Investigation of The Pain and Muscle Strength of Individuals with Sacroiliac Joint Dysfunction and Its Effect on Postural Stability

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ABSTRACT

Sacroiliac joint dysfunction (SIJD) is created by repetitive stresses and is ligaments and muscles cause compressive and elastic forces. Muscles ligaments and joints are mechanoreceptors and retains stability and bearings of the body movements and sense proprioception. However, there is little research investigating the relationship between SIJD and balance. Our aim was investigating the pain and muscle strength of individuals with SIJD and the effect of SIJD on static/dynamic balance.

20 subjects with SIJD and 20 subjects without SIJD (control group-CG) were evaluated by standing flexion, sitting flexion. In addition to sociodemographic features, visual analog scale (VAS) was used for pain assessment. Manuel Muscle Testing (MMT) was used for assessing strength of rectus abdominis and lumbar extensors. Static balance was evaluated by single leg stance test (SLST) with open and closed eyes. Dynamic balance was evaluated by Prokin PK200.

For statistical analysis SPSS program was used. There were significant difference in static balance of the lower extremities without visual feedback between subjects with SIJD and CG ($p<0.05$). There was no difference in dynamic balance values between two groups. There was a significant difference in mean rectus abdominis strength value between SIJD group and CG. There were negative correlations between rectus abdominis and lumbar extensors MMT values of SIJD group and VAS values which mean while the rectus abdominis muscle/lumbar extensor muscle strength increases, pain decreases at night.

The results suggest that strengthening of rectus abdominis is considered as a treatment option for pain related to SIJD. In our opinion, all trunk stabilizer muscles should be strengthened and additional procedures may be required for management of dynamic balance disturbances in SIJD.

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INTRODUCTION

The altered position of the sacroiliac joint surfaces, which is caused by recurrent stressors and is sustained by compressive and elastic forces of the ligaments and muscles, is known as sacroiliac joint dysfunction. Sacroiliac joint dysfunction is associated with altered biomechanical characteristics, neurological compression, and muscular spasms. In other words, the biomechanics of the sacroiliac joint will be altered, and the motor control and load transfer functions will adjust the joint's new biomechanics. [1].

A number of clinical disorders, including as high-velocity trauma, degenerative arthritis, inflamatory arthropathy, infection, and moderate impact exercise, can lead to Sacroiliac joint (SIJ) dysfunction. Automobile collisions and falls that cause SIJ ligamentous strains, hidden fractures, or pelvic ring injuries are examples of high-velocity trauma. When someone has systemic symptoms, inflamatory arthropathies should be taken into consideration. SIJ dysfunction is frequently caused by moderate exercise, such as jogging or lifting, in people without systemic signs. Prior spinal fusion, scoliosis, and leg length disparity are a few examples of secondary problems that should be taken into account. [2]. Instability results from any system in the lumbosacral and pelvic area losing its ability to function normally. Although gross SIJ instability is uncommon, patients with recurrent SIJD frequently have microinstability [3]. Subluxation, which denotes severe SI joint instability, is quite uncommon in the general athletic population [4]. On the other hand, because it frequently results in chronic pain syndromes, microinstability must be managed in conjunction with these intricate pain manifestations [3].

About 15% of chronic low back pain can be attributed to the sacroiliac joint, which is a potential source of low back and lower extremities discomfort [5]. Additionally, in cases of sacroilitis and sacroiliac dysfunction, the SIJ may be the source of pain [6, 7].

The balance problems is a demanding issue for SIJD patients. The afferent and/or efferent physiologic processes that regulate balance may be compromised in low back pain patients [8]. One's stride and daily activities involving sight, hearing, vestibular system, proprioceptive sense, position awareness, muscular force, and cognition all depend on functional balance [9]. The integration of information about body movement detected by the somatosensory system in the central nervous system and the appropriate response of the musculoskeletal system results in postural control [9]. Mechanoreceptors in muscles, ligaments, and joints feel proprioception, which maintains the body's stability and bearings throughout both static and dynamic motions [9]. The purpose of this study was to investigate the effect of sacroiliac joint dysfunction on static or dynamic balance.

