The effect of hands position on balance timing during single-leg-standing test among healthy collegiate physical therapy students

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ABSTRACT

Background: Balance skills play an axial and vital role in enjoying good physical health. Static balance skills like standing on one leg are necessary for activity of daily living. Standing on one leg is a readily simple test used for assessment of static balance across different ages.

Objectives - The aims of this study was to 1) compare the static balance ability when changing the hands position and 2) compare static balance ability when having eyes open versus closed.

Methods and Materials - Thirty three college students instructed to maintain balance as long as tolerated while standing on one leg. The order of measurement; for hands on chest, hands on pelvis, and hands dangled, was randomized. Open versus closed eyes tested from hands on pelvis position.

Results: The mean score, in seconds, for standing on right leg with hands dangled was 74.00 (SD=41.43), with hands on pelvis was 75.75 (SD=44.20), and with hands on chest was 82.09 (SD=37.95). One-way repeated-measure ANOVA showed a significant effect \( F(2,64)=3.06, P<0.05 \). Paired sample \( t \) test showed a significant increase in balance timing from eye closed to eye open test \( t (32) = 5.99, p <0.001 \).

Conclusions: Individuals were able to balance on one leg longer when they had hands on chest. Clinicians can incorporate the hands positions and visual feedback as a simple way of clinical progression in their rehabilitation program.

Keywords: Balance, posture, physical endurance, healthy participants, visual feedback.
INTRODUCTION

Balance skills play an axial and vital role in enjoying good physical health.\textsuperscript{1,2} Maintaining adequate static and dynamic balance is essential for individuals’ well-being across different ages\textsuperscript{3-5}. The ability to adopt proper balance strategies to maintain equilibrium and having good postural control is depending on the level of task demand on balance performance\textsuperscript{6-8}. Clifton et al.\textsuperscript{9} reported that some static balance tests were useful in identifying injury risk. Static balance is strongly associated with the ability to process visual information; however dynamic balance is associated with the speed of motor response\textsuperscript{10,11}. Visual information is fundamental for feedback control of balance\textsuperscript{3}.

Static balance skills like standing on one leg are necessary for activity of daily living. For example, during regular walking or walking up and down stairs, subjects need to shift their body weight on one leg and maintain balance while swinging the other leg. Standing on one leg is a readily simple test to be used for assessment of static balance across different ages\textsuperscript{1,4,10,11}. It is convenient since it can be administered at any clinical setting, by any clinician and at any time. Any individual who has the ability to balance on one leg without support tested for static balance timing. Single-leg standing used for testing of static balance skills as well as for static balance training. However, the effect of hands position on static balance ability has not been investigated in healthy individuals. Knowing the effect of the hands position on static balance skills ability will help clinicians to guide individuals during balance testing and to provide clinical progression during static balance training.

METHODS and MATERIALS

Subjects

Thirty three consecutive healthy students males, aged between 18 and 24 years, were recruited from college of medical rehabilitation, physical therapy division, Taibah University in Al-Madina Al-Munawara city. Participants’ demographic information collected. Research design is a single-group, repeated-measures design. Inclusion criteria: subjects were included if they were between the ages of 18 and 24 years old, healthy, and free from any physical disability or significant pain. Exclusion criteria: subjects excluded if they have had previous orthopedic surgery, eye or ear surgery or suffering from major health problems or physical disability.

Procedure

Subjects signed a written informed consent after explaining the study protocol to them. The study approved by institutional review board at college of medical rehabilitation. The physical therapist fully demonstrated the activity to the participants. Balance timing recorded, during standing on one leg with hands on chest, on waist, and with hands dangled. Measurements were taken with eyes are open. The order of measurement randomized.

Every participant was instructed to stand on one leg; bare feet with hands on waist (Figure 1), on chest (Figure 2), and with hands dangled (Figure 3) and maintain his static balance as long as tolerated with eyes are open. Every participant instructed to breathe normally and balance adequately. If the participant started to sway, the tester used to
give him verbal feedback to balance and if the participant could not immediately restore his balance the test terminated and the balance timing recorded using stopwatch. If any participant managed to balance up to three minutes, the time recorded and considered as ceiling time in our study.

