Doctor of Physical Therapy Research Papers | Physical Therapy

4-2016

The Effect of Hip and Hamstring Pathology on Sacroiliac Joint Dysfunction: A Case Series

Sarah DuPlissis
St. Catherine University

Rachel Hedden
St. Catherine University

Nicholas Manning
St. Catherine University

Josh Patterson
St. Catherine University

Luke Wahlstrom
St. Catherine University

Recommended Citation

DuPlissis, Sarah; Hedden, Rachel; Manning, Nicholas; Patterson, Josh; and Wahlstrom, Luke. (2016). The Effect of Hip and Hamstring Pathology on Sacroiliac Joint Dysfunction: A Case Series. Retrieved from Sophia, the St. Catherine University repository website: https://sophia.stkate.edu/dpt_papers/52

The Effect of Hip and Hamstring Pathology on Sacroiliac Joint Dysfunction: A Case Series

by
Sarah DuPlissis
Rachel Hedden
Nicholas Manning
Josh Patterson
Luke Wahlstrom

Doctor of Physical Therapy Program
St. Catherine University

December 17th, 2015
Research Advisor: Associate Professor Paul E. Niemuth, PT, DSc, OCS, ATR

ABSTRACT

Background and Purpose

The purpose of this study was to determine if there was a relationship between hamstring and/or hip mobility and/or weakness that affects SI joint dysfunction (SIJD).

Due to anatomical proximity, the hamstring muscle could potentially be involved in SIJD because of the muscle's attachment site on the pelvis. In addition, problems that occur within the hip joint are in near proximity to the SIJ. There is limited literature exploring these relationships of hip and hamstring abnormalities with SIJ pathology and provided an area of research to explore.

Methods

Two patients referred to a physical therapy clinic with medical diagnosis of SIJD, were analyzed and compared to the control group. Passive goniometric measurements at the hip were taken for flexion, abduction, internal rotation, and external rotation, as well as hamstring length. Strength measurements for the hip flexors, extensors, abductors, external rotators, internal rotators, and knee flexors were taken with a handheld dynamometer. Measurements were taken during the initial evaluation, so the physical therapist administering the tests was not blinded to the patients' diagnoses.

Results

When comparing the affected SIJ side to the unaffected side, a difference was found in both hip and hamstring strength side to side. No difference was found in hamstring length or hip ROM when comparing side to side.

Conclusion

There seems to be a relationship between SIJD and decreased strength in the ipsilateral hamstrings and hip musculature. However, the low number of patients in this series limits this conclusion, and future research with more patients is required to draw stronger conclusions.

The undersigned certify that they have read, and recommended approval of the research project entitled...

The Effect of Hip and Hamstring Pathology on Sacroiliac Joint Dysfunction: A Case Series

by

Sarah DuPlissis

Rachel Hedden

Nicholas Manning

Josh Patterson

Luke Wahlstrom

in partial fulfillment of the requirements for the Doctor of Physical Therapy Program

Primary Advisor Paul E [illegible] **Date** 4/25/16

Acknowledgements

Sarah DuPlissis: My fiancé, Michael Quinlan, as well as my close friends & family.
Rachel Hedden: My husband Jake Hedden, along with my family & friends.
Nicholas Manning: My wife, Ariel Manning, as well as my friends and family for their support as I have pursued my DPT, and the Lord above who made it all possible.
Josh Patterson: Thanks to my family, friends, and especially my wife, Katie, for supporting me through the hours poured into this study.
Luke Wahlstrom: I would like to thank my wife Jessica, as well as my family for their support over the past 3 years throughout the DPT program.

Collectively, we would like to thank:

- Our Primary Clinician and Partner: Jennifer Remitz, DPT, OCS
- Our Advisor: Paul Niemuth, PT, DSc, OCS, ATR
- As well as other supporting faculty members:
    - John Schmitt, PT, PhD, and David Chapman, PT, PhD

Table of Contents

Introduction

Literature Review

Low back pain (LBP) is an overwhelmingly prevalent problem affecting over 90% of adults at least one point over the course of their lifetime.[1] The literature on common causes of LBP such as disc and facet pathology are well documented. However, problems in the sacroiliac joint (SIJ) have become increasingly identified as another significant root cause for LBP in the literature. It has been reported that 15-25% of LBP is actually referred from the SIJ and not from the discs, facet, or surrounding soft tissue.[2] Recent literature has shown that SIJ pathology is extremely costly, averaging over $18,000 per patient over a five-year time period.[3] These findings suggest that more clinical research should be focused towards SIJ dysfunction (SIJD), what causes it, and how to treat it. This is important in order to provide better care for patients that present with LBP that may be referring from the SIJ, and to lessen the burden of cost on the healthcare system that patients with SIJD generate.

The hamstring muscles are attached to the pelvis in close proximity to the SIJ. Due to the close proximity, hamstring activity could affect the SIJ and its health.[4,5,6] Rotation or any change of the SIJ orientation could also cause increased tension on the hamstrings based on their insertions, acting as a pain generator for what may present as a strain. However, though intuition based on anatomical knowledge leads to both of these presumptions, to these authors' knowledge, there has been limited literature exploring the properties of the hamstrings, such as their strength or length, and their relationship with SIJD and pathology. Similarly, the hip joint is in close proximity to the SIJ, even sharing the pelvis as one of its bony structures in both joints. Like the deficiency of literature identified with the hamstring - SIJ relationship, to these authors' knowledge, there is also limited exploration in the literature of the properties of the hip joint and its relationship with SIJD and pathology. Strength, range of motion in the hip joint, as well as orientation of the acetabulum as it relates to any rotations or movement in the SIJ will be further explored in this review.

