A SEMG study of Gluteus Medius and Maximus Mediated Sacroiliac(SI) Pain
A Pilot Study

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Abstract

Sacroiliac dysfunction is a common problem presenting to chiropractic offices. It is estimated to be the cause of approximately 15% of low back pain in patients presenting for treatment. (1,2) Gluteus maximus and gluteus medius are also possible contributors to problems that occur at the sacroiliac joint, especially in relation to shear of the pelvis, widely mediated by gluteus maximus. (1,2) According to Lehman, et al, (3) the dysfunctional firing of gluteus maximus during hip extension is a likely cause of low back pain, seemingly from the altered action on the sacroiliac joint during motion. In this pilot study, a core muscle activation, bridge and hip pointer test were used to isolate the gluteal musculature in order to measure the activation patterns of the gluteus maximus and medius in subjects with sacroiliac pain and subjects without sacroiliac pain. The muscle activation was measured bilaterally and simultaneously using a surface electromyogram. In conclusion, the hip pointer exercise cannot be used as a reliable indicator of sacroiliac (SI) dysfunction due the large amount of variables associated with the test. Further testing could be done with a chronic SI Pain population and with possible needle electromyogram (EMG).

Introduction

Sacroiliac dysfunction is widely accepted as a contributory factor in the presence of low back pain. (1,2) However, the specific modes on how the SI joint becomes altered are in question. There are many causes of pain in the SI joint distribution. Some of these include: Ankylosing spondylitis; herniated lumbar disc; muscle strains; inflammatory bowel disease; sickle cell; reiter’s; sacroiliitis; DISH; malignancies; fibromyalgia; osteoporosis; pituitary disease; and abdominal aortic aneurysm. (1) Since the differential list is so long, much effort is required to render a proper diagnosis. Gluteus maximus and gluteus medius are also possible contributors to problems that occur at the sacroiliac joint, especially in relation to shear of the pelvis, widely mediated by gluteus maximus. (1,2) It is inferred that any change in the firing of a muscle group would change the biomechanics of motion enough to cause pain in adjacent structures. According to Lehman, et al, (3) the dysfunctional firing of gluteus maximus during hip extension is a likely cause of low back pain, seemingly from the altered action on the sacroiliac joint during motion.

The isolation of the gluteal muscles must be obtained in order to test the validity of the bridge and point exercise as an indicator for SI dysfunction. Surface electromyogram (SEMG) will be used in this study to isolate and determine if and when the gluteus medius and maximus muscles are used in the hip pointer test. The hip pointer test consists of three sequential steps, the first of which is core muscle activation which
involves squeezing the belly button in towards the spine and contracting the pelvic floor muscles. The next step in the hip pointer test consists of a gluteus maximus pelvic bridge, which from a supine position with knees bent at ninety degrees and shoulder width apart, the pelvis is lifted to where the thighs and the spine are parallel. The final step in the hip pointer test is performed from the bridge position and hip extension is actively forced on one side. SEMG is the correct tool for this study because it measures the electrical currents generated by muscle fibers on the surface of the skin before and during a forceful contraction (4,5). SEMG was chosen over needle EMG due to its non-invasive nature and the minimal risk it poses to the subjects (6). SEMG is becoming more of a clinical tool and is currently being used in chiropractic practice to monitor changes in muscle contractility before and after an adjustment (7). In this study, SEMG will be used to help us determine if the subjects have decreased gluteal muscle contractility on one side versus the other in subjects with and without SI pain. The contractility values of each muscle will then be analyzed with the subjects’ SI pain pattern presentation which will be compared using chapters 7 and 8 in Travell and Simons Myofascial Pain and Dysfunction Vol. 2 to determine which gluteal muscle may be causing their SI pain (8). The protocol to be used in this study is outlined in Appendix B and illustrates the electrode contact points to be used. By using the points and the clinical muscle test recommended by SENIAM (9), this will ensure that the readings collected during the hip pointer test will be accurate and specific to the gluteus medius and maximus muscles.

If gluteal musculature is determined to be the cause of SI dysfunction, then a rehabilitation strategy for these muscles could be employed to treat the sacroiliac joint effectively. After the joint is stabilized, manual therapy should be administered in conjunction with strengthening and/or stretching of the gluteus maximus and medius to prevent a later exacerbation of the problem. (1,2)

