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Sacroiliac joint mobilization versus gluteus medius strengthening in sacroiliac joint dysfunction

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The aim of this study was to compare the effect of gluteus medius strengthening exercises versus sacroiliac joint mobilization in anterior sacroiliac joint dysfunction. Comparative study.

Thirty adult patients with pain, tenderness on posterior superior iliac spine and chronic low back pain from both genders participated in this study, their age was ranging from 25 to 40 years old, their body mass index was ranging from 20 to 25 (kg/m^2).

The thirty patients were randomly divided into 2 equal groups with 15 patients each. Both groups were given conventional physiotherapy which included ultrasound and corrective exercises as a baseline treatment. Along with conventional physiotherapy Group A received strengthening exercises for gluteus medius subdivisions while Group B received mobilization techniques. The treatment duration was for 3 weeks. Provocation tests, pelvic tilt angle and pain were measured for evaluation before starting the treatment and then after 3 weeks.

There was no significant difference in pain and pelvic tilt between both groups post-treatment ($p > 0.05$). There was a significant decrease in pain and pelvic tilt angle post treatment in group A and B compared with that pre-treatment ($p < 0.001$). There was no significant difference in the results of provocation tests between group A and B at pre and post treatment ($p > 0.05$). There was a significant decrease in the number of patients who had positive provocation tests post-treatment compared with that pre-treatment ($p < 0.05$) in both groups.

Both the gluteus medius strengthening exercises and the sacroiliac joint mobilization techniques were effective in treatment of anterior sacroiliac joint dysfunction.

Keywords: Sacroiliac joint, gluteus medius, mobilization techniques, sacroiliac dysfunction, provocation tests, corrective exercises, pelvic tilt

INTRODUCTION

Sacroiliac joint (SIJ) pain is pain arising from SIJ structures and SIJ dysfunction (SIJD) generally refers to aberrant position or movement of SIJ structures (Laslett, 2008). An estimated 15–30% of all low back pain cases are due to SIJ pain Schwarzer et al. 1995; Cohen, 2005.

The SIJ is designed for stability rather than mobility. This facilitates safe load transfer through the pelvis. It has been proposed that the stability of the pelvis depends on form and force closure Pool-Goudzwaard et al.1998. A deficit in the form or force closure mechanism may be related to pain disorders of the lumbopelvic region O'sullivan et al. 2002.

The common onset of SIJD occurs with an anterior shift of the line of gravity when leaning forward to perform some task (DonTigny, 1973).

The most critical support necessary to maintain the balanced sacro-innominate relationship when leaning forward is a strong voluntary contraction by the abdominal muscles (DonTigny, 1979; DonTigny, 1990; DonTigny, 2001).If the balanced sacro-innominate relationship is not maintained when leaning forward to lift, bend or lower, the line of gravity will shift anterior to the acetabula and will cause the innominates to rotate anteriorly on the sacrum on an acetabular axis. The pelvis will also rotate anteriorly with a protruding abdomen or with advanced pregnancy causing anterior SIJD Dontigny et al. 2011.

Common pain patterns include medial buttock pain, groin pain, anterior thigh pain, posterior thigh pain, and pain in the superior lateral thigh. Long term sitting present a classic sign of pain from the SIJs. A complaint of unilateral pain rather than bilateral pain is also considered more likely to be coming from an SIJ Young et al. 2003; Boyle, 2012. The pain distribution and tenderness on palpation under the posterior superior iliac spine (PSIS) are reliable signs that the SIJ is the source of pain Maigne et al. 1996.

The gluteus medius (GMED) controls femoral motion primarily during dynamic lower extremity motion and stabilizes the pelvis in the frontal and transverse planes (Schmitz et al. 2002; Earl, 2005). Weakness in or injury to the GMED is associated with ilio tibial band friction syndrome, SIJ pain, and low-back pain (LBP) (Earl, 2005).

In clinical practice, therapists commonly suggest hip abduction exercises as a GMED strengthening exercise for patients with SIJ pain. However, the GMED muscle is segmented into three distinct portions: the anterior, middle, and posterior fibers. Several studies have suggested that the three subdivisions of the GMED can be activated in isolation O'Sullivan et al. 2010.

