Immediate Effect of Hold-Relax Stretching of Iliopsoas Muscle on Transversus Abdominis Muscle Activation in Chronic Non-Specific Low Back Pain with Lumbar Hyperlordosis

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Objective: *To determine the immediate effect of hold-relax (HR) stretching of the iliopsoas muscle on pain, transversus abdominis (TrA) activation capacity, lumbar stability level, lumbar lordosis angle and iliopsoas muscle length in chronic non-specific low back pain (CNSLBP) with lumbar hyperlordosis.*

Material and Method: *Participants aged from 30-55 years with CNSLBP with lumbar hyperlordosis were divided in two groups: Group 1) Intervention group received 10-second isometric contraction of the iliopsoas muscle (HR), 10-second rest, 20-second static stretch, 5 repetitions. Group 2) control group received 15 minutes resting in supine lying. The visual analog scale, prone test with the pressure biofeedback unit, modified isometric stability test, a flexible ruler and modified Thomas test were used for pre- and post-test. Two-way ANOVA was used for within and between-group comparisons.*

Results: *The present study consisted of 20 participants. Significant differences were found in pain, TrA activation capacity, lumbar lordosis angle and iliopsoas muscle length between intervention and control groups and between pre- and post-test for intervention group ($p<0.05$). Lumbar stability level showed no significant difference in within and between-group comparisons.*

Conclusion: *The HR of the iliopsoas muscle reduced pain and lumbar lordosis angle, enhanced TrA activation, and increased length of hip flexor in CNSLBP with lumbar hyperlordosis.*

Keywords: *Back pain, Hyperlordosis, TrA activation, Hold relax, Iliopsoas*

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Low back pain (LBP) is a common problem among musculoskeletal symptoms. A previous study showed that 85% of LBP are classified as non-specific low back pain (NSLBP)(1). The highest prevalence of NSLBP was found in middle age and elderly groups(1). The common physical factors related to chronic low back pain (CLBP) were abnormal posture, abnormal lumbopelvic alignment, alteration of lumbopelvic muscle length and mobility(2). The spinal stabilization system consists of three inter-relating components: the passive, active and neural control subsystems(3). The dysfunction of motor control in the transversus abdominis muscle (TrA) is related to CLBP(4,5). Shortening of the iliopsoas muscle was found to be the primary cause of lumbar hyperlordosis and excessive anterior pelvic tilt(6). This abnormal alignment may inhibit the function of the TrA(7,8). Murhern and colleagues(9) showed the dysfunction of the TrA muscle was associated with lumbar hyperlordosis. Moreover, the TrA muscle endurance decreased in LBP with lordotic posture, compared with sway back posture or ideal posture when measured with a biofeedback unit (PBU). One study(10) compared the effect of segmental stabilization exercise (SSE) and stretching groups of back and hamstring muscle on pain, disability, and the TrA activation capacity in CLBP. Both groups showed significant improvements. The SSE group was more effective than the stretching group in reducing pain and disability while the stretching group showed no effect on TrA activation(10). However, they did not apply specific stretching on the shortened muscle.

Hold-relax stretching (HR) is one of the

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proprioceptive neuromuscular facilitation (PNF) techniques, commonly used by therapists to increase muscle length, and reduce pain. Notably, only few studies have investigated HR stretching on the length of the iliopsoas muscle[11]. However, previous studies did not demonstrate the treatment effect of the iliopsoas muscle. They did not focus on pain, TrA function and lumbar lordosis after stretching. Therefore, the present study aimed to determine the immediate effect of HR stretching of the iliopsoas muscle on pain, TrA activation capacity, lumbar stability level, iliopsoas muscle length and lumbar lordosis angle.

Material and Method

The study employed a quasi-experimental design.

The study setting recruited participants from the Physical Therapy Center, Faculty of Physical Therapy, Mahidol University.

This study was approved by the Mahidol University Institutional Review Board (MU-IRB COA. NO. 2014/002.0601). All subjects read and signed informed consent forms. Inclusion criteria included chronic non-specific low back pain of more than three months, age between 30-55 years old; both sexes; Body Mass Index (BMI) range between 18.5 to 25 kg/m^2; lumbar lordosis angle was more than mean of normal lordosis angle plus one standard deviation from previous study[12]; shortening of iliopsoas muscle at least one side ("positive" from modified Thomas test)[11]; and back pain intensities at least 3/10 on a 10-cm visual analog scale (VAS). The exclusion criteria comprised having a past history of abdominal, back and hip surgery, fracture of the spine and hip; red flags; menstruation at the time of testing; pain and severe joint stiffness of hip and knee and problems of cardiovascular and respiratory systems. The participants were divided into two groups by convenience sampling (matched age and sex): the intervention group and the control group.