**Literature Review**

The sacroiliac (SI) joints are some of the most important yet poorly understand joints in the human frame. For a time, they were thought to be immovable, but now are widely accepted as diarthrodial joints moving as little as 2mm. (10) Actions that involve
the SI joints include walking, spinal movement, leg movement and position changes. The SI joints primary role in such activities is to act as stabilizers of the dynamic pelvis through absorption, redirection and compensation of biomechanical load. (10) This role is possible due to the intrinsic stability of the overall SI joint structure, which is influenced by a tongue and groove relationship between the opposing surfaces of the sacrum and the iliae of the pelvis (10) and the presence of very strong interosseous ligaments. There are many differences in the overall shape of the SI joint evident on A-P radiographs. The five main categories according to Denton (1980) are the inverted S, the straight slip, which is slightly L shaped, the inverted S with the addition of a tubercle at the inferior portion of the joint, the c shape, and the SI that is partially formed by a transitional segment at L5 or S1 (11). Each of these categories offers unique problems with stability and therefore the biomechanics of the pelvis. Overall, the main axis of motion in the SI joint occurs along the middle fossa of the joint (10) where a small degree of rotation is allowed. In addition to the interosseus ligament, the anterior and posterior sacroiliac ligaments surround the surfaces of the SI joint, which contribute only slightly to the stability of the joint. There are three other accessory ligaments that contribute to SI stability. The sacrotuberous and sacrospinous ligaments restrict the amount of sacral nutation (10) and the iliolumbar ligament keeps the SI joints from gapping excessively in response to the possible lateral tilt of the pelvis (10). Overall, the SI joint is well designed to be a stable base for the vertebral column. The SI joints are innervated by the nerve roots of L4 thorough S2, but much variation in this distribution is thought to exist (10).

Motion at the sacroiliac joints is multifaceted. As stated before, nutation of the sacrum is accomplished as anteroposterior nodding of the sacral base. In addition, motion may occur longitudinally allowing superomedial and inferolateral movement of the ilium (10) and the SI joint itself may gap. These motions occur as a result of several large muscle groups acting on the pelvis. Some of the most important muscles influencing the joint according to Cramer and Darby (1995) are erector spinae, quadratus lumborum, multifidus, iliopsoas, rectus abdominus, gluteus maximus and piriformis.

Sacroiliac dysfunction is a common problem presenting to chiropractic offices. It is estimated to be the cause of approximately 15% of low back pain in patients presenting for treatment. (1) The main symptom arising from SI joint dysfunction is pain, but the
pattern may be widespread. (1) Due to the differences in innervation of the SI joints from person to person, and even within the same person, some of the pain referral patterns due to pelvic dysfunction may be even harder to determine (10). In addition, the wide variety of muscles that act on the SI joints make for an additional challenge in determining the origin of the problem. Since the origin of pain can prove difficult to pinpoint, challenges arise in making a specific diagnosis. The most common pain presentation involved with sacroiliac dysfunction is pain that begins over the posterior superior iliac spine and moves into the ipsilateral buttock (10). In addition, the pain may radiate into the groin or lower extremity on rare occasions (12). The overall pain is not dermatomal in nature and will occur without accompanying neurological signs.

The possible causes for SI dysfunction are varied and thought to be primarily due to a musculoskeletal component, there are other known inflammatory, malignant and medical factors that bring about pain in the SI joint distribution and should be mentioned. (1) Some of the disorders acting directly on the pelvis are degenerative change, osteosclerosis, idiopathic hyperostosis, ankylosing spondylitis, enteropathic arthritis and inflammatory bowel disease, hyperparathyroidism, and infection (1, 10). Oftentimes, SI dysfunction may coexist with some of these disorders. Determining the cause of such pain is essential to the well being of the patient.

The origin of sacroiliac dysfunction must be accurately determined especially to design appropriate treatment of the problem. In order to do so, there are a variety of tests utilized to pinpoint the location of sacroiliac pain and loss of functional ability. Examples of these tests include: Gillet; Gaenslen; Fabere-Patrick; provocative palpation over the PSIS; Yeoman; prone hip extension; and Laguere. (1,2,13) Unfortunately, there are few pathognomic signs that point to SI dysfunction as a specific cause for low back pain, and provocative tests have very little intra-examiner reliability. (2) Part of the difficulty with evaluating the SI joint for dysfunction is due to its deep location (10) which is beneath the erector group origin and the thick ligaments of the joint itself. In addition, the motion found at the SI joint is multi-factorial so determining which aspect is moving incorrectly may prove to be a challenge. Once the tissue of origin is identified, adjustive procedures and rehabilitation are performed to better stabilize the area and restore function.
Gluteal musculature is not thought of as the usual and primary contributor to sacroiliac dysfunction, although gluteus maximus has received some attention on the matter, as with the prone hip extension move. (3,14) According to Lehman, et al, (3) the dysfunctional firing of gluteus maximus during hip extension is a likely cause of low back pain, seemingly from the altered action on the sacroiliac joint during motion. The attachments and functions of gluteus maximus as well as gluteus medius do in fact indicate that they may be a cause in some cases. Gluteus maximus arises from the superior/posterior ilium, the dorsal surface of the sacrum, coccyx and the sacrotuberous ligament and inserts at the iliobibial tract and posterior femur to allow hip extension. (15) Gluteus medius arises from the posterior ilium and attaches laterally on the greater trochanter of the femur to contribute to abduction of the thigh, medial rotation and stabilization of the contralateral hip. (15) These motions all act on the SI joint, especially the gluteus maximus’ role in shear of the SI joints. (1,2) It therefore can be inferred that a muscular dysfunction in the gluteal muscles, especially gluteus maximus may cause altered biomechanics in the sacroiliac joint.