Regarding the effect of being tested for balance with eyes open versus eyes closed, the hands on waist position was chosen and the tester provided close supervision during testing to assure safety especially when eyes are closed. Every participant was instructed to stand on one leg; bare feet with hands on waist, and maintain his static balance as long as tolerated with eyes are open (Figure 1) and with eyes are closed (Figure 4). The order of measurements was randomized. Every participant had to breathe normally and balance adequately. Three minutes used as ceiling time.

Statistical analysis

Descriptive statistics conducted for all variables included in the study. A one-way repeated-measure ANOVA calculated comparing the balance time of participants at different hands positions. A protected dependent $t$ tests conducted to detect any difference between every pair of the three measurements. Pearson correlation was conducted to detect for the relationship between the significant measurements. A paired sample $t$ test calculated to compare the mean balance score when eyes open versus closed eyes. A Pearson correlation was calculated to examine the relationship between balance time of standing on one leg with eyes open and with eyes closed. Statistical significance was set at alpha $\leq 0.05$. SPSS 20.0 was the software used for all data analysis. (SPSS Inc. Headquarters, 233 s, Wacker Drive, Chicago, Illinois 60606, USA).

RESULTS

The focus of this study was to compare the static balance ability of the healthy individuals when standing on one leg with hands on chest, on pelvis, and with hands dangled. Participants were all physical therapy students at college of medical rehabilitation, Taibah University in Al-Madina Al-Munawara city. Participants’ balance time mean, standard deviation (SD), and standard error mean (SEM) scores during standing on one leg with hands at different positions can be seen in (Table 1, Fig. 5).

A one-way repeated-measure ANOVA calculated comparing the balance time of participants at different hands positions. A significant effect was found [$F(2,64)=3.06, P<0.05$]. A protected dependent $t$ tests were conducted and revealed that scores increased significantly from hands dangled to hands on chest position [$t(32)=2.11, P<0.05$].

A Pearson correlation calculated examining the relationship between participants’ balance time values for standing on one leg with hands on chest and with hands dangled. A strong positive correlation was found [$r(31) = 0.85, p < .005$], indicating a significant linear relationship between the two positions. Participants who scored high time during standing on one leg with hands dangled were able to score high with their hands on chest.

A paired sample $t$ test was calculated to compare the mean score of balancing on one leg with eyes open and with eyes closed. The
mean score, in seconds, for standing on one leg with

Table 1. Mean number of seconds of balancing on one leg with different hands positions (N=33).

| Pair | Hands Position | Mean  | N  | Std. Deviation | Std. Error Mean | t    | df | Sig. (2-tailed) |
|------|----------------|-------|----|----------------|-----------------|------|----|----------------|
| 1    | HanDanSLS      | 74.00 | 33 | 41.43          | 7.21            | -.337| 32 | P >0.05        |
|      | HanPelSLS      | 75.76 | 33 | 44.21          | 7.69            |      |    |                |
| 2    | HanDanSLS      | 74.00 | 33 | 41.43          | 7.21            | -2.105| 32 | P <0.05        |
|      | HanChesSLS     | 82.09 | 33 | 37.96          | 6.61            |      |    |                |
| 3    | HanPelSLS      | 75.76 | 33 | 44.21          | 7.69            | -1.295| 32 | P >0.05        |
|      | HanChesSLS     | 82.09 | 33 | 37.96          | 6.61            |      |    |                |

HanDanSLS; Hands Dangled Single-leg standing, HanPelSLS; Hands on Pelvis SLS, HanChesSLS; Hands on Chest SLS

Figure 1. Single-leg standing balance test with hands on waist with open eyes

Figure 2. Single-leg standing balance test with hands on chest.
Figure 3: Single leg standing, balance test with hands dangle.

Figure 4. Single-leg standing, balance test with hands on waist and eyes closed.