SIJ mobilization is a method of physical therapy. The advantages of the SIJ mobilization are reported in many aspects, such as decrease of LBP (Bogduk, 2004), decrease lumbar spinal stress by restoring normal function of innominates, promote pelvic symmetry, correct the SIJD, and relax surrounding muscles of the SIJ Kenkampha et al. 2014.

MATERIALS AND METHODS

Thirty adult patients with pain, tenderness on PSIS and chronic LBP from both genders (22 females and 8 males) participated in this study. Patients age was ranging from 25 to 40 years old, their body mass index (BMI) was ranging from 20 to 25 (kg/m^2), minimum 3 positive clinical SIJ provocation tests, SIJ pain score (“average SIJ pain in the last week”) of at least 5 on a 0-10 cm visual analogue scale (VAS), where 0 represents no pain and 10 represents worst imaginable pain. Exclusion criteria included abdominal or back pain referred due to organic cause, neurological disorder, psychosomatic disorders, infectious condition, pregnancy, tumor, recent hip or pelvis fractures or dislocations, radiating pain up to toes, any recent surgeries, severe back pain deemed to be due primarily to other causes (e.g., lumbar disc degeneration, spinal stenosis, etc.) and metabolic bone disease (either induced or idiopathic).

Study Design:

Comparative study. All participants were assigned randomly into two equal groups (A & B).

Group A: Consisted of 15 patients received strengthening exercises for GMED subdivisions as described by Yoo, 2014 and O'Sullivan et al. 2010 and conventional physical therapy (PT) (corrective exercises and theraputic ultrasound (US)) as described by Mathew et al. 2015.

Group B: Consisted of 15 patients received mobilization techniques as described by Dontigny et al. 2011 and conventional PT same as group A.

All participants in both groups were evaluated before and after treatment program.

Instrumentation:

Weight–height scale: used to measure body weight and height of each patient in the study to calculate BMI.

The PALM (palpation meter): The PALM made by performance Attainment Associates (Saint Paul, MN, USA); was used for measuring the pelvic tilt in degrees.

VAS for measuring pain intensity (Hawker et al. 2011).

U.S Device (Mettler Sonicator 730 Ultrasound Machine).

Evaluation Proceures;

Patient's signature was taken in a consent form.

The demographic data for each patient included the name, age, sex and date of participation were collected in an examination sheet.

Height (cm), and weight (kg) were reported. BMI was calculated using the reported data for height and weight (BMI= weight [kg] divided by height [m^2]).

Provocation Tests:

The provocation tests used in this study were: the compression test (side-lying), thigh thrust test, patrick's sign (FABERs), distraction test, gaenslen test.

Pelvic Tilting angle measurement:

Pelvic angle measure was taken in a standardized standing position, with left and right feet spaced equal to the width of the left and right acromial processes and toes facing forward. Subjects were instructed to look straight ahead during standing measures with equal weight over both feet and arms crossed over their chest while the examiner palpated the anterior superior iliac spine ASIS and PSIS. (Nguyen and Shultz, 2009; Herrington, 2011).

Once palpated the calliper tips established position over the marked landmarks and were compressed to a firm resistance as suggested by Gajdosik et al. 1985. The angle of inclination was directly read from the inclinometer by the examiner (Herrington, 2011).

The angle of pelvic inclination represents the angle formed by a line from the ASIS to the PSIS relative to the horizontal plane using inclinometer .This method has been reported to have an ICC of 0.77 to 0.99 for intra tester reliability Krawiec et al., 2003; Shultz et al. 2006.

A study by Herrington (2011) showed that 85% of males and 75% of females have an anteriorly rotated pelvis as measured by the PALM which was on average in the range of 6-7° for both sexes. The study also found that overall there was no significant difference in pelvic angle in standing between the sexes.

The Visual Analogue Scale (VAS):

The patient was asked to describe his pain mainly in the last week by giving it a number where '0' no pain and '10' pain as bad as it could be.