Measurements

All participants were assessed at pre- and post-test by one examiner who was blinded to the participant group. The test-retest reliability value in all measurements were high as shown by ICC(2,1), 1.00 for pain, 0.95 for TrA activation capacity, 0.97 for lumbar lordosis, 0.98 for the length of the iliopsoas muscle and the kappa agreement was 0.87 for the lumbar stability level. Pain intensity was marked on the 10-cm VAS pain during movement that aggravated symptoms. The VAS score was measured from the start of line to their point. The PBU was used to measure both TrA activation capacity and lumbar stability level. The TrA activation capacity was assessed by the prone test with the PBU[13]. Before measurement, all participants were instructed and the abdominal hollowing action was practiced in crook lying and prone positions, once for each position. Subjects received the same instructions for abdominal hollowing action. The pressure change was reported as negative pressure reduction (mmHg). The lumbar stability level was assessed by the modified isometric stability test (MIST)[14]. The MIST was composed of a set of six progressive exercise tests: level 1: abdominal hollowing, level 2: unilateral hip abduction, level 3: unilateral knee extension, level 4: unilateral knee raise, level 5: bilateral knee raise, level 6: bilateral knee raise together. The highest performance level was recorded. The lumbar lordosis angle (θ) measured by a flexible ruler was calculated by the following formula based on the Hard and Rose method[15]:

$$\theta = 4 \arctan 2 h/l$$

l = The length of the line connecting between the point of lumbar level 1 and sacrum level 2.

h = The length of the perpendicular line between the center of l and the curve.

The length of the iliopsoas muscle was assessed by the modified Thomas test using a standard goniometer[11]. The examiner was blind to the goniometer scale during measurement. The passive range of motion (ROM) of hip extension represented the length of the iliopsoas muscle.

Intervention protocol

The HR stretching technique was used in the same position as the modified Thomas test. The shortened iliopsoas in one or both legs was treated by HR. The target hip was moved toward the floor until the participant felt a mild stretch sensation. Then the participant was asked to perform a submaximum voluntary isometric contraction (MVIC) (approximately 25% MVIC)[16] of the iliopsoas muscles for 10 seconds, then completely relax for 10 seconds. The participant's leg was slowly moved to the new range until a mild stretch sensation was felt and held at this position for 20 seconds. This HR stretching was repeated 5 times, followed by a 1-minute rest, for 15 minute. For the control group, the participants took a rest in the supine position for 15 minutes. All subjects were immediately measured after intervention for post test by the same examiner.

Statistical analysis

SPSS version 19 was used for statistical analysis. The level of statistical significant was set at $p<0.05$. Independent sample t-test and Chi-square test were used to determine the difference of the characteristics of the participants. Two-way analysis of variance (two-way ANOVA) was used to determine differences in mean value of the dependent variables for between- and within-groups comparisons when the data indicated a normal distribution. The Mann Whitney U and Wilcoxon signed rank tests were used to compare the MIST level for between- and within-groups comparisons.

Results

No significant differences were found in age, sex and BMI between groups (Table 1). Each group consisted of 2 males and 8 females. Significant differences were found in mean change of pain intensity, the TrA activation capacity, length of iliopsoas muscle and lumbar lordosis between intervention and control groups and between pre- and post-test for the intervention group only ($p<0.05$) (Table 2). For lumbar stability, no significant difference was observed in mean change of MIST level both between- and within-groups comparisons (Table 2).