Pain patterns of the sacroiliac joint have previously been described as local to the affected joint and radiating into the buttock. Pain patterns associated with muscular involvement of the gluteal musculature are quite similar. Referral pain from the gluteus maximus tends to localize to the ipsilateral buttock, the sacrum and the lower part of the SI joint. (8) Trigger points in the gluteus medius muscle commonly refers pain to the top of the iliac crest, the sacroiliac joint and the sacrum on the ipsilateral side as well as up into the lowest lumbars. (8) Referral patterns of the gluteus minimus may be the most similar to sacroiliac dysfunction (8), however the muscle is poorly isolated in exercises due to its size and location. Overall, the SI joint is a common location of pain due to trigger points in the gluts.

If sacroiliac joint dysfunction can truly be determined, the actual cause of the dysfunction is often still unknown. (16) More diagnostic opportunities would tend toward a higher success rate in determining the cause of SI dysfunction. For this reason, it is important to determine whether a core muscle activating bridge and hip pointer exercise, that isolates the gluteal musculature, may be used as a reliable indicator for the presence of SI dysfunction mediated by these muscles. If gluteus maximus and/or medius are
found to be implicated, then a more accurate treatment plan for the rehabilitation of the sacroiliac joint would be possible. It would also support gluteus maximus as a major player in SI joint function and dysfunction and introduce gluteus medius as a possible contributor.

Specific Aims and Hypothesis

This is a pilot study that centers on whether or not a core exercise referred to as the hip pointer test is diminished in the face of all or some SI problems. The hypothesis is that people with sacroiliac joint pain will perform the test poorly on the side of pain. The difficulty encountered performing the exercise should be measurable by a lower level of muscle contractility, which will be measured by SEMG protocol. The exercise may further point to a cause of specific joint dysfunction mediated by the gluteus medius or maximus muscles.

Materials and Methods

Group Inclusion/Exclusion Criteria

The control group will consist of 10 people with no known sacroiliac pain or associated symptoms. The experimental group will include 10 participants that do report pain in the pain distribution of gluteus medius and gluteus maximus muscles as outlined in Travell and Simons (1999). Subject eligibility for the control or experimental group will be determined based on the results of the subject questionnaire. (See Appendix D) Volunteers that complain of pain in the sacroiliac region and who otherwise meet the criteria on the questionnaire will be placed into the experimental group. Volunteers denying the presence of low back pain who otherwise meet questionnaire criteria will be placed into the control group.

Subject participation will be based on several criteria. Both the control and experimental groups will include subjects that must meet the criteria of being 18-40 years of age, a Logan College student, and available for a 5-10 minute commitment. The experimental group must meet criteria included on the subject questionnaire. (See Appendix D) Subjects to be excluded from the study are those that have known chronic back pain not related to SI dysfunction, a history that includes hip or knee reconstruction
or replacement, an anatomical short leg measured on X-ray greater than 6mm, those that may be pregnant, and those that have a handicap that may alter pelvic biomechanics.

**Role of Subjects**

Participants will be required to wear shorts with an elastic waist, fill out a short questionnaire and sign the consent form before beginning the study.

1) Electrodes will be attached to skin of the subjects over the gluteus medius and maximus muscles. They will be placed over specific motor points in the gluteal muscles bilaterally. (See Appendix C).

2) The subject will perform the bridge and hip pointer test on one side. The muscle contractility will be measured by the surface EMG electrodes. Also while the subject is bridging, bridge height values will be recorded by a ruler on the wall next to the subject. The height value is the difference between the subjects’ pelvis bridge height and the height of the subjects hip during the hip point. This will be repeated two times on that same side and then repeated on the opposite side. (See Appendix A)

3) Subject will be released.

**Subject Confidentiality**

Subject identity in this study will be treated as confidential. Any records or data obtained as a result of the subjects’ participation in this study may be inspected by Dr. Laney Nelson or any member of the Logan research department, by the Logan College Institutional Review Board, or by Jennifer Gooden or Jamie Young. The inspectors listed above are legally obligated to protect any identifiable information from public disclosure. The results of the study may be published for scientific purposes but will not give any names or include any identifiable references to the subjects.