Treatment Procedures:

Strengthening exercises for Gluteus Medius subdivisions :

The anterior GMED exercise: was side lying abduction exercise (Yoo, 2014). Figure 1

The middle GMED exercise: was a wall press exercise O'Sullivan et al. 2010. Figure 2.

Figure (1): Side lying Abduction exercise

Figure (2): Wall Press exercise

The posterior GMED exercise: was the pelvic drop exercise (O'Sullivan et al., 2010). (Figure 3)

Figure (3): pelvic drop exercise

For all exercises, 1 set of 30 repetitions per day were performed for 3 weeks.

Mobilization Techniques :

Dontigny et al. 2011 said this can be done with:

Traction correction (Figure 4).

Figure 4: Traction correction: Stand to one side and gently pull the leg at about 45-degree angle, to enhance the correction have the patient lift his head to tighten his abdominal muscles.

Direct rotation (Figure 5).

Figure 5: Direct rotation

Self-correct Figure 6.

Figure 6: a) **direct self-corrective stretch**, b) **strong isometric contraction**

Oscillations were performed at a rate of about two to three per second for about 1 minute, followed by a rest period of several seconds Dontigny et al. 2011.

Corrective Exercises:

The following low back corrective exercises were given as described by Mathew et al.2015

To stretch the tight lower back muscles: Seated Forward Bend and Full Squat held for 5 sec and repeated for 3 times, once a day.(Figures 7 & 8).

Figure 7: seated Forward bend

Figure 8: Full Squat

To strengthen the weak lower abdomen:

Draw in and Reverse Crunch 3 seconds, repeated 5 times, once a day. (Figures 9 & 10).

Figure 9: Draw in exercise

Figure 10: Reverse Crunch

To stretch the tight hip flexors:

held for 10-15 seconds repeated 5 times on both legs, once a day. **(Figure 11).**

To strengthen the weak gluteus:

Bridge both single and double leg held for 3 seconds, repeated 10 times, once a day. (Figure 12)**.**

To stretch the tight quadriceps:

held for 3 seconds, repeated 5 times on each side, once a day. **(Figure 13).**

To strengthen weak hamstrings:

Kick Butts 2 sec, repeated 8 times, once a day. (Figure 14).

Figure 11: Hip flexor Stretch for the backward leg

Figure (12): Bridging exercise

Figure 13: Quadriceps stretch

Figure14: Hamstring strengthening exercise

Ultrasound:

US was administered in continuous mode at PSIS with patient in prone lying position, with a frequency of 1 MHz and intensity of 0.8 W/cm2 for 5 minutes every alternating day Mathew et al., 2015.

Statistical analysis

Descriptive statistics and Unpaired t-test were conducted for comparison of age and BMI between both groups. Chi- squared test was used for comparison of sex and affected distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to ensure the homogeneity between groups**.** Unpaired t-test was conducted to compare the mean values of VAS and pelvic tilt angle between groups. Paired t-test was conducted for comparison within group. Chi- squared test was used for comparison of provocation tests between groups. McNemar test was conducted for comparison of provocation tests within each group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 22 for windows (IBM SPSS, Chicago, IL, USA).

RESULTS

Subject characteristics:

Table (1) showed the mean ± SD age and BMI of groups A and B. There was a statistically non-significant difference between both groups in the age and BMI ($p > 0.05$). Also, there was a statistically non-significant difference in sex and affected side distribution between groups ($p > 0.05$).

Effect of treatment on score of VAS and pelvic tilt angle:

Within group comparison:

There was a significant decrease in score of VAS and pelvic tilt angle within both groups ($p < 0.001$). The percent of decrease in VAS and pelvic tilt angle in group A were 65.37 and 63.65% respectively. The percent of decrease in VAS and pelvic tilt angle in group B were 58.33 and 59.01% respectively. (Table 2).

Between groups comparison:

There was statistically non-significant difference in the VAS and pelvic tilt between both groups neither pre treatment nor post treatment ($p > 0.05$). (Table 2).

