

Analysing the Relationship between Gluteus Maximus Muscle Activity and Hamstring Muscle Length and its Influence on Sit to Stand Activity in Persons with Sacroiliac Joint Dysfunction

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Abstract

Background: The sacroiliac (SI) joint has been found to be a source of discomfort for 25 to 35% of people suffering from persistent low back pain. Though the Gluteus Maximus and Hamstring muscles play a vital role in sit-to-stand activity in normal people, its role in individuals with sacroiliac joint dysfunction is yet to be studied.

Purpose: To assess the association between Gluteus Maximus activity and Hamstring muscle length and determine the efficacy of Gluteus Maximus activation exercise and Hamstring muscle eccentric training on improving sit-to-stand activity in people with SI Joint dysfunction.

Materials and Methods: In the first phase of the study, Hamstring muscle length, Gluteus maximus muscle activity, Pain during sit-to-stand activity was recorded. All thirty participants in the second phase of the study underwent six weeks of Hamstring muscle eccentric exercise and Gluteus Maximus muscle activation exercise.

Results: A Pearson correlation test shows a positive correlation ($r = 0.208$) but the weaker relationship between the variables. Paired t test analysis shows a significant improvement after the treatment in terms of Gluteus Maximus muscle activity, Hamstring muscle length and pain reduction with a P value < 0.001 .

Conclusion: This study concluded that Gluteus Maximus activation exercise and Hamstring muscle eccentric training will significantly improve sit to stand activity and reduce pain.

Key Words: Sacroiliac joint dysfunction, Gluteus Maximus, EMG activity, Hamstring muscle length, Active knee extension test

Introduction

Sacroiliac joint dysfunction acts as an important contributor in individuals with persistent and functionally limiting low back pain with symptoms that vary from person to person, making it challenging to diagnose. Common symptoms include

lower back pain, sciatica-like pain radiating down the hips or legs, pain during or after prolonged sitting or standing, tenderness around the joint, and a reduced range of motion in the hips and lower back¹.

Sacroiliac joint dysfunction can arise from various factors, including injury, pregnancy,

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repetitive motion, and degenerative changes. Trauma or sudden impact to the joint, such as a fall or car accident, can lead to ligamentous sprains or even fractures. Pregnancy, on the other hand, can cause hormonal changes that result in increased laxity of the ligaments surrounding the joint, leading to instability and dysfunction. Repetitive motions, such as heavy lifting or bending, can strain the joint and eventually lead to dysfunction. Additionally, degenerative changes due to aging can contribute to the deterioration of cartilage and the development of osteoarthritis, further exacerbating the dysfunction².

The Gluteus Maximus and Hamstrings, particularly the Biceps Femoris muscles, have attachments over the “sacro-tuberous ligament” and “long dorsal ligament” of the sacroiliac joint. Contraction or tension created in this muscle can produce compressive force on the sacroiliac joint, which creates a force closure mechanism at the sacroiliac joint³.

Since the sacroiliac joint serves as an axis for load transmission, individuals with sacroiliac joint dysfunction have improper weight transfer across the pelvis. Ligament tension, muscle contraction, and joint proprioception should work in harmony to produce normal force transfer. In this part, the sacroiliac joint is stabilised by muscle activity acting as a self-bracing mechanism⁴.

Sit-to-stand activity is a fundamental movement pattern involved in daily activities, from rising from a chair to initiating gait. The execution of this seemingly simple movement relies on the coordinated functioning of various muscle groups, particularly the “Gluteus maximus and the Hamstring muscle”. These muscles play a crucial role in stabilizing the pelvis and lower limb during the transition from a seated to a standing position. The efficient execution of sit-to-stand is crucial for functional independence and plays a significant role in activities ranging from getting out of a chair to initiating walking or climbing stairs⁵.

The biomechanics of sit-to-stand can be understood as a series of sequential events involving several key phases. Initially, the individual shifts their weight forward, activating the lower extremity muscles to generate the necessary force for pushing

the body upward. Subsequently, the hips and knees extend, and the individual rises to a standing position, finally achieving an upright posture⁶.

