J Int Acad Phys Ther Res 2019; 10(3): 1834~1839
ISSN 2092-8475
www.japtr.org
https://doi.org/10.20540/JIAPTR.2019.10.3.1834

Effects of Static and Dynamic Stretching on Lumbar Lordotic Angle and Low Back Pain in University Students

Background: Lumbar lordosis is a result of muscle shortening and may cause low back pain. Objective: To examine the effects of static and dynamic stretching on lumbar lordosis and low back pain in university students. Stretching is an intervention that can be applied to shortened muscles; however, very few studies have compared the effects of static and dynamic stretching on lumbar lordosis and low back pain.
Design: Randomized controlled clinical trial (single-blind)
Methods: The 12 selected subjects were randomly assigned static stretching and dynamic stretching groups each containing six students. The subjects in each group performed their respective stretching programs for 17 minutes, 3 times a week for 4 weeks. Lumbar lordotic angle, low back pain, and Oswestry Disability Index (ODI) were measured before and after the intervention.
Results: Intragroup comparisons showed significant reductions in lumbar lordotic angle and low back pain in the static stretching group while the dynamic stretching group showed significant decreases in lumbar lordotic angle, low back pain, and ODI. The intergroup comparisons showed significantly greater differences between pre- and post-intervention in lumbar lordotic angle and low back pain in the dynamic stretching group compared to those in the static stretching group while ODI did not show any intergroup difference.
Conclusions: The results of this study indicated that, while both static and dynamic stretching helped to reduce the lumbar lordotic angle and low back pain, dynamic stretching was more effective in alleviating lumbar lordotic angle and low back pain compared to static stretching.

Key words: *Lumbar lordosis ; Low back pain; Static stretching; Dynamic stretching*

Heayoung Ga, Ph.D[a], Mina Gim, PT, Ph.D[b]

[a]Department of Physical Therapy, Namseoul University, Republic of Korea
[b]Department of Physical Therapy, Wonkwang Health Science University, Republic of Korea

Received : 28 June 2019
Revised : 25 July 2019
Accepted : 03 August 2019

Address for correspondence
Mina Gim, PT, Ph.D
Department of Physical Therapy, Wonkwang Health Science University, 514, Iksan-daero, Iksan-si, Jeollabuk-do, 54538, Republic of Korea
Tel: 82-10-7396-0120
E-mail: happyday0120@naver.com

INTRODUCTION

In lumbar lordosis, the lumbar region shows excessive curvature along with excessive anterior tilting of the pelvis as a result of hyperextension of the lumbar region caused by a downward movement of the pubic symphysis when the pelvis tilts forward [1]. The pelvis tilts forward due to a shortening of the erector spinae, rectus femoris, and the iliopsoas muscle that pull the lumbar forward. A study comparing the hip joint between individuals with and without low back pain reported a shorter iliopsoas muscle as well as a significantly smaller hip joint angle in the low back pain group than that in the control group [2]. This lumbar lordosis, in turn, increases the load on the facet joint, causing abnormal rhythm in the lumbar and pelvis, resulting in low back pain [3, 4]. An increase in lumbar lordosis also increases the lumbosacral angle, which reduces the intervertebral foramen gap between L5 and S1, causing pain in the lower extremities as the sciatic nerve is pressed [5].

Stretching is generally applied as an intervention for shortened muscles. Stretching is performed to increase the range of motion (ROM) of joints and to prevent the risk of damage due to shortened muscles [6]. Stretching can be largely divided into static and dynamic. In static stretching, a fixed posture is maintained as the tension in the stretched muscle is maintained for a certain time, slowly lengthening the muscle for as long as it can hold to the point of relaxation [7]. Performance is enhanced by improving the coordination of joints [8] through increase and maximization of the range of joint motion [9]. In dynamic stretching, repetitive exercise is performed using a bouncing movement while the muscle is stretched. The repetitive contraction of the agonist muscle is used to bring about a rapid contraction in the antagonist muscle; the range of joint motion is increased through a series of torsion or traction in the resisting muscle tissues. In addition, dynamic stretching increases flexibility through the movement of the joints without a reduction in neuromuscular activity [10], showing a greater enhancing effect than static stretching on most motor performances including agility, lower limb muscle power, and jumping ability [11].