**Instrumentation**

Disposable, silver chloride, surface electrodes were used to connect the surface EMG leads to the subjects. The electrodes contain hypoallergenic adhesive and conducting gel to minimized subject discomfort. The adhesive portion of the electrode is 1.5” in diameter with a conductive portion of 7/16”. Two surface EMG electrodes were
attached to the motor points on each gluteus maximus and gluteus medius muscles bilaterally, while a ground electrode for every two active electrodes was placed on the subject’s lumbar erector spinae. A total of twelve electrodes were used to attach eight active leads and four ground leads to each subject.

**Testing procedure**

Participants are required to wear shorts with an elastic waist or pants that will easily slide down for electrode attachment without excessive patient exposure. They are also required to fill out a short questionnaire (Appendix D) and sign a consent form (Appendix B) before beginning participation in the study to insure that the subjects meet the inclusion and exclusion criteria. Once the subject has completed the appropriate paperwork and is assigned to the control or the experimental group based on their questionnaire answers, the electrodes are attached to the skin of the subjects over the gluteus medius and gluteus maximus muscles’ motor points bilaterally. (See Appendix C) After the electrodes are applied, the subjects are required to lie on the floor on their back with their knees bent to 90 degrees and with their feet on the floor, shoulder width apart. Once in position, the subjects are then asked to activate their core musculature including abdomen and pelvic floor and then perform the bridge and hip pointer test on both the right and left sides, performing one side at a time with a short relaxation period between sides. The muscle contractility is measured by the surface EMG electrodes while the subjects performs the bridge once and the hip pointer test three consecutive times on each side.

Also while the subject is bridging and pointing, the bridge height and point height values are visually recorded by a ruler next to the subject and a digital camera. The height value is the difference between the subjects’ pelvis bridge height and the height of the subject’s hip during the hip point. The height values are measured for an average intra-subject comparison of one sides function versus the other.
Data Analysis

In order to determine whether or not significant differences in overall muscle contractility exists in the experimental group, the contractility value for each muscle on each side is determined through the data acquisition and used in the t-test for comparison purposes. The purpose of comparison is to determine if a pattern of weakness or instability is present in either the gluteus maximus or the gluteus medius during the bridge and hip pointer maneuver in subjects with sacroiliac pain. The control group data will be compared in the same manner as above to the experimental group data to establish what patterns may exist in the general population, and to determine how the experimental group muscle activation patterns differ from the control group.

Experimental Design

An experimental group and a control group are required in this study. Subjects that report no known low back pain and meet the inclusion and exclusion criteria are assigned to the control group, while subjects that report known sacroiliac pain and meet the inclusion and exclusion criteria are assigned to the experimental group. As the subjects were available for an appointment time, they were assigned a number 1-10 in the experimental group which was termed the “pain” group and the control group termed the “no pain” group.

Results

Results indicate that there are consistent patterns of muscle activation during the bridge and point exercise. During the initial bridge, gluteus maximus and gluteus medius are both active bilaterally. This is evidenced by a cluster or wave of activity that registers on the sEMG globally when the exercise is first performed. Once the hip pointer test is performed, additional information or waves are gained. In both pain free subjects and those who suffer from sacroiliac pain, the gluteus maximus on the ipsilateral side is most active while the hip is elevated.
Figure 1 demonstrates each surface EMG lead for each muscle as a subject performs the bridge and hip pointer test. The first wave of activity (from 0-4sec) is showing the subject’s muscle activity when they first activate for the bridge, as you can see both the glutus maximus and medius are active bilaterally. The next three sequential waves are showing the recruitment of additional glutus maximus and medius motor units during three hip pointer tests performed on the left side. This particular control subject is demonstrating that while the hip pointer test is performed on the left side the ipsilateral glutus maximus is most active as well as the contralateral glutus medius.

In general, there is a marked amount of variation in muscle activation patterns throughout all of the subjects, whether pain-free or not. Subjects that complain of sacroiliac pain do have tendencies for lesser activation of either the glutus medius or the glutus maximus (or both) during the bridge and point exercise.
Figure 2

EMG 1 = left glut max, EMG 2 = right glut max
EMG 3 = left glut med, EMG 4 = right glut med

Figure 2 is demonstrating an example of a lack of right gluteus medius activation during a left hip pointer test. The figure shows the recruitment of the other gluteus maximus and medius muscles in order to compensate for the decreased activation on the right gluteus medius and to stabilize the pelvis. Pain-free subjects also display occasional lack of activation as is evidenced by lower than average values of contractility as compared to their other tested muscles. This differs greatly among test subjects as exhibited below in Figures 3.
Figure 3 demonstrates a lack of activation in the right gluteus medius muscle and the left gluteus maximus muscle, where as Figure 4 is demonstrating a normal activation pattern of a control group subject. Overall, there is no statistical difference in contractility except for the left gluteus medius during the left hip pointer exercise. The activation and contraction of the left gluteus medius appears to be reduced in subjects
with SI pain as compared to subjects without SI pain. Within each group, one group being subjects with SI pain and the other group being subjects without SI pain, we compared the maximum peak of each muscle and the average peak of each muscle throughout the entire hip pointer test. We analyzed these collected values using a t-test analysis and determined that only one comparison across groups showed statistical significance with a p-value of .046, all other values appeared to be insignificant. The values were compared between the two groups collectively and from between right and left within each group.