The gold standard to determine a diagnosis for SIJD is radiography.[7] However, when used in combination, non-invasive clinical tests can be nearly as effective at differentiating SIJD or SIJ pain from other types of LBP and diagnosing SIJD.[8] Clinical tests such as the hamstring length test and instruments such as a goniometer and handheld dynamometer can also be used to accurately determine ROM, and strength respectively of muscle groups.[9-13] Using a battery of clinical tests, the relationships between hamstring and hip joint properties with SIJ pathology are easily explorable in the clinic.

Hip

A study by Morgan et al. hypothesized that segmental degeneration in the spine could lead to pathologies further down the chain in the hip and SIJ, exploring the idea that someone presenting with SIJD could also have hip dysfunction or that someone with hip dysfunction could also have SIJD. Out of 30 subjects diagnosed with SIJD, 77% were found to also have a hip abnormality or dysfunction. The information found in this study encourages clinicians to consider patients with suspected SIJD for a diagnosis of hip dysfunction and vice versa.

Sacroiliac Joint

A study by Massoud et al. who hypothesized two things. First, that there is a higher proportion of gluteal weakness in those with SIJD and second, of the proportion that have gluteal weakness and SIJD, they will have decreased hamstring length. The authors found that there is an increased risk at 66% of developing SIJD when they also have LBP and gluteal weakness versus a 34% risk of developing SIJD if they only had gluteal weakness, but no LBP. Their findings showed that subjects with the combination of SIJD and gluteal weakness had decreased hamstring length versus if they just had SIJD alone. The rationale for their findings include that the gluteus maximus and the hamstrings have common attachment sites therefore a hamstring can compensate for a weak gluteal muscle. Because of the close proximity of structures and common attachment sites, decreased hamstring muscle length could theoretically lead to increased tension on the SI ligamentous structures to improve SIJ stability.

Hamstring

A study done by Herrington et al. hypothesized that hamstring length increases with an increased posterior pelvic tilt. The findings showed their hypothesis to be true, an increase in hamstring length with a posterior pelvic tilt and a decreased length with anterior pelvic tilt due to the attachment of the hamstrings to the pelvis. A posterior pelvic tilt may be indicative of tight hamstrings, placing an increased load on the lumbar spine and SIJ, which could possibly lead to pathology.

Anatomy

Sacroiliac joint dysfunction in this study is inclusive of SIJ pain and is defined as bony incongruences between the sacrum and its attachments to the bottom of the spine and to the pelvis. One of the main mechanisms of SIJD is an alteration of these normal biomechanics of the joint. Often times these biomechanical abnormalities are due to a lack of form closure. Form closure is defined as how the joint's structure, orientation, and shape contribute to stability and potential mobility. When poor bony contact exists between the surfaces of the innominate bone of the pelvis and the sacrum, the force applied by the muscles around the SIJ become important players to increase the level of form closure. It has been shown that the strength of sacroiliac form closure can double with activation of the erector spinae, gluteus maximus and biceps femoris.[16] Therefore, having proper muscle activation and muscle strength is a protective quality of the SIJ.

Along with muscular stabilization, the SIJ is also stabilized by bony contact and ligamentous support. The SIJ is comprised of the sacrum and its contact bilaterally with the ilium portions of the innominate bones. This bony contact is stabilized by four primary ligaments that stabilize the SIJ: the iliolumbar, which causes the SIJ to side bend along with the lumbar spine; the sacrotuberous which prevents excess anterior tilt of the sacrum on the innominate bones; the sacrospinous which limits general sacral tilt; and the dorsal sacroiliac which limits posterior sacral tilt.[17]

The importance of shared musculature between the hip and the femur rises from the formation of the joint at the acetabulum. There are muscles that attach to both, with examples being the gluteus medius and maximus. The piriformis muscle, attached to the sacrum, crosses the ilium and attaches to the greater trochanter of the femur, acting on both the hip joint and the SIJ. It is important to note that the relationships between the SI ligaments, hip musculature, hip ligaments, pelvic acetabulum, and the femur can all cause dysfunction at any level, leading to chain effects at different joints. Recognizing the close proximity of the hip joint to the lumbopelvic region, hip function could also be a contributor to LBP or SIJD and should be examined in clinical evaluations.

As described above, the SIJ connects the sacrum with the pelvis, also known as the hip or innominate bones. The hip is one of the body’s largest weight bearing joints, second to the knee, and is made of three parts: the ilium, the ischium and the pubis. The sacrum articulates with the ilium, the rami of the pubis articulates with the opposite side innominate bone, and the three parts together form the acetabulum, which is a concave formation fused in adults. The acetabulum then articulates with the convex femoral head forming a synovial ball and socket joint.[18] The orientation of the acetabulum is thus dependent on the orientation of the bones that it articulates with, as well as the positioning of the SIJ. If dysfunction is present in the SIJ it can then lead to hip dysfunction and impingement in the acetabulum.

The ilium is the most superior part of the innominate bone, extending away from the acetabulum, and is the attachment site for posterior musculature such as the iliocostalis, longissimus, spinalis, iliacus, and gluteus maximus, all of which also connect to the pelvic bones.[18] The ischium is the most inferior part, extending downward from the acetabulum as well as coming anterior to fuse with the pubis; it is the attachment site for the hip rotator muscles. For lateral rotation these include gluteus minimus, obturator externus, obturator internus, piriformis, superior gemellus, inferior gemellus, and quadratus femoris. For medial rotation these include the extensor fascia latae, gluteus medius, and gluteus minimus. The pubis is the most anterior part of the pelvic bone structure, forming the front of the pelvis with its opposite side, and functioning as an attachment site for abdominal wall musculature. The acetabulum itself is oriented inferiorly, laterally, and anteriorly. Again, the importance of shared musculature between the hip and the femur rises from the formation of the joint at the acetabulum. The muscles that attach to both include iliacus, rectus femoris, sartorius, tensor fascia latae, and gluteus medius/maximus. Finally, the piriformis muscle, attached to the sacrum, crosses the ilium and attaches to the greater trochanter of the femur, acting on both the hip joint and the SIJ. While weak posterior musculature is thought to be a contributor to SIJD, currently there is a limited research of the consequences of weak surrounding musculature.