Effect of treatment on results of provocation tests:

Within group comparison:

There was a significant decrease in the number of patients who had positive distraction, compression, thigh thrust and FABER tests in group A ($p < 0.05$) but non-significant difference for gaenslen test. There was a significant decrease in the number of patients who had positive distraction, thigh thrust and gaenslen tests in group B ($p < 0.05$) but non-significant difference for compression and FABER tests. (Table 3).

Table (1): Comparison of subject characteristics between groups:

	x̄±SD				
	Group A	**Group B**	**MD**	**t- value**	**p-value**
Age (years)	30.46 ± 4.56	31.93 ± 4.89	-1.47	-0.84	0.4
BMI (kg/m²)	23.22 ± 1.26	23.5 ± 1.54	-0.28	-0.52	0.6
Males/females	3/12	5/10		(χ^2 = 0.68)	0.4
Affected side Right/left	7/8	9/6		(χ^2 = 0.53)	0.46

x̄, Mean; SD, Standard deviation; MD, Mean difference; χ^2, Chi squared value; p value, Probability value.

Table (2). Mean VAS and pelvic tilt angle pre and post treatment of the group A and B:

	Group A	Group B			
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	MD	t- value	p value
VAS					
Pre treatment	6.93 ± 1.27	7.2 ± 1.52	-0.27	-0.51	0.6
Post treatment	2.4 ± 1.6	3 ± 2.1	-0.6	-0.88	0.38
MD	4.53	4.2			
% of change	65.37	58.33			
t- value	10.42	9.34			
	*p = 0.001**	*p = 0.001**			
Pelvic tilt angle (degrees)					
Pre treatment	8.06 ± 2.52	8.93 ± 2.21	-0.87	-1	0.32
Post treatment	2.93 ± 2.28	3.66 ± 2.94	-0.73	-0.76	0.45
MD	5.13	5.27			
% of change	63.65	59.01			
t- value	8.12	10.49			
	p = 0.001*	p = 0.001*			

$\bar{x}$, mean; SD, standard deviation; MD, mean difference; p-value, probability value; *, significant

Table (3): Provocation tests pre and post treatment of A and B groups:

		Group A	Group B		
		Positive test			
		Frequency	Frequency	χ^2- value	p value
Distraction test	**Pre treatment**	11 (73.3%)	13 (86.7%)	0.83	0.36
	Post treatment	2 (13.3%)	3 (20%)	0.24	0.62
	χ^2- value	7.11	8.1		
	p value	0.004*	0.002*		
Compression test	**Pre treatment**	10 (66.7%)	7 (46.7%)	1.22	0.26
	Post treatment	1 (6.7%)	4 (26.7%)	2.16	0.14
	χ^2- value	7.11	0.8		
	p value	0.004*	0.37		
Thigh thrust test	**Pre treatment**	11 (73.3%)	12 (80%)	0.18	0.66
	Post treatment	5 (33.3%)	2 (13.3%)	1.67	0.19
	χ2- value	4.16	8.1		
	p value	0.03*	0.002*		
Gaenslen test	**Pre treatment**	8 (53.3%)	10 (66.7%)	0.55	0.45
	Post treatment	3 (20%)	2 (13.3%)	0.24	0.62
	χ2- value	1.77	4.9		
	p value	0.18	0.02*		
FABER test	**Pre treatment**	12 (80%)	13 (86.7%)	0.24	0.62
	Post treatment	4 (26.7%)	9 (60%)	3.39	0.06
	χ2- value	6.12	2.25		
	p value	0.008*	0.12		

χ^2, Chi squared value; p value, Probability value; *, significant

Between group comparison:

There was no significant difference in the results of provocation tests between group A & B at pre & post treatment ($p > 0.05$). (Table 3).

DISCUSSION

The main purpose of this study was to compare the effect of GMED strengthening exercises versus SIJ mobilization in anterior SIJD.

It was hypothesized that in patients with Anterior SIJD there would be no significant difference between the effect of GMED strengthening versus mobilization on:

1-Pain.
2-Disability.
3-Pelvic inclination.

