THE EFFECT OF TIGHT HIPS ON SQUAT TECHNIQUE

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The purpose of this study was to examine if tight hips would effect a dynamic activity such as the squat. Twenty subjects with squat experience were evaluated for hip contracture, 8 subjects were found to have iliopsoas contracture and 12 were found to have rectus femoris contracture. Two mixed model repeated measures ANOVAs were completed on hip flexion angles during a squat between a group with and without hip contracture for the iliopsoas and rectus femoris. A significant difference was found for the Iliopsoas ($p=.014$) and rectus femoris ($p=.002$) for the main effect of repetition. However, the interaction was not significant for iliopsoas ($p=.20$) or rectus femoris ($p=.10$). No significant differences were found between the hip contracture groups for the iliopsoas ($p=.10$) or the rectus femoris ($p=.68$), indicating tight hips do not have an impact on squat technique.

KEY WORDS: hip contracture, iliopsoas, Modified Thomas Test, rectus femoris.

INTRODUCTION: Sports injury prevention is a primary goal of certified athletic trainers. In order to screen for potential injuries or re-injuries, Athletic Trainers evaluate participants with a history, physical examination, strength and cardiovascular endurance training, stretching protocols and special tests (Harvey, 1998; Krivickas & Feinberg, 1996; Lanning et al., 2006; Winters et al., 2004). The use of special tests, such as the Modified Thomas test, in orthopedic evaluations allow the clinician to differentiate between abnormalities and injuries. Some special tests are used to assess the range of motion and flexibility of anatomical appendages that may impact the posture of the patient. Additionally, patient posture and prevalence to injury is impacted by changes in flexibility and strength in the muscles surrounding the body's joints (Harvey, 1998; Peeler & Anderson, 2008; Vigotsky, 2016). The restrictions in range of motion surrounding these joints subject the body to altered biomechanical movements, which increases the amount of expended energy and predisposition to injury (Gajdosik, 1985; Krivickas & Feinberg, 1996; Witvrouw et al., 2003). Analysis of this phenomenon in the pelvis by the way of orthopedic special tests can reveal critical information on the importance of the pelvis for posture (Gajdosik, 1985; Dicharry & Kerrigan, 2010).

Hip flexor contracture refers to the iliacus, psoas major and psoas minor and/or the rectus femoris being in a contracted state. Weakness of the hamstrings or inadequate lengthening also contribute to anterior pelvic tilt, as the anterior hip musculature dominates (Wolf, Mikut, Kranzl & Dreher, 2014). A contracture of the hip flexors may impact the anterior tilt of the pelvis. The Modified Thomas test involves the assessment of contracture of two different muscles, the iliopsoas and the rectus femoris. The Modified Thomas test is commonly used by Athletic Trainers to assess hip flexor contracture. However, no research was found that examined the results of the Modified Thomas test and possilbe effects on athletic performance. The squat is a common resistance training exercise that involves hip flexion and is often done incorrectly, leading to poor performance and possibly injury. Therefore, the purpose of this study was to evaluate how hip flexor contracture affects dynamic performance. For this study, a back squat was used as the assessment test for dynamic athletic performance. We hypothesized that iliopsoas and rectus femoris contracture would result in more hip flexion during the squat.

METHODS: A causal-comparative repeated measures experimental design was used to assess the effect of hip flexor contracture on a dynamic movement. Twenty recreationally active participants (22.0±2.21 years, 175.13±11.25 cm, and 84.91±20.72 kg) were recruited

