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Hip Flexor Extensibility and Its Correlation to Hip Hyperextension and Lower Back Pain in Dancers

Introduction

In the world of ballet, flexibility and strength are the keys to success. A leg extended to extraordinary heights is equated with beauty and expertise, whereas a lower height is seen as lesser quality. Dancers are trained from their first ballet lesson to reach their toes to the utmost end of their range of motion, and push themselves beyond the regular restrictions of the human body. Despite the pressure put on dancers to be extremely flexible, tight hip flexor muscles (the rectus femoris and the iliopsoas group) are a common complaint, restricting hip hyperextension (called an arabesque). To compensate for this restriction, dancers tend to rotate the pelvis incorrectly, most commonly leading to lower back pain (LBP). Compared to other regions of pain, pain in the lower back has the highest prevalence in dancers (Miletic, 2015).

Along with a high arabesque, dancers aim for a 180 degree turn out, or external rotation in the lower limb. Turn out is rooted mostly in external hip rotation, but also comes from the knees, ankles, and feet. The degree of turn out in the general population is 45 degrees and is even more in professional dancers. Dancers can compensate their turn out anywhere from three to 72 degrees by rotating their pelvises incorrectly. This leads to significant lower back pain, which can further diminish the dancer's ability to reach a high arabesque (van Merkensteijn, 2015). There is moderate previous evidence of a link between the iliopsoas muscle group and LBP, but not specifically in dancers (Purcell, 2009).

Lower back pain tends to progress as dancers age, with an onset as early as the teen years. These are also the years when dancers become more serious about their art, dedicating more time to their dance classes and progressing to higher, more complicated class levels. The higher levels introduce more complex movements, requiring the dancer to stretch themselves beyond their previous physical limits. A larger emphasis is put on having a high arabesque, causing advanced dancers to have a higher probability of lower back pain. Unfortunately, many dance companies discourage dancers to show any signs of pain or injury. This results in lack of treatment and further health complications later in the dancers' lives.

The goal of this research was to measure the correlation between hip flexor extensibility, arabesque height, and lower back pain in advanced dancers; specifically, whether a tight iliopsoas group restricts range of motion and correlates with lower back pain. Through a series of non-invasive measurements, the rectus femoris and iliopsoas group were tested for range of motion and general extensibility. The measurements were completed as follows: Modified Thomas Test, Thomas Test, Patrick Test, and prone hip hyperextension. Each subject also completed a pre-screening form to assess degree of lower back pain. The outcomes of the measurements were analyzed to find a possible correlation between hip flexor extensibility, hip hyperextension (arabesque height), and lower back pain.

Methods

Advanced ballet and jazz dancers from the Missoula, Montana area were chosen due to the common complaint of lower back pain (LBP) in that population. The subjects chosen were analyzed based on age and years of dance and no outliers were found. Only female dancers were chosen. Each subject was given a standard pain assessment form, ranking their lower back pain from zero (no pain) to ten (worst pain) both on a regular day and for a normal dance class.

Four hip flexor extensibility tests were performed on both legs for each dancer: Thomas Test, Modified Thomas Test, Patrick Test, and hip extension range of motion. The primary investigator was previously instructed by a licensed physical therapist on how to take each measurement. These tests were chosen to isolate the hip flexors from other accessory flexion muscles in methods standard to the physical therapy field.

The Modified Thomas Test measures the angle of the relaxed knee as the subject lies supine with one leg off the side of an exam table and the other held to the chest (Fig. 1). In completely relaxed hip flexor muscles, the knee should flex to 90 degrees, with the heel pointing straight down. This test focuses on the extensibility of the rectus femoris muscle.

The Thomas Test is similar to the Modified Thomas Test, but the subject lies supine with both legs flat on the exam table (Fig. 2). The angle of the relaxed knee is again measured. This test focuses on the extensibility of the iliopsoas muscles.

The Patrick Test is a visual negative or positive test measured by the subject lying supine with one ankle crossed over the opposite knee. The examiner puts light pressure on the opposing hip and knee, visually assessing the degree to which the hips are able to stretch (Fig. 3). If the knee cannot reach parallel to the opposite leg or there is pain with the measurement, the test is positive for sacroiliac dysfunction and/or tight hip flexors.