The results of this study accepted this general hypothesis.

The current study will be discussed as following:

General characteristics of the subjects:

Age and BMI: there was no significant difference between both groups in age and BMI ($p > 0.05$).

Patients participated in this study aged from (25-40) according to DePalma et al. 2012 as their study said that the presence or absence of thigh pain significantly discriminates SIJ pain from facet joint pain (FJP) for younger (25-40) patients and older (75-90) patients with SIJ pain more likely for younger patients and FJP more likely for older patients. Older individuals with thigh pain are more likely to suffer from FJP than SIJ pain up to age 65, and older individuals without thigh pain are more likely to suffer from SIJ pain than FJP up to age 65.

Irwin et al. 2007 found that the average age of patients with a diagnosis of SIJ pain was in the mid-50s, which is possibly attributable to a degenerative process coupled with movement impairments.

Other studies have focused more on the aging of the SIJ itself. The iliac facet of the joint seems to be the most involved in degenerative changes suggesting that intra-articular derangements could play a significant role in SIJ pain (Faflia et al. 1998; Kampen and Tillmann, 1998).

The BMI used in this study was ranging from (20-25) kg/m2 according to (DePalma et al.2012) as they reported in another study that older age, decreased BMI (18.5-25) kg/m^2 and being female was associated with SIJ pain.

Faflia et al. 1998 have suggested an increased degeneration of the SIJ in obese patients, while Irwin et al., 2007showed that there was no correlation between BMI and SIJ pain as a diagnosis.

In this study there was no significant difference between both groups in sex distribution ($p = 0.4$). Group A contained 12 females with reported percentage of 80% and Group B contained 10 females with reported percentage of 66.7%.

Potential explanations for an association between SIJ pain and female gender and lower BMI include pregnancy related changes to the SIJ Dietrichs, 1991; Albert et al. 2000; Damen et al. 2002; Papageorgiou and Duchatel, 2002; Cusi, 2010), different biomechanical behavior of the SIJ between genders (Dietrichs, 1991; Ross, 2000; O'Sullivan and Beales, 2007), and displacement of weight line anterior to the pelvis in lower BMI subjects. Specific examples of pregnancy-related factors such as poor pelvic floor musculature conditioning, intra-articular bleeding during birthing process, and hormonal induced joint laxity may explain why we observed a significant relationship between female gender and SIJ pain DePalma et al. 2012.

Gluteus Medius treatment group (Group A):

In the current study there was a significant decrease in VAS in group A post treatment compared with that pre treatment ($p = 0.0001$) with percent of change 65.37%.

Yoo, (2014) investigated the effects of individual strengthening exercises for subdivisions of the GMED in a 32 year-old female patient with SIJ pain over a period of 6 months. Pain-provocation tests and VAS scores were evaluated before and after the intervention. The subject showed after 3 weeks no pain in the gaenslen or patrick tests for the left SIJ. The VAS score was less the 3/10, compared with 7/10 initially.

In a study by Barbosa et al.(2013) they used a combined program of manipulation and isotonic exercise (quadriceps eccentric and hamstring concentric contractions) on seven patients. The program aimed to increase pelvic stability by performing 12% of maximum voluntary contraction with the participants in two positions. The basis of their program was to change the number of repetitions at each session to avoid accommodation; as a result of their program, the VAS score changed from 5.83 to 1.29.

Monticone et al.(2004) used specific exercises and postural education for the treatment of SIJD. The participants were educated about how to activate and control the deep abdominal and

lumber multifidus muscle, which acts as a pelvic stabilizer. They were instructed to perform these exercises at home every day during their daily activity. Although their program lacks concentration and accuracy, the patients showed a positive improvement in VAS at several positions, implying a successful intervention.

There were almost no studies focused mainly on strengthening the GMED muscle in SIJD except that of Yoo, (2014), the other studies mentioned above focused on other muscles that when strengthened they increase the pelvic stability and by default improve function and decrease pain.