The musculature and their attachment sites allow for movement around the transverse axis (flexion and extension), the longitudinal axis (lateral/external and medial/internal rotation), and the sagittal axis (abduction and adduction).[18] The norms of these movements are as follows: 120° of flexion, 20° of extension, and 45° of internal rotation, external rotation, and abduction, and 30° of adduction.[18]

Due to the muscle attachments, as well as ligamentous structures and the joint capsule, the hip joint lacks some mobility in order to provide stability during weight-bearing and movement, but does maintain enough mobility for both static and dynamic movements.[19] The key extracapsular ligaments of the hip joint include the iliofemoral which limits hip hyper-extension, the pubofemoral which blends into the capsule and iliofemoral and limits hyper-extension, over-abduction, and external rotation, and the ischiofemoral which blends into the posterior joint capsule and limits hyper-extension and medial rotation. The intracapsular ligament is the ligamentum teres, which attaches directly from the acetabulum to the femoral head. Its function is to prevent dissociation of the two parts, as well as to provide minor blood supply. The capsule, made of longitudinal and circular fibers, further prevents dissociation, attaching to the femur and innominate bones outside of the acetabulum and then projecting into the capsular space. The longitudinal fibers of the capsule carry blood vessels to vascularize the joint.

There are also five main SI ligamentous structures whose purpose is to stabilize the SIJ.[20,21] The first is the anterior sacroiliac ligament, which is the thinnest of the ligaments and is often injured and a common pain generator. The second is the posterior/dorsal sacroiliac ligament, which connects the PSIS to the lateral crest of the sacrum. This ligament is put on slack with nutation, and tightens with counternutation. The third is the interosseous sacroiliac ligament, which forms a connection between the sacrum and the innominate, resisting anterior and inferior movement of the sacrum. The fourth is the sacrotuberous ligament, which blends into the posterior ligament and stabilizes against nutation, resisting posterior and superior movement of the sacrum on the innominates during weight bearing. The fifth and final ligament is the sacrospinous, which runs from the ischial spine to the lateral parts of the sacrum and coccyx and works in conjunction with the sacrotuberous to resist anterior tilting of the sacrum on the innominates during weight bearing. It is important to note that the relationships between the SI ligaments, hip musculature, hip ligaments, pelvic acetabulum, and the femur can all cause dysfunction at any level, leading to chain effects at different joints.

The major nerve associated with the posterior thigh is the sciatic nerve.[19] The sciatic nerve is made up of L4, L5, S1, S2, S3 nerves, whose branches innervate the hamstring muscles among others. Nerve disruption/irritation at the sacrum can compromise nerve conduction further down the chain at the hamstring muscles, which may cause muscle tightness and weakness.

Purpose

The purpose of this case series is to explore the relationships between hamstring strength and length, and hip ROM and strength in patients diagnosed with SIJ dysfunction. The hypothesis is that there will be a relationship between the symptomatic SIJ and findings of the ipsilateral hip and hamstring.

Methods

Patients and Controls

Patients with an existing referral for SI joint problems who were being seen for physical therapy at the University of MN Orthopedics Therapy Center were recruited for involvement in this study. Patients were required to be 18-50 years old and clinically diagnosed with SI pathology, as determined by existing SI diagnosis on patient chart. Patients were excluded if they were either cognitively impaired or pregnant at the time of the exam due to some of the positions required for the study. This resulted in a clinical population of two patients for analysis over the sampling period.

Patient 1, a 38 year old female, was referred from her doctor to physical therapy for treatment for right sided SIJD. She reported her pain at 6/10 in her right buttocks that got progressively worse throughout the day, and was 4/10 at best. The onset of pain coincided with the delivery of her fourth child and was getting progressively worse over the last 3 months, particularly with any lifting and bending. Running and repeated trunk flexion improved her symptoms. For activity, the patient ran 3-5 miles, five times per week and was a stay at home mom with her four children. There was no other remarkable past medical history.

Patient 2, a 26 year old female, was referred from her doctor with orders to evaluate and treat for possible low back pain and right sided SIJD. Employed by a local college as a graduate assistant, she is also working as a weight-training instructor. The patient at this time is training to be an Olympic lifter; she was weight lifting five times per week. While, the patient's mechanism of injury is unknown, she believed it to be related to either: 1) her recently increased volume of weight training and possible overtraining, or 2) a resent cross country drive in a car, resulting in difficulty sitting secondary to pain during the trip. The patient rated the intensity of her pain as 4/10 to 6/10, and described the pain as a tightness in her right side and low back that was occasionally sharp and shooting. The patient had a history of a right ACL reconstruction in 2013, but otherwise her past medical history was unremarkable.

Gender matched control subjects were taken from the student physical therapists conducting the research for additional analysis and comparison. These two individuals fell within the inclusion and exclusion criteria of the patient population besides the diagnosis of SIJD. The mean age of the control group was 24.