to participate in the study. All subjects performed back squat exercises in their workouts at least once per week for the past six months.
Reflective markers were then placed on the posterior aspect of the humeral head, greater trochanter, lateral femoral condyle, and the lateral malleolus. The subjects then completed the Modified Thomas Test three different times while being observed by a different Board Certified Athletic Trainer each time. The order that the Athletic Trainers observed the Modified Thomas test was randomized to counteract the possible effects of completing the tests three times. The Modified Thomas was performed as directed by Starkey and Brown (2015). After each special test, the participant was required to stand up by the table for one minute before the next Modified Thomas test was performed for the next Athletic Trainer.
The participants were then taken to the Biomechanics Lab where an American Medical Technologies Incorporated (AMTI) AccuPower (Watertown, Massachusetts) force plate was in a standard squat rack. A Casio camera at hip level was on the participants'' right side capturing their motion in the sagittal plane. The subjects went through a warm-up and a maximum isometric test on the force plate in the descended position when the knees were at 90 degrees to estimate a 1RM as validated by Bazyler, Beckham, and Sato (2015). An exercise load was determined through calculation of 80% of the maximum isometric test result and squats were performed for one set of eight repetitions.
After the testing was completed, joint angles were measured using Dartfish Motion Analysis Software version 8.0 (Fribourg, Switzerland). Hip flexion was measured at the bottom of the squat when the knees were at 90 degrees. SPSS version 24 was used to analyze the data. Subjects were diagnosed as positive for iliopsoas and rectus femoris contracture if at least two of the three Athletic Trainers rated them at positive for each test. Two separate 2x8 mixed-model repeated measures ANOVAs were run between the positive and negative hip contracture groups, one for the Modified Thomas test iliopsoas results and one for the rectus femoris results. The level of statistical significance was set to $p<0.05$.

RESULTS: Eight of the 20 subjects were found to have iliopsoas contracture and 12 of the 20 subjects were found to have rectus femoris contracture. No significant differences were found for the main effect of hip contracture group $F(1,18)=2.93$, $p=.10$, $\eta_p^2=.140$ or the interaction between repetition and hip contracture group for the iliopsoas $F(4, 75)=1.53$, $p=.20$, $\eta_p^2=.078$. However, a significant difference was found for the Iliopsoas main effect of repetition $F(4, 75)=3.32$, $p=.014$, $\eta_p^2=.156$. Bonferroni adjusted pair-wise comparisons found that repetition 5 and 8 were significantly different ($p=.03$). No significant differences were found between the main effect of hip contracture group $F(1,18)=.17$, $p=.68$, $\eta_p^2=.009$ or the interaction between repetition and hip contracture group for the rectus femoris $F(7, 126)=1.78$, $p=.10$, $\eta_p^2=.090$. However, a significant difference was found for the rectus femoris main effect of repetition $F(7, 126)=3.50$, $p=.002$, $\eta_p^2=.163$. Bonferroni adjusted pair-wise comparisons found that repetitions 1 and 5 ($p=.02$) and 2 and 5 ($p=.03$) were significantly different. Figure 1 shows the results for the iliopsoas contracture and Figure 2 shows the results for the rectus femoris.

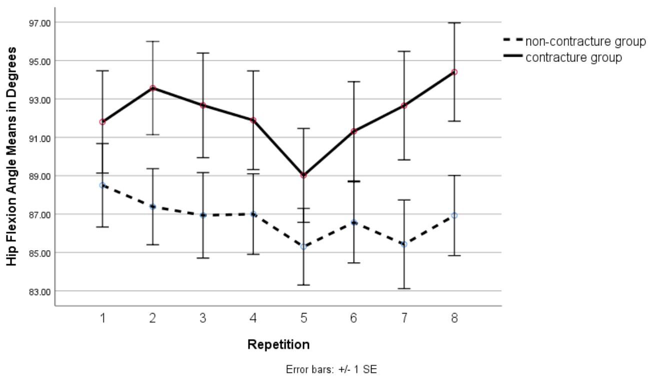

Figure 1. The means of the hip flexion angle for each repetition of the squat for the iliopsoas contracture and non-contracture groups. Note that a larger angle indicates less hip flexion.

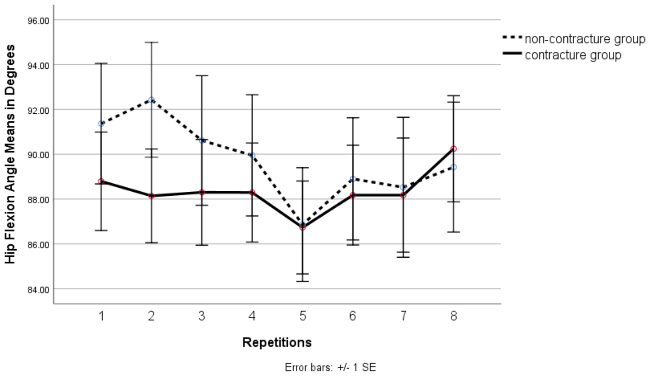

Figure 2. The means of the hip flexion angle for each repetition of the squat for the rectus femoris contracture groups. Note that a larger angle indicates less hip flexion.