Figure 1: Modified Thomas Test

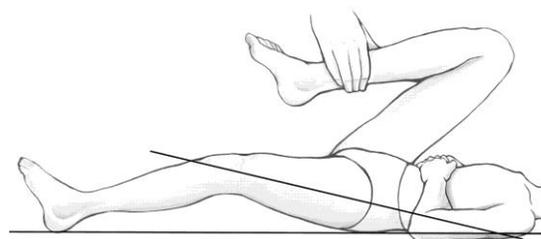


Figure 2: Thomas Test

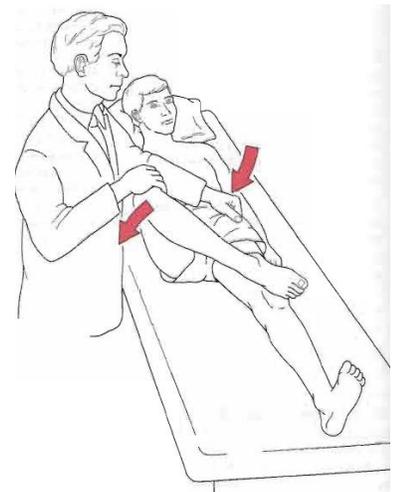


Figure 3: Patrick Test

Simple hip hyperextensibility was measured with the subject lying prone. A pillow was placed under the abdomen to adjust the pelvis into a neutral position similar to that used during a dance class. The subject extended her leg into an arabesque using her gluteus and hamstring muscles, but without using the back extensor muscles. The use of the back muscles to extend the leg was monitored. Measures were not made to accommodate for the gluteus and hamstring strengths, as they are outside the skill range for this research. The angle between the leg and the surface was measured.

Results

17 advanced female dancers ages 16.29 ± 4.33 years old were chosen from two Missoula area dance studios. The average number of years of dance was 12.4 ± 4.76 years across multiple disciplines. Two subjects had higher than average ages (26 and 28 years old), but their measurements were not significantly different than the other subjects, and therefore were not considered outliers.

The average lowest pain level for a regular day was 1.18 ± 1.70 and the average highest pain level was 4.29 ± 2.54 . LBP from dance class was broken into three categories: before, during, and after class. The average pain level before class was 1.35 ± 1.58 ; during class pain was 2.85 ± 2.12 ; and after class was 3.88 ± 2.45 . The overall LBP level for dance classes was 2.70 ± 1.89 .

The average degree of flexion combined for both legs in the Modified Thomas Test was 127.74 ± 15.85 degrees, beginning at 180 degrees. The average degree of flexion in the Thomas Test was 4.09 ± 3.07 degrees. There were two subjects with negative measurements, signifying knee hyperextension. The average range of motion for hip hyperextension was 23.47 ± 9.95 degrees. In the Patrick Test, of the 17 subjects, 10 tested negative and 6 tested positive for bilateral hip flexor tightness, and 1 tested positive for unilateral tightness (Fig. 4).

Discussion

The measurements of the two older dancers, while not significantly different than those of the younger dancers, show that LBP carries to adulthood if not treated properly.

There was a correlation between hip extension range of motion and daily pain levels ($p = 0.048$). For every one stage increase in daily pain level, hip extension reduces by 2.5 degrees (Fig. 5). Daily pain translates to motion during activity, decreasing hip extensibility.

There was also a correlation between the Thomas Test measurements and dance class-related pain levels ($p = 0.049$). For every one stage increase in pain, Thomas Test measurements increased by 0.79 degrees. A Thomas Test specifically tests the iliopsoas group: as the muscles pull on the femur, the knee lifts, giving a direct correlation between tightness and degrees of knee flexion. These results show that the higher the degree of knee flexion, the tighter the iliopsoas group and the higher the associated LBP.

While there was a correlation between iliopsoas tightness and dance-related pain, there was no correlation with daily pain. This shows that iliopsoas tightness has the greatest effect on LBP when those muscles are being worked beyond their regular daily activity level, such as with repeated arabesque exercises typical in a ballet class.

Although there is no method to separate and test the individual iliopsoas muscles, the psoas major and minor are most likely the cause for LBP in dancers. Due to their origin sites on the spine (transverse processes of T12-L5 vertebrae and bodies of T12 and L1, respectively), they would pull on the lower spine when tight, causing an anterior tilt of the pelvis, resulting in significant pain. This tension would increase with torsion of the pelvis commonly used by dancers to compensate for turn out, further increasing LBP.