MATERIAL AND METHOD

Forty volunteers (31 women and 9 men) participated in this study. Participants were between the ages of 18 and 25 years (20.92 ± 1.71 years). The study was carried out in the Physiotherapy and Rehabilitation Department of the School of Health Science at Yeditepe University. The non-invasive ethics committee of Istanbul Medipol University approved the study's procedure. Prior to participating in this study, participants provided written, informed consent. While the control group (n=20) had no sacroiliac joint problems, 20 participants had sacroiliac joint problems. The inclusion criteris were having no musculoskeletal injury or surgery history in the six months before the study, being volunteer to participate.

The exclusion criteria of the study were:

- Had a musculoskeletal injury history in the six months before the study.
- Had a neurological or specific orthopedical problem
- Had a previous surgery in the six months before the study.

A structured assessment paper with the study's objectives and the surveys that would be utilized for evaluation was given to each participant. Participants' sociodemographic characteristics were assessed using a questionnaire. A visual analog scale (VAS) was used to assess the low back pain. The existence of sacroiliac dysfunction was determined by standing flexion test (STFT) and sitting flexion test (SIFT). The participants were told to maintain a standing stance with their feet parallel to their bodies and their upper limbs beside them while not rotating their bodies in any way. The tester stood behind the subject, placed both hands on the iliac crests laterally, and used her thumbs to locate the posterior superior iliac spines (PSISs). The thumb tips' pads were positioned on the PSISs' lower obliquity. The participants were then asked to slowly perform maximum back flexion while keeping their knees extended and beginning the movement in the neck area. The test was ruled negative if the PSISs moved symmetrically, or positive if one side moved more than the other in the cranial direction [10,11,12,13]

The SIFT test is similar to the STFT, but the individuals start from a sitting position. The participants were told to sit upright in a height-adjustable seat with their feet flat on the floor in parallel with no angle of rotation, their knees and hips at shoulder width, and their knees and hips flexed to about 90 degrees. During palpating the PSISs, the assessor was in the same position as when doing the STFT. The next step was to have the participants put their hands behind their heads, stretch their backs as much as possible, starting in the cervical region, and slowly do so [10, 11,13].

The lumbar extensors and abdominal muscles were tested using the Manuel Muscle Testing (MMT) technique. A single leg stance test (SLST) was used to assess static balance. Eyes were opened and closed while a SLST was conducted. Participants were standing on one leg while flexing the other. On the chest, the arms are crossed. They were instructed to wait for 60 seconds in this position. The Prokin PK 200 device (Figure-1) assessed the participants' dynamic balance while they were standing on bipedal and unipedal feet (right and left foot). Center of Pressure (COP) perimeter length, medium speed, which is measured in displacement, and the percentage of the area (AGP) covered by the Center of Pressure were all evaluated. The screen has a circle and a coordinated system. As the test is being conducted, the physiotherapist gives the subject the following instructions: "Please keep the indicator as close to the center of the circle as feasible." The outcomes could be favorable or unfavorable. Positive results in the anteroposterior (AP) and Mediolateral (ML) measurements indicate that the patient is primarily leaning to the right and anteriorly, respectively. On the other hand, negative values in the AP and ML measures indicate that the patient is leaning posteriorly and onto her left foot, respectively.

Figure 1: The Prokin PK 200 device

Spss22.0 statistical software was used for analysis. Results were expressed in the format of mean±sd . The normality of the distribution of the continuous variables was determined using the Shapiro-Wilk test.Pearson correlation test was used for measuring the strength of the linear relationship between two variables. Mann-Whitney U test and Wilcoxon rank-sum test were used to test for differences between two independent groups . The Pearson correlation coefficient was used for measuring lineer correlation. The Independent Samples t Test was used to compare two sample means to determine whether the population means are significantly different.

For all tests, statistical significance was set at an α level of < 0.05 (2-tailed).

RESULTS

Age, body weight, height, and body mass index of the subject's mean value and standard deviation were shown in (Table 1). Participants were 20.92 ± 1.71 years old. The control group's mean age was 21.2 ± 1.54 years, whereas the age of the subjects with sacroiliac dysfunctions was 20.65 ± 1.87 years. The demographics information of two groups did not differ significantly (p>0.05).