Recent studies have shown that dynamic stretching increases the central temperature of the muscles due to active and rhythmic movements, provides opportunities for practice before the main exercise, and increases blood flow to the muscles to facilitate oxygen transport, thereby increasing the range of joint movement more than static stretching does through increased by-product (H +) removal and nerve conductivity [12]. However, Hwang (2013) reported a greater effect on joint ROM for static stretching compared to dynamic stretching [13]. Thus, controversy exists regarding the effects of different types of stretching. Therefore, this study aimed to compare the effects of static and dynamic stretching on lumbar lordosis and low back pain to identify an effective intervention for lumbar lordosis while providing information on the effects of stretching by type.

SUBJECTS AND METHODS

Subjects

The study was conducted in 12 male and female students at N University located in Chungnam. Six subjects each were randomly assigned to the static stretching group (age = 20.83 ± 0.98 years; height = 163.33 ± 7.20 cm; body weight = 69.48 ± 23.71 kg) and dynamic stretching group (age = 21.00 ± 0.89 years; height = 164.90 ± 10.39 cm; body weight = 62.53 ± 10.06 kg). The subjects were selected based on the following inclusion criteria: (1) lumbar lordotic angle of at least 40°, (2) no history of spinal disease, (3) visual analogue scale (VAS) score of 3 or above for low back pain, and (4) no neurological symptoms [14, 15]

All subjects were provided sufficient explanation on the study objective and procedures before their participation and they voluntarily signed an informed consent form. This study was approved by the Institutional Review Board of Namseoul University (No. NSUIRB-201908-008).

Intervention

The stretching interventions were performed for 17 minutes per session, 3 times a week for a total of 4 weeks. The same stretching programs were performed by the static and dynamic stretching groups; whereas in the static stretching group, the motion was maintained for 30 seconds with a focus on stretching the muscle to the maximum, the dynamic stretching group focused on stretching the muscle to the maximum for 30 seconds using a bouncing movement in addition to maintaining the stretching movement. The detailed stretching program is shown in 〈Table 1〉. The exercise program was combined or modified based on existing studies [1, 16]. The intervention was carried out as a group exercise in the research

Table 1. Stretching exercise program

Order	Type	Duration (17 min)	Period
Warm-up	Cat pose	30 sec	
	Cobra pose	for 30 sec	
Stretching	Knee to chest hip stretch	each side	4 weeks
Cool-down	Lower back twist stretch	×	
	Modified kneeling lunge stretch	3 rep	
	Prayer pose	30 sec	

Rest: between set & type 15 sec
Static stretching group: hold for 30 sec, Dynamic stretching group: bouncing movement and holding for 30 sec at the same time

laboratory for each group. During the stretching intervention for each group, the researcher provided verbal feedback on the motion. Lumbar lordotic angle, low back pain, and Oswestry Disability Index (ODI) were measured before and after completing the 4–week intervention.

Measurement methods

Lumbar lordotic angle

The lumbar lordotic angle was measured in this study using a Formetric II instrument (Diers, Germany). The Formetric is an optical measurement device used to test for spinal deformity. It also provides rapid and accurate measurement of the spinal and pelvic structures while its halogen lamp measures the posterior image of the trunk without radiation exposure, providing information on the spinal structure and angle [17].

Low back pain

Low back pain was measured in this study using a VAS. The instrument was scaled from 0 to 10㎝ and the participants were asked to mark their condition on the scale, where 0 and 10 cm indicated no pain and the most severe pain, respectively. As VAS score below 3 was categorized as mild pain; while scores of 4-6 and 7-10 were categorized as moderate and severe pain, respectively [18].