Discussion

Determining what muscles are active during specific exercises is the first step in learning whether or not an exercise can be used as an indicator for biomechanical dysfunction. The hip pointer test was used to help predict glute mediated sacroiliac (SI) dysfunction. Gluteus maximus is most involved when the ipsilateral hip is raised. This is expected since one of the primary roles of the gluteus maximus is hip extension, which occurs during the hip pointer exercise. In addition, the contralateral gluteus medius is also active. This is presumably a response of the muscle to help stabilize the overall pelvic girdle while the opposite hip is elevated.

As subjects performed the hip pointer test there was no consistent pattern of a decreased activation among the SI pain subjects as compared to SI pain free subjects. Several factors contribute to this such as, many muscle groups are active on the sacroiliac joint, including the erector spinae, quadratus lumborum, multifidus, iliopsoas, rectus abdominus, gluteus maximus and piriformis. (10) Therefore a dysfunction in any of these groups may contribute to the pain that is found around or near the SI joint. If either the gluteus medius or gluteus maximus is indeed weak, some of these other muscles may take over to stabilize the SI joint enough to mask a problem performing the hip pointer exercise. In addition, surface EMG may not have been the best choice to measure muscle contractility of the gluteus medius and maximus. Both muscles have very prominent subcutaneous fat stores overlying them. Electrode size may have also been too large to reliably exclude surrounding muscles from affecting the sEMG results.
The restricted subject size may be a major contributor to a lack of patterned dysfunction. The causes for SI joint pain are many (1, 10) and perhaps the presence of actual glut mediated SI pain was simply not prominent enough in the subject size. A subject pain questionnaire is insufficient to point to true SI dysfunction. Therefore, many of the subjects included in the pain group may not have been very good candidates for inclusion. Using a chiropractic student population is wrought with problems as well. Pain is very subjective and many of the students complained that their sacroiliac area was very painful, but when compared to people with diagnosed SI conditions, the pain may be much less or different in presentation. This leads to inconsistencies in the construct of the pain group of subjects. In addition, most of the subjects are healthy and are adjusted frequently and therefore not likely to experience the difficulties associated with a chronic sacroiliac dysfunction. One subject with a self-reported unstable sacroiliac joint performed as expected for a pain subject. On the side of pain, the subject performed the opposite of “normal” activation in pain-free subjects. The gluteus medius fired the most and the gluteus maximus the least. This leads us to believe that in an unstable joint, the gluteus medius is forced to overcompensate to keep the pelvis level. In addition, the gluteus maximus was indeed weak and she had marked difficulty performing the hip pointer exercise on that side of pain. A population with known sacroiliac dysfunction or instability would offer better and more consistent results in the performance of the test.

The lack of activation of some of the muscles in the pain free group may be due to a multitude of reasons including general weakness and difficulty of the exercise, body weight, and pain elsewhere in the core of the body such as low back, abdomen or even pelvic floor pain. Perhaps it would be appropriate to exclude anyone with any pain from a future study. It is also possible that SI pain and glut dysfunction are not associated enough. Gluteus medius pain patterns are more likely associated with sacroiliac pain (8) whereas gluteus maximus is more responsible for sacroiliac joint mechanics (1,2) then a joint that is painful due to the gluteus medius’ involvement may not register weakness in the gluteus maximus. The two muscles have quite different roles as is evidenced by the lack of significant activation patterns in subjects with SI pain as compared to those without. By activating the core musculature prior to performing the bridge and hip pointer test, the subjects are allowing the multifidus and the erector spinae to aid in
stabilization while performing the test. If the subjects were to have a weak core, then they may have difficulty performing the hip pointer test and were not stable enough to properly recruit additional musculature for stabilization. It is possible that with core training before having to perform the hip pointer test, that this may improve the activation patterns of certain subjects and create a more consistent subject base.

Valuable information may be gained from future studies using the same application but with changes noted. A properly composed SI pain group would be the first step. In order to find subjects, potential people could be subjected to provocative injection the SI joint with lidocaine to determine if the SI joint is the pain generator of the patients suspected pain pattern. Only subjects with pain officially diagnosed, as due to SI dysfunction would then be used. It is also necessary to assure that the hip pointer test is performed uniformly among all subjects. The height of the bridge is affected by variances between subjects such as core stability, leg length, and subject flexibility. It may be necessary to determine a method to minimize these variables by defining a baseline maximum bridge point. Once the bridge is performed consistently, more accurate data on muscle activation during the exercise may be obtained. Overall, the application of the hip pointer test should have been a reliable indicator of glut mediated SI dysfunction based on the biomechanics of the SI joint and gluteal pain patterns. The addition if the preceding suggestions in another study would likely illuminate the role of gluteus medius and gluteus maximus’ role in SI dysfunction.