Table 1. Distribution of average age, height, weight, and the BMI values

	Control Group (n=20) MEAN±SD(MIN-MAX)	**Sacroiliac joint dysfunction (n=20) MEAN±SD (MIN-MAX)**	**p value**
Age(years)	21.2 ± 1.54 (19-24)	20.65+1.87(18-25)	0.317
Height(cm)	1.68 ± 0.097 (1.5-1.93)	1.704+0.08(1.59-1.85)	0.463
Weight(kg)	58.48 ± 10.02 (41-87)	62.15+10.21(47-83)	0.259
BMI(kg/m²)	20.55 ± 1.54(19-24)	21.27+2.17(18.11-26.35)	0.313

Muscle strength of lower extremity muscles and abdominal and lumbar extensors were evaluated. The mean abdominal muscle strength values of subjects with sacroiliac dysfunctions was 4,75 ±0.55 and the average abdominal muscle strength values of control group was 5±0. There was a significant difference in mean abdominal muscle strength values between the two groups (p<0.05). There were no significant difference between two groups in mean lumbal extensor strength and VAS values.

Table 2. Manual muscle testing values of abdominals, lumbar extensors and visual analog scale value of low back pain

	Sij Dysfunction	**Control Group (No Dysfunction)**	**p value**	
Rectus Abdominis	4.75 ± 0.55 (3-5)	5± 0 (5-5)	**p=0.03***	z=-2.08
Lumbal Extensors	4.9 ± 0.3 (4-5)	4.75± 0.44 (4-5)	p=0.21	z=-1.23
Visual analog scale	1.15±1.69 (0-6)	0.9±1.44 (0-4)	p=0.5	u=178.5

In adition, there was no correlation between abdominal muscle strength values (subjects with sacroiliac joint dysfunctions) and The Prokin PK 200 device mediolateral or anterior posterior postural sways and area gap percentage. There were significant positive correlations between abdominal muscle strength values (subjects with sacroiliac joint dysfunctions) and Prokin medspeed, perilength measurements (p<0.05) which means if the abdominal muscle strength increases, perilength measurements and medium speed of displacement during balance will increase, so dynamic balance will worsen.

Table 3. Correlation between muscle strength test values (subjects with sacroiliac joint dysfunctions) and Prokin (bipedal) dynamic balance values

Correlation Coefficient (r)	Muscle Strength Test (subjects with sacroiliac joint dysfunctions)															
	Rectus Abdominis		Lumbar ext.		Right Hip Extension		Left Hip Extension		Right Hip Ext.Rot.		Left Hip Ext.Rot		Right Hip Int.rot.		Left Hip Int.Rot.	
	(r)	p	(r)	p	(r)	p	(r)	p	(r)	p	(r)	p	(r)	p	(r)	p
Prokin Bipedal PL(º)	**0.61****	**0.004**	0.33	0.15	0.06	0.80	-0.05	0.82	0.33	0.14	-0.10	0.64	-0.37	0.1	0.33	0.14
Prokin Bipedal AGP(%)	0.24	0.30	-0.06	0.78	0.21	0.35	-0.14	0.55	0.25	0.27	-0.13	0.58	-0.37	0.1	0.25	0.27
Prokin Bipedal MS (º/sec)	**0.61****	**0.004**	0.33	0.15	0.06	0.80	-0.05	0.82	0.33	0.14	-0.10	0.64	-0.37	0.1	0.33	0.14
Prokin Bipedal AP (º)	-0.10	0.66	-0.17	0.45	-0.20	0.93	0.01	0.94	0.21	0.35	-0.26	0.26	-0.13	0.55	0.21	0.35
Prokin Bipedal ML(º)	0.32	0.16	0.23	0.31	0.08	0.73	-0.02	0.91	0.37	0.1	-0.36	0.11	-0.17	0.45	0.37	0.1

Ext: Extension, Ext. Rot: external rotation, Int. Rot : Internal Rotation, PL: Posterolateral, AGP: Area Gap Percentage , MS: Medium Speed, AP: Anteroposterior, ML, Mediolateral

Back pain was evaluated by visual analog scale. The average visual analog scale (VAS) scores of subjects with sacroiliac dysfunctions was 1.15±1.69 and the mean scores of control group was 0.9±1.44. Individuals who have sacroiliac dysfunctions feel more pain than control group on mean but, it is not statistically significance (p >0.05)(Table 4). In addition, there was a negative correlation between rectus abdominis muscle strenght tests' values of subjects with sacroiliac joint dysfunction and visual analog scale values. Also, there was a negative correlation between lumbar extensor muscle strength tests' values of subjects with sacroiliac joint dysfunction and visual analog scale which means if the abdominal muscle or lumbar extensor muscle strength increases, pain will decreases (p<0.01)

