The Corinthian

Volume 17 Article 5

2016

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Abstract

Purpose: The purpose of this study is to identify the effect of the gastrocnemius on the posterior chain by comparing traditional Sit-and-Reach Test (TSRT) performance in the standard 90 degree of ankle dorsiflexion position with the R.S. Smith Sit-And-Reach Design (SSRT) placing the ankle at 35 degrees of ankle plantar flexion.
Methods: The researchers tested a total of 169 participants. All participants completed an informed consent prior to the tests. After completing a five-minute elliptical warm-up, participants performed three trials of each SRT variation. The highest score of each test was recorded. The researchers used a paired t-test to determine statistical significance.
Results: The participants achieved a mean distance of 24.98±9.28 cm in the TSRT and 27.83±10.10 cm in the SSRT. The results showed a significant difference between SRT performance in the standard 90 degrees of ankle dorsiflexion position and the modified ankle position of 35 degrees of ankle plantar flexion, with the significance level set at $p<0.001$.
Conclusion: The flexibility of the gastrocnemius has a significant effect on the posterior chain. Therefore, when analyzing TSRT performance, gastrocnemius flexibility must also be taken into account. Several studies have been published on the premise that the TSRT evaluates low back and hamstring flexibility. Future studies should indicate that the test is assessing low back, hamstring and gastrocnemius flexibility.

Introduction

The Sit-and-Reach Test (SRT) is a common protocol used to assess hamstring and lower back flexibility. The Sit-and-Reach Test was designed by Wells and Dillon in 1952, and the protocol requires participants to sit on the floor and maximally flex the trunk while keeping their knees flat on the floor and ankles dorsiflexed at a 90 degree angle (1). Numerous physical fitness measures and assessments include the SRT protocol as it is easy to administer and requires few materials. Two nationally recognized testing batteries, the Physical Best and FITNESSGRAM programs, utilize the SRT, as well as general fitness assessments by personal trainers and other healthcare professionals (3, 10).

Several previous studies have questioned the validity of the SRT in measuring hamstring and lower back flexibility. To eliminate alternative factors affecting the results of the SRT, modifications have been made to the SRT, such as the Modified and Back-Saver SRT. The Modified SRT aims to eliminate the negative effect of extreme differences between arm and leg length on SRT performance (5). The Back-Saver SRT tests each leg individually to account for differences in leg length, and it is intended to be safer on the spine by restricting intervertebral flexion (8). Both traditional and modified versions of the SRT, however, require the ankle to be in a dorsiflexed position. Ankle dorsiflexion activates the gastrocnemius, which likely negatively affects range of motion in the SRT.

Previous studies have investigated the effect of the gastrocnemius on hamstring flexibility assessments. In one study by Gajdosik, et al., researchers analyzed the difference in the straight-leg-raising maneuver when the ankle was fixed in dorsiflexion or relaxed in plantar flexion (4). The results showed decreased performance in both active and passive straight-leg-raise tests when subjects fixed their ankles in the dorsiflexed position. The researchers suggested the decreased performance in dorsiflexion could result from increased tension on the sciatic nerve as well as tension in the hamstrings from fascial connections between the gastrocnemius and hamstring muscles in the popliteal region (4). In an additional study by Kawano, et al., researchers investigated the relationship between hip joint angle and SRT, as well as the influence of the gastrocnemius (6). The study used a SRT box with a door that opened to allow the ankles to relax in plantar flexion. The results showed a correlation between hip joint angle and SRT performance, and the gastrocnemius activation affected the results. The researchers suggest performing the SRT with free ankle joint mobility to limit the effect of the gastrocnemius (6). In a study by Liemohn, et al., researchers studied the effect of ankle posture on SRT performance (7). By using a box that allowed the feet to plantar flex into the box, the researchers collected SRT data from subjects in both dorsiflexed and plantar flexed ankle positions. The results showed increased performance by both males and females in the plantar flexed position (7).

Although previous studies exist exploring the effects of ankle position on SRT performance, no study used a fixed angle of ankle plantar flexion when testing subjects (6, 7). The purpose of this study is to identify the effect of the gastrocnemius on the posterior chain by comparing SRT performance in the standard 90 degree of ankle dorsiflexion position with a modified box placing the ankle at 35 degrees of plantar flexion. The researchers hypothesized that participants will achieve an increased range of motion using the SSRT box than the TSRT box.