Instrumentation

A padded plinth and manual stabilization by the therapist were utilized for all tests. A standard clinical goniometer, shown to be reliable and valid in measuring hip and knee motions was used for all range of motion measurements.[22,23] In measuring strength of the musculature around the hip and knee a Nicholas Hand-Held Dynamometer was used, and along with other hand-held dynamometry has been shown to be a valid and reliable form of measurement for muscle strength.[13,24,25,26]

Procedure

Each of the patients and controls underwent the same measurement procedures for consistent measurement. First, all subjects were subjected to the special provocation tests:

FABER, FADIR, and Scour's to clear potential hip pathologies that may skew the impact of SIJD pain (Appendix, I).

All subjects then underwent goniometric measurements at the hip for flexion, abduction, internal rotation, external rotation, and at the knee for hamstring length (Appendix, II). These were all taken in the standardized positions as described by Norkin and White, excluding hamstring length which was measured in accordance with recent literature.[15] Only one trial was performed for all goniometry.

Additionally, subjects had strength measurements taken with a Nicholas Handheld dynamometer for hip extension, abduction, and hamstring strength with knee flexion (Appendix, III). Strength measurements were performed in standard positions as described by Reese and using a "make test". This "make test" is common in handheld dynamometry with a resistive force of a therapist against a patient initiated movement rather than the therapist initiated resistive force in a "break test" common in manual muscle testing. Subjects were allowed a warm-up trial and then two measurements were taken, the higher of the two being used in data analysis.

For the comfort of the patients, all tests were done in one position before moving on to the next starting in sitting, to supine, to side lying on each side, to prone. In all testing the unaffected side of the patients was tested first. All measurements were taken by experienced physical therapist clinicians with a minimum of 8 years of experience in the orthopedic field at the initial evaluation of the clinical patients, the clinician was not blinded to the diagnoses of the patients.

Hip Pathology Clearing Provocation Tests

FABER [28]

The Flexion, ABduction, and External Rotation (FABER) test is a test that screens for intra-articular hip pathologies including possible diagnoses of hip osteoarthritis, labral tears, femoroacetabular impingement (FAI), and avascular necrosis (AVN). For this test to be done the patient was put in supine on the plinth with the clinician passively bringing the tested hip into flexion, abduction, and external rotation so that the foot rests on top of the opposite leg which is still flat on the plinth. The clinician the applied overpressure on the distal femur of the bent lower extremity with their caudal hand while the cranial hand stabilized the opposite ASIS with their hypothenar mass. A positive sign is determined by a lack of motion in the tested leg becoming parallel with the ground, or a reproduction of the patient's painful symptoms over a muscle stretching pain that may also occur. Also referred to as Patrick’s test or figure four test.

FADIR [29]

The Flexion, ADduction, and Internal Rotation (FADIR) test screens a patient for anterior-superior impingement syndrome of the hip, anterior labral tears, and iliopsoas tendonitis. The patient was put in supine with the tested lower extremity put into full flexion, lateral rotation, and full abduction for a starting position. The clinician then brings the hip into extension with a combination of medial rotation and adduction motions. A positive test is a provocation of the patient's’ painful symptoms with or without a click that may also occur throughout the motion.

SCOUR TEST [29]

The scour test is a test that screens for non-specific hip pathology like FAI and labral tears. For this test the patient was supine on the plinth with the clinician passively flexing and adducting the hip. Then the clinician applied a compressive force at the knee resulting in an axial load through the long axis of the femur, now pushing into the head of the femur into the acetabulum. With this force the hip is then passively moved through an arc of motion of flexion and abduction. A positive test was indicated with any resistance through the arc of motion, asymmetry side to side, or a provocation of the patient's painful symptoms.

Goniometry

HIP ABDUCTION [11]

In supine, hip abduction range of motion was measured with the axis of the goniometer on the same side ASIS. The moving arm followed parallel along the femur while the stationary arm was fixated along a line between the patient's two ASIS. In all patients' there was a soft end feel to determine when the motion was accurately measured as the line between the two ASIS that the stationary arm was in line with.

HIP FLEXION [11]

In supine, for the hip flexion measurement the therapist passively brought the hip into flexion with a force upon the knee and allowed the knee to flex in a relaxed state, to negate hamstring tightness from impacting the measurement. The stationary arm remained parallel with the shaft of the tibia, the stationary arm remained parallel with the midline of the trunk, and the axis rotated around laterally of the greater trochanter obtaining a final range with a soft end feel.

HAMSTRING LENGTH [9,10,15]

Hamstring length was measured in supine in the 90/90 position, as opposed to the traditional straight leg raise (SLR) hamstring length test. This was done to counter the proposed posterior hip rotation that can arise from the SLR. When compared to the SLR, the 90/90 position is not shown to be statistically different from the SLR in hamstring length and has excellent test-retest reliability. The patient was brought to 90 degrees of hip flexion and knee flexion passively. As the therapist extended the knee, the stationary arm followed parallel with the shaft of the tibia while the stationary arm remained parallel to the shaft of the femur around the axis of the lateral epicondyle of the femur. The measurement was obtained by marking the degree the patient was away from 180 degrees at a soft end feel.

HIP INTERNAL/ EXTERNAL ROTATION [11]

Once in sitting both hip internal and external rotation were measured. For both, a towel was placed under the knee for stabilization and a pressure was placed on the distal tibia into either external or internal rotation of the hip until a soft end feel was reached. With the hip flexed to 90 degrees the moving arm remained parallel to the tibia as it rotated at the midpoint of the patella while the stationary arm was fixed to be perpendicular to the ground.

Strength Testing

HIP FLEXION [27]

Hip flexion was measured in sitting. Patients were allowed to stabilize themselves in sitting with their arms and as the dynamometer was placed on the distal femur the patients were instructed to push up against the therapist.