Conclusion

In conclusion, the hip pointer exercise cannot be used as a reliable indicator of sacroiliac (SI) dysfunction. The nature and cause of SI pain is varied and the scope of this study is too narrow to determine whether or not pain in the SI area is truly SI dysfunction. The hip pointer exercise is also difficult to perform on a consistent basis. This study failed to support dysfunction of gluteus maximus or gluteus minimus as major contributors to SI pain. The performance of the hip pointer exercise is not consistent enough from subject to subject to reliably isolate the gluteal musculature in order to determine weakness affecting the SI joint. In addition, there appears to be no consistent
statistical difference between muscle contractility among subjects with or without SI pain while performing the hip pointer exercise. The relative heights of the hip during the exercise are therefore not important to the study at this time.

Overall, this study failed to shed any new light on muscle mediated SI pain. Future studies with the preceding changes added may contribute to a better understanding of gluteal musculature and its role in creating dysfunction at the sacroiliac joint.
Appendix A

Demonstration of the bridge and point test to be performed by participants

Step 1 - Neutral

Step 2 - Bridge - activate core muscles and lift pelvis

Step 3 - Hip Point - elevate left or right hip from the bridge
Appendix B
Consent Form

A SEMG Study of Gluteus Maximus and Medius Mediated Sacroiliac(SI) Pain

(A) Basic Elements

(1) Description of the research and your participation

I am invited to participate in a research study conducted by Dr. Nelson, Jennifer Gooden, and Jamie Young. The purpose of this research is to examine subjects with sacroiliac pain and their ability to perform a pelvic bridge and then additional hip pointer test of each hip. The subjects’ ability to do the hip pointer test will be examined along with surface electromyogram(SEMG) recordings of the activity of the gluteus maximus and the gluteus medius muscles. The pelvic and hip heights will also be measured with a ruler while the maneuver is being performed. The purpose of this study is to determine the muscles used and their contractibility in the pelvic bridge in subjects that present with sacroiliac(SI) pain.

My participation will involve my presence in the research lab for approximately 5-10 minutes. I will be required to fill out a short questionnaire, wear shorts with elastic waist, and to perform four pelvic bridges and additional hip pointer test with each bridge. Each time before performing these maneuvers, three electrodes must be attached to skin of my buttocks, which is the skin over the gluteus medius and maximus muscles that are to be examined. The electrodes will be placed over specific points in the gluteus medius and maximus muscles. The points to be used can be seen at SENIAM.org under sensor location for the gluteus medius and gluteus maximus.

The amount of time required for my participation will be approximately one visit of 5 to 10 minutes duration.

(2) Risks and discomforts

There are minimal risks or discomfort to me as the subject from the application or use of the SEMG electrodes. There are minimal risks or discomforts associated with this research procedure and my duties. They include the risk of the me feeling or being exposed while the electrodes are being applied, risk of possible fatigue of the muscles being used in the pelvic bridge, residual muscle soreness, and risk of possible reproduction of the my SI pain if present. The researchers will try to minimize these risks by insuring that I am comfortable and properly covered at all times, only one subject will be in the examining room at a time to insure privacy, and the test will be performed in a quick and efficient time frame to minimize the amount of time I spend performing the bridge maneuver.
(3) Potential benefits

There are no known benefits to me that would result from my participation in this research. This research may help the researchers to understand SI pain and its relationship to the gluteus medius and maximus muscles.

(4) Alternatives to Procedure

The only alternative available to me as a subject is non-participation in the study.

(5) Confidentiality

My identity in this study will be treated as confidential. The researchers will do everything they can to protect my privacy. Any records or data obtained as a result of my participation in this study may be inspected by Dr. Laney Nelson or any member of the Logan College research department, by the Logan College Institutional Review Board, or by Jennifer Gooden or Jamie Young. The inspectors listed above are legally obligated to protect any identifiable information from public disclosure. These records will be kept private so far as permitted by law. The results of the study may be published for scientific purposes but my identity will not be revealed in any publication or include any identifiable references to me.

(6) More than Minimal Risk

This study does not involve more than minimal risk to the me as a subject than those listed above.

(7) Contact information

If I have any questions or concerns about this study or if any problems arise, I can contact Dr. Nelson at (801) 232-3511, Jennifer Gooden at (910)876-5379, or Jamie Young at (314) 608-5839. If I have any questions or concerns about my rights as a research participant or in case of research-related injury, I can contact Dr. Gutweiler at Logan College of Chiropractic (336)227-2100 ext.1910.