Table 4. Correlation between visual analog scale and trunk muscle strength values

Correlation coefficient(r)	Sacroiliac Joint Dysfunction				Control Group			
	Abdominal		Lumbar extensors		Abdominal		Lumbar extensors	
	(r)	p	(r)	p	(r)	p	(r)	p
VAS (Visual analog scale)	**-0.637****	**0.003**	**-0.647****	**0.002**	0	1	-0.124	0.60

There were significant differences in single leg stance test values without visual feedback. There was a significant difference in static balance of the left lower extremity without visual feedback between the subjects with sacroiliac joint dysfunction and the control group and there was another difference in static balance of the right lower extremity without visual feedback between these two groups (p<0.05).

DISCUSSION

Sacroiliac joint dysfunction (SIJD) which occurs occurring in 16–30% of patients is a common cause of, low back pain (14) . Individuals with SIJD have a lower quality of life, and they frequently complain of discomfort, disability, and activity restrictions [15,16,17]. The Balance is an important component for activities of daily living, and there are still lack of evidence about the effect of SIJD and balance. The purpose of this study was to investigate the effect of SIJD on balance.

In their systematic review Cranacher et al concluded that core strength training and/or Pilates exercise training can be used as an adjunct or even alternative to traditional balance and/or resistance training programs for old adults [18]. . In their study Hlaing mentioned tahat despite the fact that both workouts for strengthening and stabilizing the core reduce pain, stabilizing the core is more effective than strengthening [19] . Low back pain , which is known to be brought on by SIJ instability, can alter the motor control strategy. It is also mentioned as one of the reasons why chronic low back pain's motor control changes [20].

The majority of studies have shown a relation between weak trunk extensors and chronic low back pain (CLBP) [21,22,23]. However, Descarreaux et al. [24] reported no discernible difference in trunk muscle strength between CLBP patients and healthy controls. Our study found a negative correlation between trunk muscle strength and the visual analog pain scale and a negative correlation between lumbar extensor muscle strength and the visual analog pain scale.

The transversus abdominis, in particular, possesses transversely orientated muscle fibers that have been demonstrated in one study to dramatically reduce the laxity of the sacroiliac joints [25]. Similar to that, we discovered in this study that there was a significant

Table 5. Static and dynamic balance values according to sacroiliac joint dysfunction

			Sacroiliac Joint Dysfunction Group	Control group	p value	
Static Balance Results	Eyes Open	Right *(sec)*	59.8±0.52(58-60)	59.9±0.3(59-60)	0.6	z= -0.51
		Left *(sec)*	59.8 ±0.48(58-60)	59.8 ±0.48(58-60)	1	z=0
	Eyes closed	Right *(sec)*	23.9±17.1(5-60)	35.79±18.58(9-60)	**0.04***	t =-2.1
		Left *(sec)*	17.86±13.71(6-60)	33.57±20.81(5-60)	**0.01***	z=-2.4
Dynamic Balance Results	Bipedal Position	PL(°)	224.65±67.5(127.74-386.13)	233.27±66.37(102.97-333.27)	0.68	t =-0.4
		Agp (%)	6.5± 8.35(-8.13-24.69)	6.55± 10.34(-8.49-31.37)	0.98	t= -0.01
		MS(°/sec)	7.48± 2.25(4.26-12.87)	7.77± 2.21(3.43-11.11)	0.68	t= -0.4
		AP(°)	0.49±1.27(-1.39-3.27)	0.95±1.24(-0.93-3.68)	0.26	t= -1.1
		ML(°)	0.88±1.62(-4.78-2.92)	1.49±0.86(0.16-3.72)	0.14	t = -1.47
	Unipedal Position (Right)	PL(°)	234.9±53.22(169.79-349.84)	20.39±60.24(102.87-332.27)	0.08	t=1.75
		Agp (%)	-0.34±6.4(-6.39-19.64)	-3.19±4.47(-8.72-9.11)	0.11	t= 1.62
		MS(°/sec)	7.83± 1.77(5.66-11.66)	6.78± 2.00(3.43-11.08)	0.08	t=1.75
		AP(°)	0.55±0.74(-1.11-1.46)	0.68±0.7(-0.6-1.94)	0.56	t= -0.57
		ML(°)	1.7±1.0(-1.14-3.49)	1.59±0.93(-0.13-3.12)	0.72	t=0.35
	Unipedal Position (Left)	PL(°)	198.87±48.2(118.23-301.08)	197.17±39.33(133.16-282.96)	0.9	t= 0.12
		Agp (%)	-3.28±3.55(-8.44-5.43)	-4.10± 3.48(-9.28-4.01)	0.46	t= 0.73
		MS(°/sec)	6.55±1.50(3.94-10.04)	6.57± 1.31(4.44-9.43)	0.96	t =-0.03
		AP(°)	0.75±1.04(-1.02-2.61)	0.84±0.74(-0.89-2.16)	0.74	t =-0.52
		ML(°)	0.72± 1.14(-1.78-2.36)	0.66±0.93(-1.67-2.16)	0.85	t=0.18