Discussion

The results of the present study revealed significant improvement of all variables except the lumbar stability level in the intervention group. This result was in contrast with Franca et al[10]. They studied the effect of segmental stabilization exercise (SSE) compared between stretching programs of the back and hamstrings in CLBP for 6 weeks, twice a week and 30 minutes in each session. They found significantly improved TrA activation capacity for SSE only. The results of present study showed a reduction in pain intensity, lumbar lordosis and increased length of the ilopsoas muscle and TrA activation capacity. According to previous studies[7,8] the shortening of the iliopsoas muscle induced abnormal loading on the lumbar spine and mainly caused increased lumbar lordosis and anterior tilting of the pelvis. As a consequence, the abdominal muscles such as TrA were inhibited[7,8]. Another reason was that the vicious cycle of chronic pain might be stopped by HR of the iliopsoas muscle. This was explained by the "pain-spasm-pain model[17]". Back muscle guarding from lumbar hyperlodosis resulted from the shortening of the ilopsoas muscle[8]. This guarding impaired circulation, leading to increased pain (pain-spasm-pain model). The normal negative pressure of TrA activation capacity reported -4 mmHg to the maximum -10 mmHg[18]. Although the TrA activation capacity significantly increased in the present study, post test value showed -2.91 mmHg, though still below the normal range (-4 to -10 mmHg). The lumbar stability level was not significantly increased. Therefore, further studies, designed to provide a sufficient period of training, may be needed.

For clinical implications, low intensity HR or approximately 25% MVIC of the iliopsoas muscles should be applied to reduce back pain, excessive lumbar lordosis, shortening of the iliopsoas muscle and improve the TrA activation capacity among individual CNSLBP with lumbar hyperlordosis. The limitation of the present study was that the TrA function measured by PBU was indirectly assessed. However, for in-depth analysis of the TrA muscle, EMG, ultrasound imaging or other sophisticated technologies can be used in

Table 1. The characteristics of participants at baseline

Variables	Intervention (n = 10)	Control (n = 10)	*p*-value
Age (year)[a]	41.70±9.79	47.20±7.92	0.203
BMI (kg/m²)[a]	22.35±1.59	21.74±1.52	0.393
Pain intensity by VAS (cm)	6.03±2.11	5.66±1.96	0.685
TrA activation capacity (mmHg)	-1.10±1.31	-0.66±1.45	0.861
Lumbar lordosis angle (degree)	70.75±14.78	63.39±10.24	0.212
Left hip extension ROM (degree)	-14.20±9.19	-14.20±5.71	1.000
Right hip extension ROM (degree)	-10.50±10.41	-11.90±10.93	0.773
MIST level	1.90±0.57	2.00±0.47	0.673

VAS = visual analog scale; TrA = transversus abdominis muscle; MIST = modified isometric stability test; BMI = body mass index

[a] Independent sample t-test for age and BMI

Table 2. Comparison of mean change of pain intensity, TrA activation capacity, lumbar lordosis angle, iliopsoas muscle length (hip extension ROM) and MIST level between and within group comparisons

Parameter	Pre-test mean $\pm$ SD	Post-test mean $\pm$ SD	Mean difference (post-pre) mean $\pm$ SD		*p*-value
			Within	Between	
Pain intensity (VAS; cm)					
Intervention	6.03$\pm$2.11	3.26$\pm$2.64	2.77$\pm$2.23	0.003*	0.010*
Control	5.66$\pm$1.96	5.74$\pm$2.04	0.08$\pm$0.30	0.427	
TrA capacity (mmHg)					
Intervention	-1.10$\pm$1.31	-2.91$\pm$1.94	-1.81$\pm$1.55	0.005*	0.003*
Control	-0.99$\pm$1.44	-1.10$\pm$1.43	-0.31$\pm$0.67	0.178	
Lumbar lordosis angle (°)					
Intervention	70.75$\pm$14.78	63.29$\pm$16.11	-7.46$\pm$5.05	0.001*	0.001*
Control	63.39$\pm$10.24	63.81$\pm$10.07	0.41$\pm$0.76	0.120	
Left hip extension ROM (°)					
Intervention	-14.20$\pm$9.19	-1.30$\pm$2.16	12.90$\pm$9.69	0.002*	0.002*
Control	-14.20$\pm$5.71	-14.00$\pm$6.45	0.20$\pm$1.13	0.591	
Right hip extension ROM (°)					
Intervention	-10.50$\pm$10.41	-0.50$\pm$1.08	10.00$\pm$10.43	0.014*	0.008*
Control	-11.90$\pm$10.93	-11.50$\pm$10.68	0.40$\pm$0.69	0.104	
MIST level[a] (Median (Q1, Q3))					
Intervention	2 (1.75, 2)	2 (2, 2.25)	0 (0, 0.25)	1.000	0.146
Control	2 (2, 2)	2 (2, 2)	0 (0, 0)	0.157	

[a] analyzed by Non-parametric statistics
* *p*-value <0.05 analyzed by two-way ANOVA

future studies.

Conclusion

HR stretching can reduce back pain, excessive lumbar lordosis angle, lengthen the iliopsoas muscle and increase TrA activation capacity. However, the lumbar stability level was not changed in the present study.