HIP EXTENSION [27]

Hip extension was measured in prone. A stabilization force by the therapist was placed upon the lumbar spine as the patient was instructed to lift, with a straight leg, against the therapist that had placed a hand held dynamometer on the distal portion of the femur.

HAMSTRING STRENGTH [27]

Hamstring Strength was also measured in prone. A stabilization force was applied to just below the ischial tuberosity and the patients were asked to flex their knee against the therapist holding a handheld dynamometer at the distal tibia.

Statistical Analysis

The program SPSS, developed by IBM, was used as a means to analyze the data. Paired t-tests were run to assess for any difference in strength or range of motion when comparing the affected leg to the unaffected leg within a singular group. To assess for any difference between groups, a 2-sample t-test was used. These statistics were run knowing that in reality, the sample size of this study is too small to demonstrate important findings. However, the data is presented in this pilot study as a template for future research to follow.

Results

Two females, aged 38 and 26 years respectively, participated in the study. Their objective findings are outlined in Tables 1 and 2. Both patients reported their painful side to be on the right, now referred to as the affected side. The affected side also happened to be the patient's weaker side in both cases. In the special test component of the exam, Patient 1 had positive FADIR and Scour tests on her unaffected side. In Patient 2, FADIR and Scour tests were positive bilaterally.

A statistically significant difference was found when comparing the patient's hamstring strength on their affected leg to the hamstring strength on their unaffected leg, with the affected hamstring being the weaker of the two in both cases (p= .042, Figure 1). In the control group, hamstring strength compared side to side, had a similar trend but was not found to be significant (p= .058).

As with the hamstring data, the patients' hip abduction strength was stronger on their unaffected side than their affected side, however it was not by a significant amount (p= .079, Figure 2). In the control group, the average difference side to side yielded was also not significant (p= .259).

In conclusion, other than hamstring strength, there was no significant difference found in either range of motion or strength between affected and unaffected legs in the patients. And when looking for side to side differences in the control group, no significant differences were found in either strength or range of motion (Table 3).

All values between patients and controls were also compared directly. These comparisons resulted in no significant differences in any of the raw ROM and strength values, establishing that our controls and patients were similar in ROM and strength at baseline (Tables 4 & 5).

Looking specifically at side to side differences in hamstring length in patients compared to controls suggested no significant difference (p= .106, Figure 3). However, there is a trend toward a difference between the patients and controls in average difference side to side in hip abduction strength (p=0.051, Figure 4).

Discussion

The main finding of this study was a significant difference in strength found between the affected and unaffected hamstrings in the small sample size of two patients, with the affected side being the weaker of the two. There was a near significant difference noted for hamstring strength compared right to left in the control group, indicating that a difference in hamstring strength side to side may be a relatively normal finding. Hip abduction strength in the patient group had a near significant difference when comparing affected side to unaffected side, with the affected side being the weaker of the two. The difference between affected and unaffected side hip abduction strength appeared to be greater in the patients compared to the controls, as evidenced by a 2-sample t-test run between the two groups (Figure 2**)**. This resulted in a near statistically significant difference of .051. All other values showed no statistically significant difference when comparing range of motion or strength values from the affected side to the unaffected side within groups or between groups. At this time, this indicates that a difference between the values of the patients compared to the controls could be just due to chance.

Morgan et al. found that 77% of SIJD patients had a hip abnormality when looking at FAI special tests, strength and length differences. The results of this study had positive FAI findings for the FADIR and Scour in Patient 1 on the unaffected side and Patient 2 bilaterally. There were also positive findings for hamstring strength differences in both patients with SIJ pain. Again, though the sample size was not large enough to draw any statistical significance from these findings, it is noted that there are similar trends in associations between hip pathology and SIJD.

In 2011, Massoud et al. found decreased hamstring length on the affected side of patients with SIJD with the presence of ipsilateral weak gluteal muscles; in the study it was a small statistically significant difference. The findings were based on the anatomical theory that the hamstring shortens to stabilize the SIJ, in compensation for weak gluteal musculature, based on their shared muscular attachment sites of the ischial tuberosity and sacrotuberous ligament. Research is unable to show causation between gluteal weakness and SIJD, however Massoud et al. found a higher presence of gluteal weakness in those with SIJD than those without. The results of this current study were negative findings in hamstring length change from affected side to unaffected side in the patient population. However, there was a similarity, showing a trend in hip abduction/ gluteal muscle strength difference comparing affected to unaffected side, both patients stronger on the unaffected side.

Limitations

The main limitation of this study was diminished sampling time. This was affected by the unforeseen time involved in the process of filing multiple IRBs in order to work within the specific outpatient clinical setting, as well as limited availability of the primary clinician during the time the study took place. Both of those factors contributed to the low sample size. The sample size was also affected by changes in referral patterns from physicians; Patient 2's referring medical diagnosis included LBP along with possible SIJD. The researchers of this study also excluded those who were pregnant at the time of examination due to some of the positions required in the examination, further decreasing the available clinical population.

Finally, there were not strong diagnostic findings of SIJD in either patient in this study. Both patients were negative for the full battery of SI tests described in the methods. However, by the leading therapist's clinical reasoning and the use of SI pain as an inclusion factor, the patients maintained clinical diagnoses of SIJD.

Power Analysis

A power rating of 80% is the standard adequacy to reject a null hypothesis when it is false.[30] Due to the small sample size of the current study, all findings hold limited power as to what trends shown or generalizability in clinic. According to a power analysis run for this study, a sample size of 40 patients would give 84% power, and the ability to confidently reject the null hypothesis if indicated by the results.