In the current study the mean difference of the pelvic tilting angle between pre and post treatment was 5.13 degrees and the percent of change was 63.65%. There was a significant decrease in pelvic tilt angle in group A post treatment compared with that pre treatment ($p = 0.0001$)

The GMED subdivisions are primary pelvic stabilizers and are essential for maintaining normal movement patterns of the pelvis and lower limb during daily activities (Anderson, 2003; Brindle et al.2003).

The Results of Boudreau et al. 2009 study supported the function of the GMED as integral to pelvic stabilization versus mainly being described as an active abductor.

The anterior part has fibers running almost vertically from the anterior iliac crest to the top of the trochanter. The fibers of the middle part also tend to be more vertically orientated. The fibers of the more horizontal or posterior part run almost parallel to the neck of the femur Gottschalk et al. 1989).

The anterior and middle GMED were significantly more active during combined abduction and internal rotation than during simple abduction or a combined abduction/external-rotation task Earl, 2005; Otten et al.2015.

A study by Boudreau et al.2009 said that posterior portion of the GMED extends, abducts, and laterally rotates the hip.

Another study by O'Dwyer et al.2011 found that the posterior GMED demonstrated consistently lower levels of activity during abduction than the anterior and middle GMED.

The hypothesis that the posterior GMED would be more active during external rotation because of the more horizontal alignment of its fibers Fredericson et al. 2000; McConnell, 2002; Mascal et al. 2003; Conneely and O'Sullivan, 2008) is contradicted by the results of O'Dwyer et al.2011study, because the posterior GMED actually demonstrates lower activation during external rotation than during either abduction or internal rotation.

In the current study we focused on the anterior dysfunction of the SIJ which happens in the sagittal plane. Nearly all the studies about GMED talked about it`s function in the frontal and transverse planes. But standing on the fact that the posterior portion of the muscle is more horizontal and can extends the hip so we focused on strengthening the GMED with it`s different portions to enhance the pelvic stability, restore pelvic symmetry and correct the anterior SIJD. The results showed a significant decrease in the pelvic tilting angle.

Mobilization treatment group (Group B):

In the current study there was a significant decrease in VAS in group B post treatment compared with that pre treatment ($p = 0.0001$) with percent of change 58.33%.

The decrease in VAS in group B can be illustrated by the fact that the SIJ are richly innervated by nociceptors and proprioceptors Forst et al. 2006. Histological analysis confirms the presence of nerve fibers (myelinated and demyelinated) in the capsule and ligaments and in the mechanoreceptors and nociceptors, suggesting that pain and proprioceptive information is transmitted from the SIJ Jonsson and Nachemson, 2000.Therefore, Barbosa et al expected that by providing specific stimuli to the joint and muscle, positional changes and pain response could be noted Barbosa et al.2013. (Melzack and Wall, 1965) explained the physiological effects of joint mobilization, which is aimed at increasing the range of joint motion and pain reduction, by the gate control theory. The vicious cycle of muscle pain and spasm can be broken by closing the gate where the pain stimulus is largely transmitted through thin filaments, which have slow stimulus conduction velocity, while proprioceptive neurons of thick filaments are stimulated.

SIJ mobilization may facilitate fluid flow physiology dynamics of the local tissue, improve the cellular environment and support the repair process. Its mechanism may also help reduce pain by encouraging the removal of inflammatory by producing and reducing tissue eodema. This role of mobilization in stimulating flow is also important in affecting synovial flow and joint repair processes. It may help reduce joint inflammation, effusion and pain. Manual gating of muscle pain should be close to the area of damage (pain) by

SIJ mobilization. The common observation that muscle pain can be reduced by stretching is possibly related to the stimulation of muscle mechanoreceptors to the exclusion of nociceptors. Pain relief may occur when the muscle's mechanoreceptors gate the pain sensation conveyed by the nociceptors (Lederman, 2005; Zusman, 2005).

Previous study has suggested that the primary effect of SIJ mobilization is a stretch of the connective tissue with mobilization of the passive congestion associated with immobility. Its might also anticipate modulation of neural activity to relieve pain and discomfort and restore more normal neural activity in spinal cord segments (DeStefano, 2011).