(8) Voluntary participation

My participation in this research study is voluntary. I may choose not to participate and I may withdraw my consent to participate at any time. I will not be penalized in any way should I decide not to participate or to withdraw from this study.
(B) Additional Elements

(1) Unforeseeable risks

The SEMG procedure and the pelvic bridge maneuver may involve risks to me (or to an embryo or fetus, if I am or become pregnant) which are currently unforeseeable.

(2) Subject Termination

My participation in the study may be terminated by the investigators at any time without my consent. Circumstances that will lead to my participation termination are as follows but are not limited to lack of participation or total absence from the study and non-compliance or inability of me to perform the described and needed tasks for the study.

(3) Additional Costs

There are no additional costs to me that will result from my participation in this study.

(4) Consequences of Withdraw

There are no consequences to me if I decide to withdraw from the study. If I decide to withdraw from the study, this form and any material containing information about me will still remain confidential. If my information is not used for study purposes then it will be discarded of appropriately to still protect my identity and privacy.

(5) Significant New Findings

Significant new findings that develop during the course of this study which may affect my willingness to continue participation in the study will be provided to me as the subject.

(6) Number of Subjects

The approximate number of subjects involved in this study is 30.

Consent

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant’s signature: ___________________________ Date: ____________
Appendix C

The information and protocol to be followed is listed below and comes directly from the Seniam website www.seniam.org

What is Seniam?
The SENIAM project (Surface Electromyography for the Non-Invasive Assessment of Muscles) is a European concerted action in the Biomedical Health and Research Program (BIOMED II) of the European Union. The SENIAM project has resulted in European recommendations for sensors and sensor placement procedures and signal processing methods for SEMG.

The SENIAM recommendations for sensors restrict to bipolar sensors only. 'Electrode shape' is defined as the shape of the conductive area of the SEMG electrodes. SENIAM has found no clear and objective criteria for recommendations for electrode shape. SEMG users should clearly indicate the type, manufacture and shape of the electrodes used.

The SENIAM recommendations for sensors restrict to bipolar sensors only. 'Electrode size' is defined as the size of the surface of the conductive area of a SEMG electrode. SENIAM recommends that the size of the electrodes in the direction of the muscle fibers is max. 10mm.

The SENIAM recommendations for sensors restrict to bipolar sensors only. 'Inter electrode distance' is defined as the centre to centre distance between the conductive areas of 2 bipolar electrodes. SENIAM recommends to apply the bipolar SEMG electrodes around the recommended sensor location with an inter electrode distance of 20 mm. When bipolar electrodes are being applied on relatively small muscles the inter electrode distance should not exceed 1/4 of the muscle fiber length. In this way unstable recordings, due to tendon and motor endplate effects can be avoided.

The SENIAM recommendations for sensors restrict to bipolar sensors only. SENIAM recommends to use pre-gelled Ag/AgCl electrodes.

The SENIAM recommends to shave the patient if the skin surface at which the electrodes have to be placed is covered with hair and to clean the skin with alcohol and allow the alcohol to vaporize so that the skin will be dry before the electrodes will be placed.
'Sensor location' is defined as the position of the centre of 2 bipolar electrodes on the muscle. SENIAM has developed recommendations for sensor locations on 30 individual muscles. Within these recommendations the location of the electrodes is described as a point on a line between 2 anatomical landmarks. First the position of the anatomical landmarks has to be located according to the SENIAM recommendations for sensor locations. Next a line needs to be drawn between the 2 landmarks. The location for the sensors can be located somewhere on this line according to the SENIAM recommendations for individual muscles. These individual recommendations are based on 2 general recommendations: With respect to the longitudinal location of the sensor on the muscle SENIAM recommends to place the sensor halfway the (most) distal motor endplate zone and the distal tendon. With respect to the transversal location of the sensor on the muscle SENIAM recommends to place the sensor at the surface away from the 'edge' with other subdivisions or muscles so that the geometrical distance of the muscle to these subdivisions and other muscles is maximized.

The SENIAM recommendations for electrode placement and fixation consist of recommendations for the:

Inter electrode distance
'Inter electrode distance' is defined as the centre to centre distance between the conductive area's of 2 bipolar electrodes. SENIAM recommends to apply the bipolar SEMG electrodes around the recommended sensor location with an inter electrode distance of 20 mm. When bipolar electrodes are being applied on relatively small muscles the inter electrode distance should not exceed 1/4 of the muscle fibre length. In this way unstable recordings, due to tendon and motor endplate effects can be avoided.