Figure 5. Bar chart showing the balancing time values in second (mean± SD) scored by the participants (n=33) during single-leg standing with different hands positions. HanDanSLS; hand dangled single leg standing, HanPelSLS; hand on pelvis single leg standing, HanChestSLS; hand on chest single leg standing.
HANDS POSITIONS, VISUAL FEEDBACK AND BALANCE ABILITY

eyes open was 71.21 (SD=45.19), and the mean score for standing on one leg with eyes closed was 29.30 (SD=28.78). A significant increase in balance timing from eye closed to eye open when standing on one leg, was found [ t (32)= 5.99, p <0.001].

A Pearson correlation was calculated examining the relationship between participants’ balance time values for standing on one leg with eyes open and with eyes closed. A moderate positive correlation was found [ r (31)= 0.484 p <.005], indicating a significant linear relationship between the two variables. Participants who scored high time during standing on one leg with eyes open able to score high with their eyes closed.

DISCUSSION

Balance skills are essential for individuals’ wellness and welfare. Static balance is mainly concerned with maintaining stability and having good control over body posture at different positions. Balance deficiencies might increase the physical demand on the musculoskeletal system, which exhaust the muscles and eventually lead to chronic fatigue and physical disorders. The findings in the present study showed a significant difference for hands positions and for visual feedback during single leg standing balance test. The single leg-standing test used to evaluate static balance has been reported by Matsuda et al. who examined the balance ability in 25 male adults and 25 male soccer players. Sway factors recorded. The results showed no difference in balance abilities between dominant-legged and non-dominant-legged stances. Authors also recommended one-legged stance as a useful tool to test static balance ability in young people. Participants were able to balance on one leg longer when they had hands on chest whereas hands dangled position was the shortest time. The change in hands position might have changed the relationship of center of gravity, line of gravity and base of support. Clinicians can incorporate the hands positions as a simple way of clinical progression in their rehabilitation program.

All participants (N=33) in the present study were all able to balance on one leg with their eyes open as well as with their eyes closed but with significant difference in favor of eye open balance timing. This agrees with Kane and Barden who reported that the poor performance in postural control may be associated with delayed anticipatory adjustment mechanism and inconsistent preparatory activation. When eyes are open, the central nervous system integrates the peripheral somatosensory, visual and vestibular inputs and selects the most appropriate muscular strategy to control body posture. Moreover, since static balance is strongly associated with the ability to process visual information; old people especially those with poor visual abilities are more at risk of balance disorders because the ability to perceive and process visual information is fundamental for feedback control of balance.

Regarding the subnormal performance of the participants in static balance skills, it can be attributed to the lack of engaging in regular physical activities. About 90% of the participants in the present study are physically inactive according to the American college of sports medicine classification Which recommends having all healthy adults above 18 years old to engage in moderate- intensity aerobic exercise x 30 minutes x five days each week. The findings are in agreement with
Gribble and Hertel\textsuperscript{21} who reported that fatigue of the muscles of lower extremity decreases postural control which subsequently decreases balance ability. It is also in harmony with the findings mentioned by Hottenrott et al.\textsuperscript{22} who pointed out the importance of high intensity training on functional outcomes. None of the participants in the present study indicated practicing any high intensity training.

Balance is crucial for injury prevention. McGuine et al.\textsuperscript{23} studied balance abilities in a group of high school basketball players. Results showed that diminished stability and poor static balance performance considered as a predictor of injury. Moreover, pre-season functional movement screen can predict injury but in professional athlete.\textsuperscript{24}

In essence, poor static balance performance among the healthy students participated in this study could put them at risk of losing balance that might cause serious injury and lead to physical impairment. Therefore individuals can simply practice static balance training; like standing on one leg with eyes open first and progress to eyes closed in addition to incorporating hands position, in order to enhance balance abilities.

**CONCLUSIONS:** In essence, individuals managed to balance longer when having their hands on chest. Balance scores increased significantly from hands dangled to hands on chest position and a positive correlation was found between different hands positions. Clinicians can incorporate hands position and visual feedback as a simple way for clinical progression.

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**Declaration of interest:** We affirm that the submission represents original work that not been published previously and is not currently being considered or submitted to another journal, until a decision has been made. In addition, we confirm that each author has seen and approved the contents of the submitted manuscript.

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