What is already known on this topic?

Chronic low back pain patient has insufficient TrA function, the length of hip flexor muscles and lumbar lordosis are associated.

What this study adds?

The immediate effect of HR stretching on iliopsoas muscle can reduce pain intensity, excessive lumbar lordosis and improve the quantifiable function of the TrA muscle in NSCLBP with lumbar hyperlordosis.

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Potential conflicts of interest

None.

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ผลทันทีของการยืดด้วยการเกร็งและผ่อนคลายของกล้ามเนื้อไอลิโอโซแอสต่อประสิทธิภาพการทำงานของกล้ามเนื้อทรานซ์เวอร์ซัสแอบโดมินิสในผู้มีอาการปวดหลังส่วนล่างเรื้อรังแบบไม่จำเพาะร่วมกับกระดูกสันหลังส่วนเอวแอ่นกว่าปกติ

สุทธิฉันท์ มาลัย, โสภา พิชัยยงค์วงศ์ดี, ประเสริฐ สกุลศรีประเสริฐ

วัตถุประสงค์: *ศึกษาผลทันทีของการยืดด้วยการเกร็งและผ่อนคลายของกล้ามเนื้อไอลิโอโซแอสต่ออาการปวด ประสิทธิภาพการทำงานของกล้ามเนื้อทรานซ์เวอร์ซัส แอบโดมินิส ระดับความมั่นคงกระดูกสันหลังส่วนเอว มุมแอ่นกระดูกสันหลังส่วนเอว และความยาวกล้ามเนื้อไอลิโอโซแอส ในคนปวดหลังส่วนล่างเรื้อรังแบบไม่จำเพาะร่วมกับกระดูกสันหลังส่วนเอวแอ่นกว่าปกติ*

วัสดุและวิธีการ: *ผู้เข้าร่วมการศึกษาอายุระหว่าง 30-55 ปี มีอาการปวดหลังส่วนล่างเรื้อรังแบบไม่จำเพาะร่วมกับกระดูกสันหลังส่วนเอวแอ่นกว่าปกติ แบ่งเป็น 2 กลุ่ม: กลุ่ม 1 กลุ่มการรักษาได้รับการเกร็งค้างของกล้ามเนื้อ ไอลิโอโซแอส 10 วินาที ช่วงพัก 10 วินาที ช่วงยืดค้าง 20 วินาที จำนวน 5 ครั้ง กลุ่ม 2 กลุ่มควบคุมได้รับการพักในท่านอนหงายเป็นเวลา 15 นาที การทดสอบด้วย visual analogue scale, การทดสอบท่านอนคว่ำร่วมกับอุปกรณ์วัดแรงดัน, modified isometric stability, ไม้บรรทัดกระดูกงู และ modified Thomas ใช้เป็นการทดสอบก่อนและหลัง ใช้สถิติ Two-way ANOVA เปรียบเทียบความแตกต่างระหว่างกลุ่มและภายในกลุ่ม*

ผลการศึกษา: *ผู้เข้าร่วมการวิจัยในการศึกษานี้ จำนวน 20 คน พบความแตกต่างอย่างมีนัยสำคัญทางสถิติในอาการปวด ประสิทธิภาพการทำงานของกล้ามเนื้อทรานซ์เวอร์ซัส แอบโดมินิส มุมแอ่นกระดูกสันหลังส่วนเอวและความยาวกล้ามเนื้อไอลิโอโซแอส ระหว่างกลุ่มรักษาและกลุ่มควบคุม และระหว่างการทดสอบก่อนและหลังในกลุ่มการรักษา ($p<0.05$) ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติของระดับความมั่นคงกระดูกสันหลังส่วนเอวทั้งระหว่างกลุ่มและภายในกลุ่ม*

สรุป: *การยืดด้วยการเกร็งและผ่อนคลายของกล้ามเนื้อไอลิโอโซแอส สามารถลดอาการปวดและมุมแอ่นกระดูกสันหลังส่วนเอวเพิ่มประสิทธิภาพการทำงานของกล้ามเนื้อทรานซ์เวอร์ซัส แอบโดมินิส และเพิ่มความยาวกล้ามเนื้อไอลิโอโซแอส ในคนปวดหลังส่วนล่างเรื้อรังแบบไม่จำเพาะร่วมกับกระดูกสันหลังส่วนเอวแอ่นกว่าปกติ*