Aim

The goal of this research was to study the association between Gluteus Maximus activity and Hamstring muscle length and determine the efficacy of Gluteus Maximus activation exercise and hamstring muscle eccentric training on improving sit-to-stand activity in people with (SI) joint dysfunction.

Materials and Methodology

Subjects with SI Joint dysfunction was screened based on the selection criteria and informed consent was obtained. Out of which thirty subjects were recruited for the phase I. In the first phase of the research the Hamstring muscle length and Gluteus Maximus muscular activity were assessed using active knee extension test and surface EMG (peak to peak amplitude) respectively. Pain during sit-to-stand activity was recorded using the NPRS scale. All thirty subjects in the second phase of the study underwent six weeks of Hamstring muscle eccentric exercise and Gluteus Maximus activation exercise. This study was conducted from June 2022 to November 2022.

Inclusion criteria:

- Between the ages of 18 and 40
- Both male and female
- Had at least three positive results on the SI joint provocation test
- Positive Froment sign

Exclusion criteria:

- Pregnancy
- History of recent pelvic, hip, or lower spine fractures
- Positive neurological evaluation related to LBA
- Spinal infectious diseases

Outcome Measures:

- EMG (Peak to Peak amplitude)
- Active Knee Extension Test (AKE)
- Numerical Pain Rating Scale.

Procedure

Based on the inclusion criteria subjects underwent sacroiliac joint provocation tests, namely "Pelvic Compression Test", "Pelvic Distraction Test", "Sacral Thrust Test", "Thigh thrust test", "Gaenslen's Test". Patients who exhibit a minimum of three positive provocation tests were selected for the study. The study was divided into two phases.

PHASE I:

In this phase, EMG activity of Gluteus Maximus and Hamstring muscle length were measured to find out the relation between Gluteus Maximus activity and length of the Hamstring muscles.

Recording Gluteus Maximus (GM) muscle activity: Surface EMG was used to find out the GM muscle activity. The active electrodes were placed over the lower inner quadrant of the buttock (GM Muscle) while the reference electrode was placed 3cm away from the active electrode and a ground electrode in between the recording electrodes. The subjects were instructed to perform sit to stand activity in a chair without arm support to trail the activity. The peak-to-peak amplitude of GM activity was recorded. The subjects underwent a total of three sets of sit-to-stand tasks in order to measure the muscle activity.

An AKE test was performed to determine the length of the Hamstring muscle. The subjects were lying supine, with the untested knee extended and the ankle in neutral position. To minimise compensatory pelvic tilt, a pelvic strap was secured around the ASIS. The patients were instructed to position the testing leg vertically with a 90-degree bent knee. Patients were instructed to grasp their thighs with their hands in order to prevent trick movement of the hip. They were now told to extend their knees as far as they could. Now a Goniometer was used to measure the angle of extension. Anything less than 60 degrees is considered hamstring tightness. Pain during sit-to-stand activity was recorded using the NPRS scale.

PHASE II

In phase two study exercises to activate the Gluteus Maximus and Hamstring eccentric training were given to all thirty subjects. The exercises were given for 5 days per week for the period of 6 weeks. 10-12 repetition \times 2 sets. Each exercise consists

of 10 seconds hold and 10 seconds rest period on every five repetitions.

Intervention Protocol:

Exercises to activate the Gluteus Maximus

- Quadruped hip abduction,
- Forward and Retro step up,
- Unilateral and Bilateral pelvic bridge