DISCUSSION: Identifying modifiable risk factors (e.g, muscle imbalances) through evaluation is critical for prevention of orthopedic injuries (Harvey, 1998; Witvrouw, et al., 2003). Athletic Trainers use special tests to assist in the diagnosis of musculoskeletal injuries. However, the clinical application to sport performance of the results of those studies is rarely studied (Peeler & Anderson, 2008). Previous researchers have suggested a relationship between tight anterior hip musculature and a subsequent decrease in hip extension (Riley, Dicharry, & Kerrigan, 2010; Schache, Blanch, & Murphy, 2000). Schache et al. (2000) found a positive correlation between anterior pelvic tilt and hip extension in competitive runners using the Modified Thomas Test and goniometer to measure angles.

We hypothesized that those individuals who were assessed as having either a tight iliopsoas or a tight rectus femoris would have greater hip flexion during a squat because the anterior musculature would pull the hip into flexion. We tested this hypothesis by examining for hip contracture in the iliopsoas and rectus femoris and their effect on squatting technique. The way Dartfish angle measurements work for relative angles is that a larger angle would indicate less hip flexion. As can be seen in Figure 1, the subjects rated as having iliopsoas contracture had slightly less hip flexion than those who did not, but there was not a significant difference between them. Therefore, whether the subjects' were diagnosed with iliopsoas contracture had no significant impact on hip flexion during the squat.

The rectus femoris contracture results (Figure 2), show that the subjects who were rated as positive for rectus femoris contracture were found to have slightly greater hip flexion during the squat, except for repetition 8. However, there were no significant differences between the groups with and without rectus femoris contracture. Therefore, overall, whether the subjects' had hip contracture had no significant impact on hip flexion during the squat.

Although not an original purpose of this research, the over differences in hip flexion angle between some of the repetitions was an interesting finding. We observed during the squats that around repetition 5 is where the subjects often started to get fatigued and were struggling. We wanted them to complete all 8 repetitions so typically we starting verbally encouraging them when they started to fatigue. As can be seen in Figures 1 and 2, repetition 5 is where the hip flexion was the greatest, possibly indicating that the subjects were beginning to lose their squat technique. However, our verbal encouragement may have increased their effort and helped them maintain their hip flexion position for the rest of the repetitions.

The Modified Thomas Test is used frequently by Athletic Trainers. However, limited research has been conducted specific to the reliability and validity of the Modified Thomas Test, as well as results pertaining to the clinical applicability of a positive diagnosis to sport performance (Peeler & Anderson, 2008). Therefore, a limitation of the current study is the reliability and validity of the Modified Thomas Test. It is possible that the Modified Thomas Test may not be a good test for hip contracture. The literature suggests there are several methods to performing the special test and even the name of Thomas Test versus Modified Thomas Test appears to be controversial (Starkey & Brown, 2015). Secondly, we had a limited number of subjects all of whom reported generally healthy lower extremities. Further research is required by biomechanists and Athletic Trainers to examine the quality of the Modified Thomas Test and the effects of hip contracture on the squat and other dynamic movements. It is possible that more dynamic movements, such as running, may be affected by tight hips.

CONCLUSION: No significant differences were found between groups with and without iliopsoas and rectus femoris contracture in hip flexion during a squat. These results indicate that tight hips do not make a difference during a dynamic movement such as a squat. However, there was a trend for the iliopsoas contracture group to have less hip flexion and for the rectus femoris group to have more hip flexion. Although the Modified Thomas Test is used regularly by Athletic Trainers the reliability and validity need to be further tested as well as the effects a positive indication may have on dynamic movement.

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