Orientation of electrodes
'Electrode orientation' is defined as the position of the line between the 2 bipolar electrodes with respect to the direction of the muscle fibers. SENIAM recommends that the bipolar SEMG electrodes should be placed around the recommended sensor location with the orientation parallel to the muscle fibers.

Fixation on the skin
SENIAM recommends to use elastic band or (double sided) tape / rings for the fixation of the electrodes(construction) and cables to the skin in such a way that the electrodes are properly fixed to the skin, movement is not hindered and cables are not pulling the electrodes(construction).

Location of the reference electrode
Depending on the application SENIAM recommends to use the wrist, the spinous process of C7 or the ankle as the standard location of the reference electrode.
### Recommendations for sensor locations in hip or upper leg muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Gluteus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subdivision</td>
<td>Maximus</td>
</tr>
</tbody>
</table>

#### Muscle Anatomy
- **Origin**: Posterior gluteal line of ilium ad portion of bone superior and posterior to t, posterior surface of lower part of sacrum, side of coccyx, aponeurosis of erector spine, sacrotuberous ligament and gluteal aponeurosis.
- **Insertion**: Larger proximal portion and superficial fibres of distal portion of muscle into iliotibial tract of fascia lata. Deeper fibres of distal portion into gluteal tuberosity of femur.
- **Function**: Extends, laterally rotates and lower fibres assist in adduction of the hip joint. The upper fibres assist in adduction. Through its insertion into the iliotibial tract, helps to stabilise the knee in extension.

#### Recommended sensor placement procedure
- **Starting posture**: Prone position, lying down on a table.
- **Electrode size**: Maximum size in the direction of the muscle fibres: 10 mm.
- **Electrode distance**: 20 mm.
- **Electrode placement**
  - **location**: The electrodes need to be placed at 50% on the line between the sacral vertebrae and the greater trochanter. This position corresponds with the greatest prominence of the middle of the buttocks well above the visible bulge of the greater trochanter.
  - **orientation**: In the direction of the line from the posterior superior iliac spine to the middle of the posterior aspect of the thigh.
  - **fixation on the skin**: (Double sided) tape / rings or elastic band.
- **Reference electrode**: On the proc. spin. of C7 or on / around the wrist or on / around the ankle.
- **Clinical test**: Lifting the complete leg against manual resistance.
- **Remarks**: The SENIAM guidelines include also a separate sensor placement procedure for the gluteus medius muscle.
### Recommendations for sensor locations in hip or upper leg muscles

<table>
<thead>
<tr>
<th>Muscle</th>
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</thead>
<tbody>
<tr>
<td>Subdivision</td>
<td>Medius</td>
</tr>
</tbody>
</table>

#### Muscle Anatomy
- **Origin**: External surface of ilium between iliac crest and posterior gluteal line dorsally, and anterior gluteal line ventrally, gluteal aponeurosis.
- **Insertion**: Oblique ridge on lateral surface of greater trochanter of femur.
- **Function**: Abduction of the hip joint. The anterior fibres medially rotate and may assist in flexion of the hip joint; the posterior fibres laterally rotate and may assist in extension.

#### Recommended sensor placement procedure
- **Starting posture**: Lying on the side on a table.
- **Electrode size**: Maximum size in the direction of the muscle fibres: 10 mm.
- **Electrode distance**: 20 mm.
- **Electrode placement**:
  - **Location**: Electrodes need to be placed at 50% on the line from the crista iliaca to the trochanter.
  - **Orientation**: In the direction of the line from the crista iliaca to the trochanter.
  - **Fixation**:
    - On the proc. spin. of C7 or on / around the wrist or on / around the ankle.
- **Clinical test**: Lying on the side with the legs spread against manual resistance (holding the ankles).
- **Remarks**: The SENIAM guidelines include also a separate sensor placement procedure for the gluteus maximus muscle.
Appendix D

Subject Questionnaire

1. Please check any of the following that apply.
   - You have chronic back pain not related to SI dysfunction
   - You have an anatomical short leg
   - You have ever had knee or hip reconstructive surgery
   - You are or may be pregnant
   - You have a known physical handicap

If you answered yes to any of the above conditions please see one of the researchers in charge before proceeding. If you did not answer yes to any of the above conditions please continue with the questionnaire.

2. Do you have pain in the sacral, low back, or buttocks region?  YES  NO
   If so, please indicate the area, side and distribution of your pain on the diagram below.

   ![Diagram of lower back and buttocks]

3. On the scale below please indicate the average severity of the pain you experience, 1 being the least and 10 being the worst.

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   & & & & & & \\
   & & & & & & 10
   \end{array}\]

4. How long have you been experiencing this pain?

   1-2 wks  3-4 wks  2 mos  4 mos  6mos  1 yr  Several years

5. Has the cause of your pain ever been determined or properly diagnosed?  YES  NO
   If so, what region was the diagnosis?  __________________________
Appendix E

References