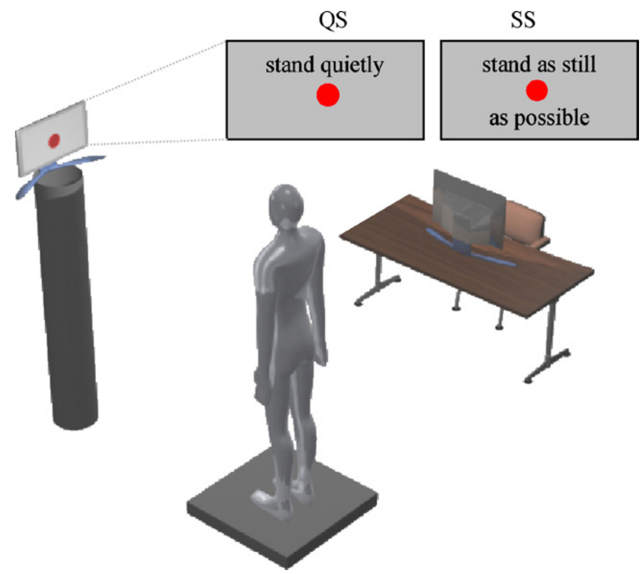

Fig. 1. Experimental setup.

Force platform data were acquired for 60 s (sampling rate = 100 samples/s) and then filtered at 10 Hz using a low-pass second-order Butterworth filter as recommended in the literature [5]. Feet positions were marked and the base of support area was computed [6].

To assess body sway, the most commonly used CoP parameters, and their corresponding medio-lateral (ML) and antero-posterior (AP) components when present, were calculated [15]: mean velocity (MV, MV_{ML}, MV_{AP}), mean distance (MD, MD_{ML}, MD_{AP}), range (R, R_{ML}, R_{AP}), mean frequency (MF, MF_{ML}, MF_{AP}), and areas of both the 95% confidence circle (CC) and ellipse (CE).

The Pearson correlation coefficient (r) was used to investigate the correlations among the quantities related to the subjects' anthropometry (height and mass) and to the experimental protocol (base of support area) and the CoP parameters. Following the recommendations available in the literature, when any of these correlations was found to be considerable ($|r| > 0.7$), the relevant CoP parameter was normalized using a detrending technique [16]. Significance of the differences between the QS and the SS conditions was assessed using a two-tailed t-test ($p < 0.05$).

3. Results

Differently from previously reported results [6], correlations were found only between MV and height. Table 1