Fig 1: Quadruped Hip Abduction



Fig 2: Forward Step Up



Fig 3: Bilateral Pelvic Bridge

Eccentric exercises for hamstring muscles

- Prone Hamstring Curl
- Seated Thera-band Hamstring Curl

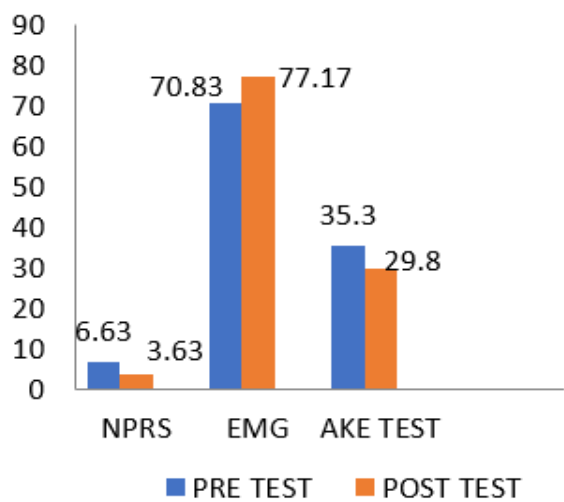


Fig 4: Seated Thera-band Hamstring Curls



Fig 5: Prone Hamstring Curls

Data analysis



Graph No: 1

INTERPRETATION: Graph No.1 shows

statistically significant improvement in Pre and Post intervention mean values

Result

A Pearson Correlation test was used to find the relationship between Gluteus maximus muscle activity and Hamstring muscle length, it shows a positive correlation ($r = 0.208$) but the weaker relationship between these variables.

The mean value of NPRS before treatment (Pre NPRS) was 6.63 ± 1.10 . The mean value of NPRS after treatment (Post NPRS) was 3.63 ± 1.03 . The t-value for the comparison between Pre NPRS and Post NPRS was 17.35. The p-value for this comparison is stated as < 0.001 , indicating that the difference in NPRS before and after treatment is statistically significant. The mean value of EMG for gluteus maximus before treatment (Pre EMG glut.max) was 70.83 ± 4.50 . The mean value of EMG for gluteus maximus after treatment (Post EMG glut.max) was 77.17 ± 4.88 . The t-value for the comparison between Pre EMG glut.max and Post EMG glut.max was 14.8. The p-value for this comparison is stated as < 0.001 , indicating that the difference in EMG activity of gluteus maximus before and after treatment is statistically significant. The mean value of AKE Test before treatment (Pre AKE test) was 35.30 ± 4.42 . The mean value of AKE Test after treatment (Post AKE test) was 29.80 ± 4.57 . The t-value for the comparison between Pre AKE test and Post AKE test was 15.94. The p-value for this comparison is stated as < 0.001 , indicating that the difference in AKE Test results before and after treatment is statistically significant. From the results presented, it can be inferred that the treatment had a significant positive effect on reducing pain (NPRS scores) and increasing the muscle activity of Gluteus Maximus (EMG) as well as improving the AKE Test performance.

Discussion

In our study we found that there is a reduced Gluteus Maximus activity, which has a positive but a weaker relationship with hamstring muscle length. With a reduction in the Gluteus Maximus muscle activity, a considerable reduction in the Hamstring Muscle length can be seen. These results were supported by a number of studies as follows.

A study conducted by Added MA et al. (2018)

found that patients with sacroiliac joint dysfunction had a significantly weaker Gluteus Maximus muscle and concluded that strengthening could improve sacroiliac joint dysfunction and provide relief from pain⁷.

Several studies have investigated the role of the Gluteus Maximus in the sit-to-stand activity. One such study by Dimple et al. (2018) found that decreased activation of the Gluteus Maximus in the elderly was associated with increased difficulty in performing sit-to-stand activity⁶.

A study, conducted by Chen et al. (2015), investigated the influence of Hamstring flexibility on sit-to-stand performance in healthy individuals. The study found that individuals with limited Hamstring flexibility exhibited reduced sit-to-stand performance, indicating that Hamstring flexibility is essential for sit-to-stand activity⁸.

Research studies have demonstrated the effectiveness of the AKE test in assessing Hamstring flexibility. A study conducted by Yildirim et al. (2015) compared the active knee extension test to other commonly used methods and concluded that it was a valid and reliable test for assessing hamstring flexibility⁹.

Conclusion

The conclusion of this study is that the subjects with sacroiliac joint dysfunction have decreased Hamstring muscle length and Gluteus maximus activity, both of which are crucial for executing sit-to-stand activity. The sit-to-stand activity was significantly improved by activating the Gluteus Maximus and eccentrically training the Hamstring muscles.

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Conflict of Interest: Nil

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