In the current study the mean difference of the pelvic tilting angle between pre and post treatment was 5.27 degrees and the percent of change was 59.01%. There was a significant decrease in pelvic tilt angle in group B post treatment compared with that pre treatment ($p = 0.0001$).

The connective tissues might be shortened and tightened as the result of altered position of SIJ articulation and the healing of the inflammatory process following injury (DeStefano, 2011). Moreover, based on the anatomical characteristics of the SIJ were associated with the lumbopelvic rhythm and many muscles across the SIJ, Some study had suggested that the function of SIJ was linked with the lumbar spine and the hip (lumbopelvic rhythm). Additionally, movement of SIJ mechanism appeared to be mainly passive, in response to muscle action in the surrounding area above and below. The researcher has believed that SIJ mobilization would decrease lumbar spinal stress by restoring normal function of SIJ, promote pelvic symmetry, correct the SIJD, and relax surrounding muscles of SIJ Herbert et al. 2011.

Son et al.2014said that the analysis of the pelvis obliquity showed that the intervention of their study provided the greatest statistically significant interaction effect on left and right pelvis obliquity ($p<0.001$). Furthermore, a group performing combined joint mobilization and functional exercise showed statistically significant differences between before and after the exercise whereas the control group performing simple joint mobilization did not ($p<0.001$).

In a previous study, (Yang, 2009) reported the measurement results of changes around the SIJ after 12 weeks of rolling massage for patients with chronic LBP. He found that ilium deviation was reduced by about 2.37 mm, SIJ deviation by about 2.25 mm, and ischium deviation by about 2.5 mm, resulting in a significant difference overall in the SIJ related areas ($p<0.001$).

Conventional PT (Corrective exercises and Theraputic U.S.):

In the current study patients were given stretching exercises for tight lower back muscles, tight hip flexors, and tight quadriceps. Also they were given strengthening exercises for weak lower abdomen, weak gluteus and weak hamstrings.

Most patients with SIJD respond to physical therapy. In a prospective study, Sasso et al reported functional improvement in 95% of the patients with SIJD following PT at a 2-year follow-up Sasso et al. 2001. Inferior results were obtained in 25% of patients with chronic symptoms. Their physical therapy program consisted of patient education, lumbopelvic stabilization exercises, abdominal strengthening, and joint mobilization with adjustments in the training program according to age, body habits, and mobility Zelle et al. 2005.

(Han, 2008) reported that a combination of functional exercises resulted in significant pain relief from 4.61 to 1.94 on VAS, while simple exercise resulted in non-significant pain relief from 3.93 to 1.57. Furthermore, Lim et al.2011 reported that VAS showed a significant difference between before and after Chuna therapy and spinal stabilization exercises for 16 weeks. Significant differences were also found between two groups: a group of single treatment with Chuna therapy and a group of combined treatment of Chuna therapy and spinal stabilization exercise.

In a previous study, (Lee, 2012) reported significant reductions of LBP, functional disorder level, and low back instability in patients with chronic LBP after lower extremity strengthening exercise along with low back stabilization exercise ($p<0.05$). He also claimed that a program of combined exercise performing low back stabilization exercise and lower extremity strengthening exercise was more effective at decreasing LBP, functional disorder level, and low back instability than a stabilization exercise alone.

A principle-centered, functional rehabilitation program (Brolinson and Gray, 2001) that focuses first on the stretching of tight, hypertonic postural muscles, strengthening of weak phasic muscles, and proprioceptive retraining must be carried out (Schlink, 1996; Jones and Tomski, 2000; O'Sullivan, 2000; Comerford and Mottram, 2001). It is critical to remember that muscle imbalances

must be eliminated, and coordinated movement patterns returned to normal before strengthening of the core can begin effectively Brolinson et al. 2003.

CONCLUSION

Both the strengthening exercises for GMED and the SIJ mobilization techniques are effective in treatment on anterior SIJD.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed in this study starting from the evaluation to select patients according to the inclusion criteria, treatment and final evaluation equally.

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