Conclusion

While significant differences were noted intra-subjectively between hamstring strength and hip abduction strength, they were not found to be significant inter-subjectively when compared to a control group. Due to insufficient power from the population tested these findings cannot be generalized in the clinical setting. Therefore the researchers of this study present these findings as a pilot study for further investigation with a greater sample population.

References

1. Weksler N, Velan GJ, Semionov M, et al. The role of sacroiliac joint dysfunction in the genesis of low back pain: the obvious is not always right. Arch Orthop Trauma Surg. 2007;127(10):885-8.
2. Sembrano JN, Polly DW Jr: How often is low back pain not coming from the back? Spine (Phila Pa 1976) 34:E27–E32, 2009.
3. Ackerman SJ, Polly DW, Knight T, Holt T, Cummings J. Nonoperative care to manage sacroiliac joint disruption and degenerative sacroiliitis: high costs and medical resource utilization in the United States Medicare population. J Neurosurg Spine. 2014;20(4):354-63.
4. Cibulka MT, Rose SJ, Delitto A, Sinacore DR. Hamstring muscle strain treated by mobilizing the sacroiliac joint. PhysTher. 1986;66:1220–3.
5. Liebenson C. The relationship of the sacroiliac joint, stabilization musculature, and lumbo-pelvic instability. Journal of Bodywork and Movement Therapies. 2004; 8(1): 43-45.
6. Hossain M, Nokes L. A biomechanical model of SI joint dysfunction as a cause of low back pain. J Bone Jt Surg. 2008;90B(Suppl. 2):222–223.
7. Morgan PM, Anderson AW, Swiontkowski MF. Symptomatic sacroiliac joint disease and radiographic evidence of femoroacetabular impingement. Hip Int. 2013;23(2):212-7.
8. Laslett M, Aprill CN, Mcdonald B, Young SB. Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. Man Ther. 2005;10(3):207-18.
9. Worrel TW, Perrin DH, Gansneder BM, Gieck JH. Comparison of isokinetic strength and flexibility measures between hamstring injured and noninjured athletes. *JOSPT* 1991;13(3):118-125.
10. Gajdosik RL, Rieck MA, Sullivan DK, Wightman SE. Comparison of four clinical tests for assessing hamstring muscle length. *JOSPT* 1993; 18(5): 614-618.
11. Norkin CC, White DJ. Measurement of Joint Motion, A Guide to Goniometry. F.A. Davis; 2009.
12. Halbertsma JP, Göeken LN, Hof AL, Groothoff JW, Eisma WH. Extensibility and stiffness of the hamstrings in patients with nonspecific low back pain. Arch Phys Med Rehabil. 2001;82(2):232-8.
13. Whiteley R, Jacobsen P, Prior S, Skazalski C, Otten R, Johnson A. Correlation of isokinetic and novel hand-held dynamometry measures of knee flexion and extension strength testing. J Sci Med Sport. 2012;15(5):444-50.
14. Massoud Arab A, Reza Nourbakhsh M, Mohammadifar A. The relationship between hamstring length and gluteal muscle strength in individuals with sacroiliac joint dysfunction. J Man Manip Ther. 2011;19(1):5-10.
15. Herrington L. The effect of pelvic position on popliteal angle achieved during 90:90 hamstring-length test. J Sport Rehabil. 2013;22(4):254-6.

16. van Wingerden JP, Vleeming A, Buyruk HM, Raissadat K. Stabilization of the sacroiliac joint in vivo: verification of muscular contribution to force closure of the pelvis. Eur Spine J. 2004;13(3):199-205.
17. Bjornaraa J. Sacroiliac [PowerPoint]. Minneapolis, MN: St Catherine University DPT Program; 2014.
18. Neumann DA. Kinesiology of the Musculoskeletal System, Foundations for Physical Rehabilitation. Mosby Incorporated; 2002.
19. Agur AM, Dalley AF, Grant JC. Grant's Atlas of Anatomy. Lippincott Williams & Wilkins; 2013.
20. Levangie PK, Norkin CC. Joint Structure and Function, A Comprehensive Analysis. F A Davis Company; 2005.
21. Dutton M. Orthopaedic Examination, Evaluation, and Intervention. 2nd ed. New York: McGraw Hill, 2008.
22. Gogia PP, Braatz JH, Rose SJ, Norton BJ. Reliability and validity of goniometric measurements at the knee. *Phys Ther* 1987; 67(2): 192-195.
23. Nussbaumer S, Leunig M, Glatthorn JF, Stauffacher S, Gerber H, Maffiuletti NA. Validity and test-retest reliability of manual goniometers measuring passive hip range of motion in femoroacetabular impingement patients. *BMC Musculoskeletal Disorders* 2010;11:194.
24. Trudelle-Jackson E, Jackson AW, Frankowski CM, Long KM, Meske NB. Interdevice reliability and validity assessments of the Nicholas hand-held dynamometer. *J ortho Sports Phys Ther* 1994;20(6):302-306.
25. Stark T, Walker B, Phillips JK, Fejer R, Beck R. Hand-held dynamometry correlation with the gold standard isokinetic dynamometry: a systematic review. PM R. 2011;3(5):472-9.
26. Pua YH, Wrigley TV, Wrigley TW, Cowan SM, Bennell KL. Intrarater test-retest reliability of hip range of motion and hip muscle strength measurements in persons with hip osteoarthritis. Arch Phys Med Rehabil. 2008;89(6):1146-54.
27. Reese NB. Muscle and Sensory Testing. Saunders; 2011.
28. Maslowski E, Sullivan W, Forster harwood J, et al. The diagnostic validity of hip provocation maneuvers to detect intra-articular hip pathology. PM R. 2010;2(3):174-81.
29. Reiman, M. P., Goode, A. P., Hegedus, E. J., Cook, C. E., & Wright, A. A. Diagnostic accuracy of clinical tests of the hip: a systematic review with meta-analysis. *British Journal of Sports Medicine.* 2012;3-11.
30. Portney LG, Watkins MP. Foundations of Clinical Research, Applications to Practice. Prentice Hall; 2009.