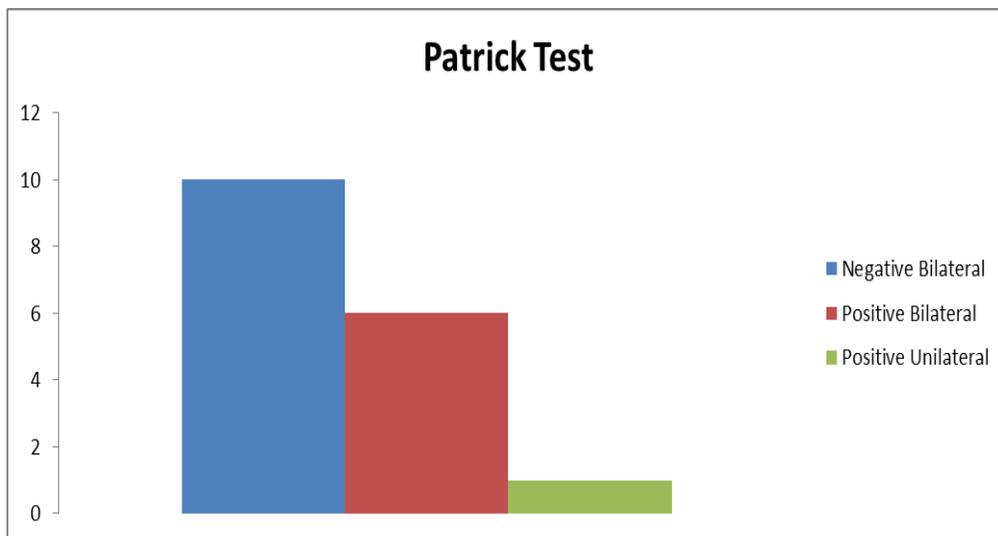


Figure 4: Patrick Test Results

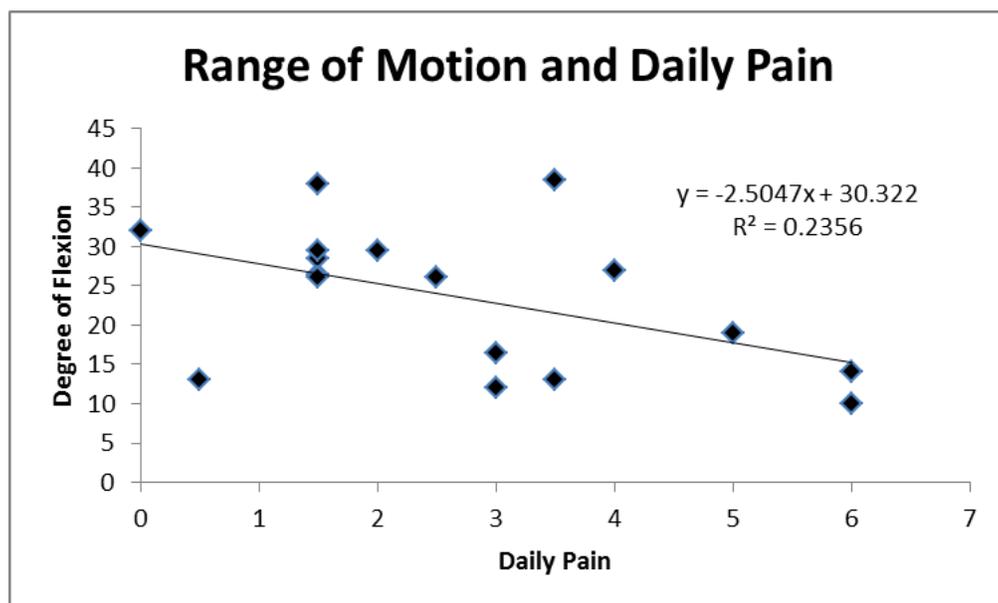


Figure 5: ROM and Daily Pain

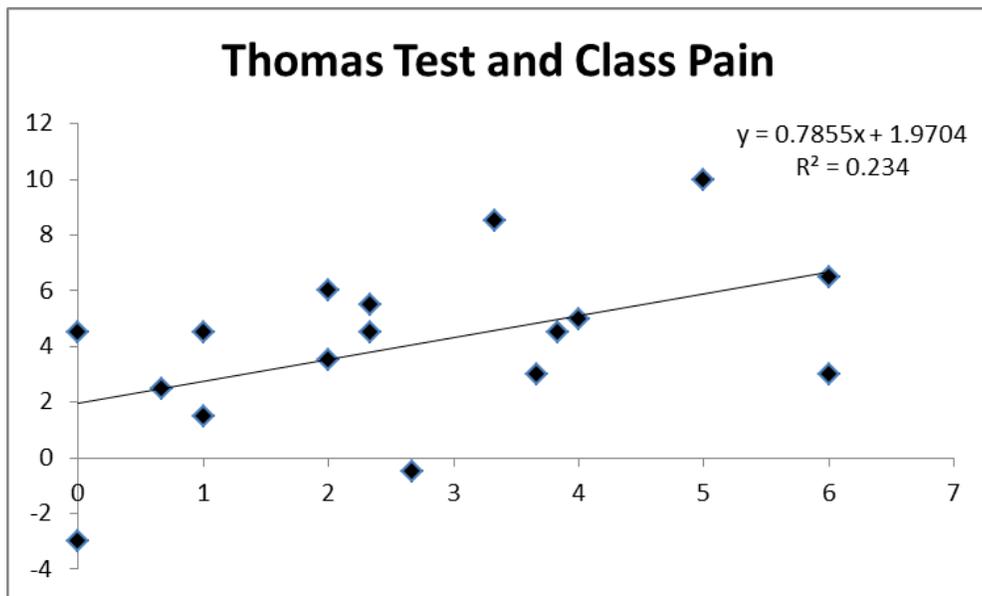


Figure 6: Thomas Test and Class Pain

Conclusion

Lower back pain is a serious issue in dancers, beginning as early as their teenage years. LBP can have various causes, but there is a definitive link between tight iliopsoas muscles and pain during dance-related activities. The best method for finding this correlation is the Thomas Test, as it measures the length of the iliopsoas indirectly. The iliopsoas connects to the lower back and upper femur, and pulls painful on each when tight. A simple solution is stretching the hip flexors with a focus on the iliopsoas group. Making the hip flexor muscles more extensible could greatly reduce the instance of LBP in dancers, and can easily be carried out by any suitable dance instructor. However, if LBP continues, it can be debilitating to the dancer and potentially become career-ending.

Citations

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