Methods

Procedures

The Georgia College & State University (GCSU) Institutional Review Board approved this study. A total of 169 college-aged participants volunteered for the study, and the researchers gave participants a pre-scheduled time to report to the GCSU Wellness and Recreation Center. All participants were required to wear athletic attire and tennis shoes for the study. Each subject read and completed an informed consent document prior to beginning the data collection. After completing the informed consent, subjects completed a five-minute elliptical warm-up at 50-60 RPM with a 0% grade. The participants then moved to the GCSU Wellness and Recreation Center testing lab to begin the SRT assessments. The researchers randomly assigned participants a starting test. The participants removed their shoes and performed three trials of each SRT variation. The highest score from the three trials was recorded for each test. The participants' names were removed from the data collection sheet to keep results anonymous.

Instrumentation

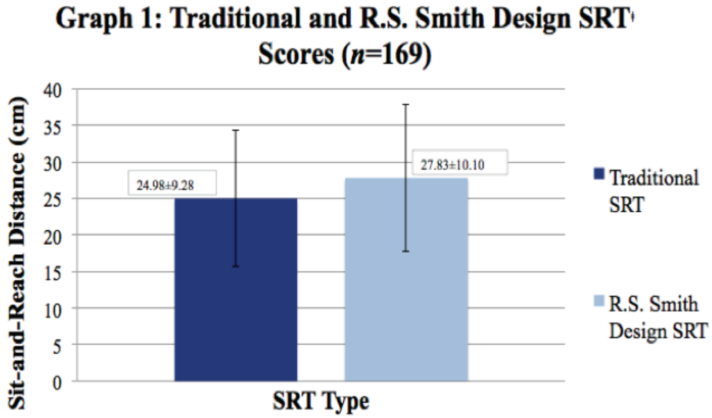
The researchers used an Acuflex I Modified Flexibility Sit-and-Reach Test Box to collect the TSRT data. The researchers used a modified SRT box (R.S. Smith Design) with an open end that allowed the subjects to plantar flex at the ankle to collect the SSRT data. An adjustable piece of wood was set at 35 degrees of plantar flexion to allow the subjects to perform the test at a fixed foot angle. For each variation, subjects sat on the floor with legs extended and placed their feet against the box or board. The subjects placed one hand over the other with palms facing the floor and pushed the adjustable tab forward as far as possible while keeping the posterior aspect of the knees on the floor. The subjects held the furthest position for one-to-two seconds until the researchers recorded the distance.

Data Analysis

The researchers used the data to assess the difference between traditional SRT mean and the modified SRT mean. A two-tailed, paired t-test was performed to determine statistical significance. The significance level was set at $p<0.001$.

Results

A total of 169 students volunteered for the study. Overall, 47.9% (n=81) of the participants were males, and 52.1% (n=88) of the participants were females. College-aged students of all class ranks participated in the study. The participants achieved an average distance of 24.98±9.28 cm on the TSRT and 27.83±10.10 cm on the SSRT. Refer to **Graph 1** for a visual representation of these results. The t-test results showed a significant difference between the t



Mean±Standard Deviation are shown
SRT-Sit and Reach Test

Discussion

The results show that there can be significant variation in the results of a SRT depending upon the type of sit-and-reach box used. The TSRT yields lower scores because of the forced dorsiflexed position of the ankle. The SSRT box yields higher scores because of the fixed angle of the box, which allows the participants' ankles to be in a plantar flexed position. Therefore, ankle position has a significant effect on hamstring flexibility. These results further support the findings of Gajdosik, et al. and Kawano, et al. that indicate the gastrocnemius activation in the dorsiflexed ankle position negatively affects performance in both the straight-leg-raise test and the SRT (6, 7). Since the gastrocnemius is not under the same tension during the SSRT, the results show that the TSRT not only assesses lumbar and hamstring flexibility, but gastrocnemius flexibility as well. When a traditional box is used and the ankle position is not taken into account, the score that is attained may not accurately depict hamstring and low back flexibility. It is important for strength and conditioning coaches, personal trainers, and other healthcare professionals to be mindful of the role the gastrocnemius plays in the traditional SRT assessment. When making a flexibility exercise prescription after a SRT assessment, these professionals may not elicit the most improvements possible if they only focus on hamstring flexibility. The main goal for this study was to find information regarding the relationship between plantar flexion and a greater range of motion. Previously, these tests were thought to assess hamstring and low back range of motion, when in fact, gastrocnemius mobility was a big factor as well. Several studies have been published on the basis that the SRT evaluates low back and hamstring flexibility. Future studies should indicate that the test is assessing low back, hamstring, and gastrocnemius flexibility.

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