Tables

Table 1: Patient 1 Objective Findings.

Strength (lbs)			**Range of Motion (degrees)**		
	Unaffected	Affected		Unaffected	Affected
Hip Extension	49	37	Hip Flexion	122	127
Hip Abd	48	41	Hip Abd	40	44
Hamstring	34	21	Hamstring	-10	-12
			IR	52	42
			ER	50	44

* Patient tested positive for FADIR and Scour on unaffected side

Table 2: Patient 2 Objective Findings.

Strength (lbs)			**Range of Motion (degrees)**		
	Unaffected	Affected		Unaffected	Affected
Hip Extension	55	54	Hip Flexion	123	118
Hip Abd	55	46	Hip Abd	71	65
Hamstring	58	50	Hamstring	-20	-24
			IR	47	48
			ER	33	29

* Patient tested positive for FADIR and Scour on both sides

Table 3: Intra-group comparison statistics via paired t-tests.

Patient Non-Significant Findings (side to side comparison)		Control Non-Significant Findings (side to side comparison)	
Range of Motion		Range of Motion	
Hip Flexion	1.0	Hip Flexion	.742
Hip Abduction	.874	Hip Abduction	.258
Hip IR	.563	Hip IR	**
Hip ER	.126	Hip ER	.500
Hamstring Length	.205	Hamstring Length	.500
Strength		Strength	
Hip Extension	.447	Hip Extension	**

** Not Tested.

Tables 4 & 5: Direct inter-group comparison statistics via 2 sample t-tests.

Table 4: Patient Group vs Control Group

Range of Motion	
Hip Flexion	.500
Hip IR	.437
Hip ER	.625
Hip Abd	.504
Hamstring Length	.504
Strength	
Hip Extension	.639

Table 5: Patient Group vs Control Group

ROM Comparison		Strength Comparison	
Left Hamstring	.264	Left Hamstring	.314
Right Hamstring	.330	Right Hamstring	1.00
Left Hip Abduction	.830	Left Hip Abduction	.111
Right Hip Abduction	.726	Right Hip Abduction	.500
Left Hip Flexion	.444	**	
Right Hip Flexion	.249	**	
Left Hip IR	.126	**	
Right Hip IR	.795	**	
Left Hip ER	.930	**	
Right Hip ER	.500	**	
**		Left Hip Extension	.222
**		Right Hip Extension	.900

** Not Tested.

Figures

Figure 1: Hamstring Strength. Paired t-test analysis of patients (p=.042) and controls (p=.058).

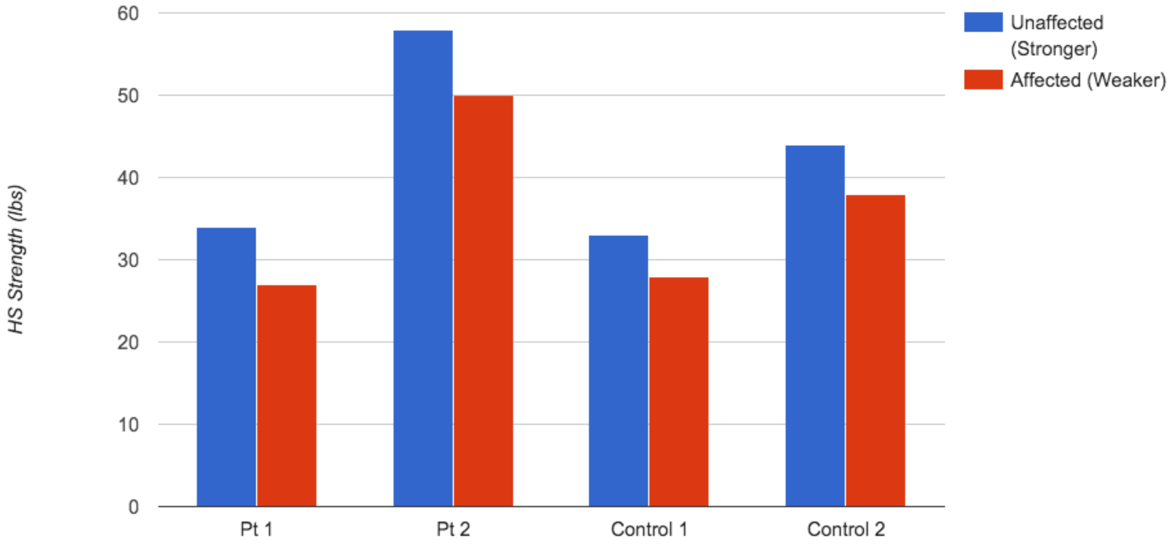


Figure 2: Abduction Strength. Paired t-test analysis of patients (p= .079) and controls (p= .259).