difference in mean abdominal muscle strength between participants with and without sacroiliac joint impairment . Additionally, there is a positive correlation between abdominal muscle strength and Prokin medspeed and perilength measurements in particular . If abdominal muscle strength increases, perilength measurements and medspeed of displacement during balance will also increase, which could lead to a worsening of dynamic balance.

Either there was a significant difference in mean abdominal muscle strength across participants according to sacroiliac joint dysfunction or there was a significant relation between abdominal muscle strength and prokin medspeed and perilength measures. Despite these sorts of effects, there was no discernible difference between the two groups in terms of prokin perilength and medspeed measures. The anterior tibialis initiates muscular activity in response to backward instability, which is followed by the quadriceps and abdominal muscles since we did not make any evaluation collection strategies use[16]. A person's center of mass can be brought into a stable posture by compansating motions at the ankle during silent stance and minor disturbances [26].

We cannot conclude that abdominal muscle strength has an absolute effect on dynamic balance in participants with SI joint dysfunction and more research is required. Although abdominal muscle strength increased in direct proportion to the increase of perimeter length and medspeed, it has no relationship with the direction of the postural sway.

Although abdominal and lumbar extensor muscle training reduces discomfort, it also leads to an increase in medspeed of displacement and perilength measurement during dynamic balance evaluation, suggesting that dynamic balance may deteriorate as a result of abdominal muscle strengthening. Our belief is that it is preferable to strengthen not just the abdominal muscles but also the lumbar extensors and other stabilizator muscles if the clinician's goal is to increase dynamic balance.

Nies and Sinnott [27] reported that compared to healthy adults, those with low back pain exhibited more postural sway and were less likely to maintain their postural stability when standing on one foot with their eyes closed. Furthermore, Mientjes and Frank [28] observed that doing activities that required the loss of vision significantly enhanced medial/lateral instability in individuals with persistent low back pain, particularly when combined with increased task complexity.

We can conclude from the assessment of the literature that while many studies have looked at the relation between postural control and low back pain, there is little data to support a link between static and dynamic balance control and sacroiliac joint dysfunctions. With our findings, we so hoped to contribute to the existing body of literature. Our findings show that participants with sacroiliac joint dysfunction and the other subjects have substantially altered static balance of the left and right lower limbs without visual feedback. However the sample size of our study was very little, which is a constraint.

CONCLUSION

This study demonstrated that the single left leg stance without visual feedback is found significantly different between the participants with/without sacroiliac joint dysfunction. In contrast, it is not obvious to see relationship between postural control and sacroiliac joint dysfunction. When manual muscle strength values are compared between the two groups and there was a significant difference in the abdominal muscle strength of subjects ($p<0.05$). Moreover, there is a negative correlation between abdominal muscle strength of subjects' with sacroiliac joint dysfunction and visual analog scale values at night. Based on our study results and literature review, strengthening of abdominal muscle is considered as a treatment option of pain relief. In our opinion all trunk stabilizator muscles should be strengthened and additional procedures may be required for management of dynamic balance disturbances in sacroiliac joint dysfunction.

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The authors declare that they have no conflict of interest.
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