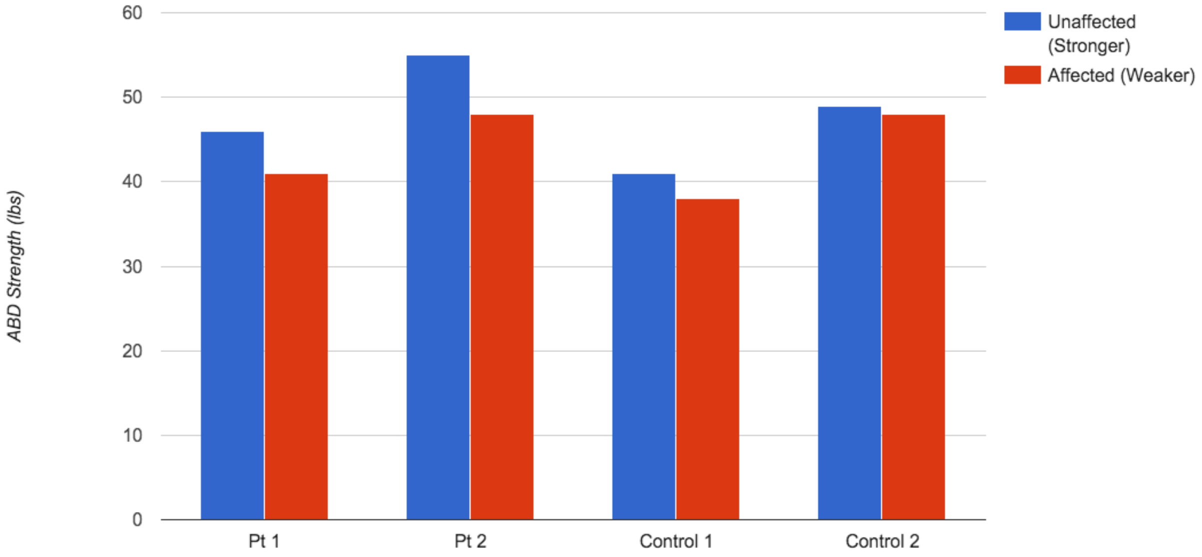


Figure 3: Average Difference Side to Side in Hamstring Strength (p=.106). Direct comparison between patients and controls via 2 sample t-test.

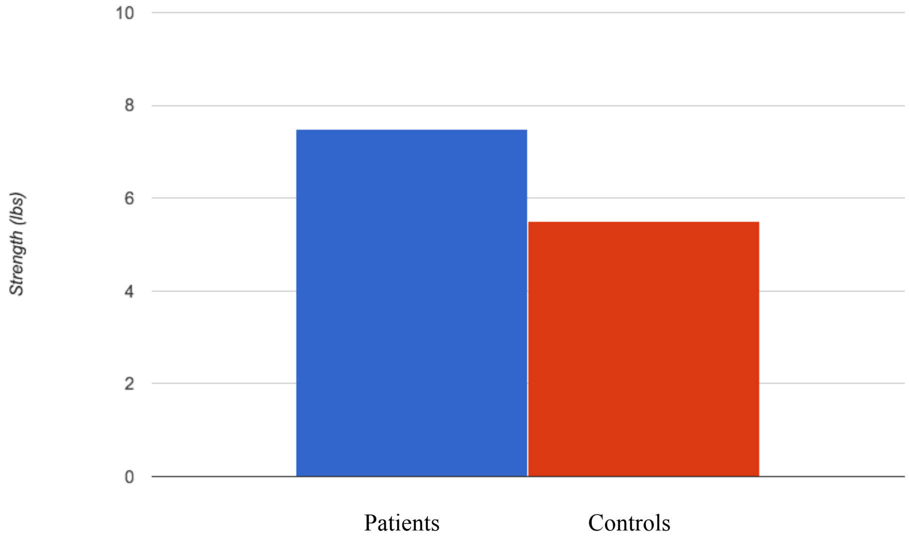
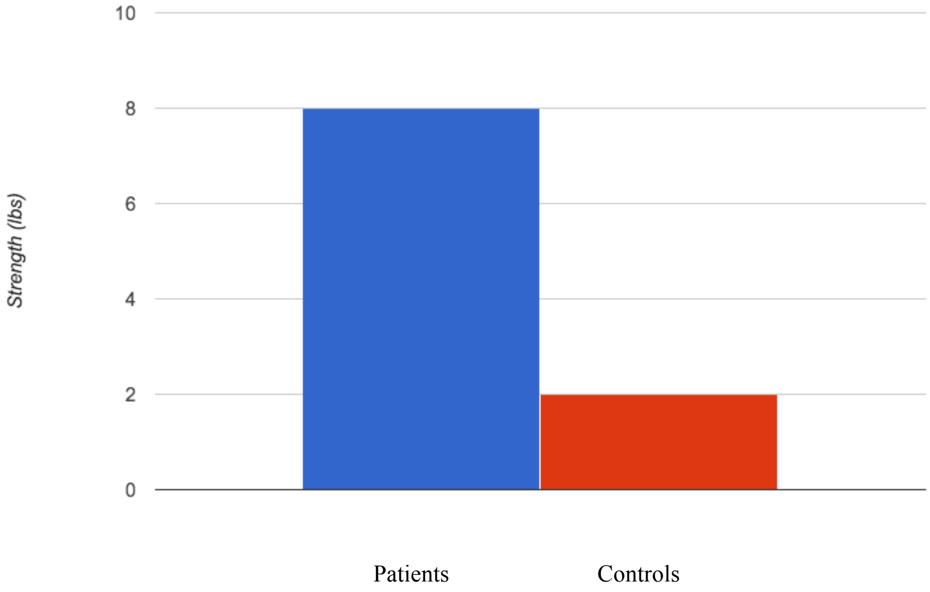


Figure 4: Average Difference Side to Side in Hip Abduction Strength (p=.051). Direct comparison between patients and controls via 2 sample t-test.



Appendix

I. Supine Hip Pathology Provocation Tests


FABER


FADIR


Scour's

II. Range of Motion with Goniometry


Hip Flexion, supine


Hamstring Length, supine


Hip IR/ER, supine

III. Strength Measurements with Hand Held Dynamometer


Hip Extension, prone


Knee Flexion, prone


Hip Abduction, sidelying