Oswestry Disability Index (ODI)

In this study, ODI was measured using ODI, the Korean version translated by Jeon et al. (2005). The ODI consists of 9 questions with 5 possible points for each, for a total of 45 points. The first question of each section is 0 point and the last question is 5 points. A disability index score of 0–20% indicates mild disability in which daily life is still possible; 21–40% indicates moderate disability with difficulty and pain in sitting down, lifting or standing up and increased difficulty with social life in which working is sometimes impossible; 41–60% indicates severe disability affecting daily life in which pain is a major problem; 61–80% indicates near disability in which low back pain significantly affects the overall life and requires active treatment; and 81–100% indicates bed–ridden status or exaggerated symptoms [19].

Statistical analysis

All the measured data were processed by the program of IBM SPSS Statistics version 20.0. The normal distribution of all the data was validated by the K– S (Kolmogorov– Smirnov) test and the general characteristics of the subjects were calculated by descriptive statistics. Student's paired t–test was performed to compare intragroup dependent variables, and intergroup dependent variables were compared by independent t–test. The significance level was set to $\alpha = .05$.

RESULTS

The results of the study showed that the lumbar lordotic angle and low back pain in the static stretching group were significantly reduced in the intragroup comparison before and after the intervention. In the static stretching group, lumbar lordotic angle, low back pain, and ODI decreased significantly after the intervention ($p<.05$). The results of this study showed significantly greater differences after the intervention for dynamic stretching compared to those for static stretching in comparisons of intergroup differences in lumbar lordotic angle and low back pain ($p<.05$).

DISCUSSION

The objective of this study was to examine the effects of both static and dynamic stretching on the

Table 2. Comparisons lumbar lordotic angle, low back pain and ODI between before and after stretching intervention.

Variables	SSG			DSG			Between group (p)
	pre	post	p	pre	post	p	
LLA (degree)	47.17±5.38	43.0±6.39	0.00*	46.5±4.68	40.17±5.71	0.00*	0.02*
VAS (cm)	3.50±0.84	2.67±0.82	0.00*	4.33±1.21	2.33±1.03	0.00*	0.00*
ODI (score)	2.83±1.33	2.0±0.63	0.14	4.83±2.23	2.67±1.63	0.02*	0.13

*$p<.05$, Mean±SD, SSG: static stretching group, DSG: dynamic stretching group, LLA: lumbar lordotic angle, VAS: visual analogue scale, ODI: oswestry disability index

lumbar lordotic angle and low back pain in university students.

The results of the study showed that the lumbar lordotic angle and low back pain in the static stretching group were significantly reduced in the intragroup comparison before and after the intervention. In the static stretching group, lumbar lordotic angle, low back pain, and ODI decreased significantly after the intervention ($p<.05$). Previous research has shown that stretching relaxes actin and myosin, which in turn extends connective tissues such as muscles, tendons, and ligaments and induces a permanent increase through changes in the extracellular matrix [20]. Baek (1997) reported that the advantages of stretching included increased flexibility and reduced muscle tension, alleviation of myalgia, increased circulation, and reduced muscular resistance through the prevention of excessive adhesion between muscles [21]. Given these factors, static and dynamic stretching may significantly reduce the lumbar lordotic angle by relaxing the shortened iliopsoas muscle, erector spinae, and rectus femoris.

An abnormal spinal curve causes a load on surrounding muscles or tissues; pain in the soft tissues or joint structure caused by this load induces secondary pain or overall dysfunction of the spine [22]. In this study, the lumbar lordotic angle decreased after the stretching interventions, which may have reduced the low back pain in the students due to structural changes.

The results of this study showed significantly greater differences after the intervention for dynamic stretching compared to those for static stretching in comparisons of intergroup differences in lumbar lordotic angle and low back pain ($p<.05$). The significant differences in lumbar lordotic angle and low back pain were likely due to the effectiveness of dynamic stretching in increasing blood flow, muscle temperature, oxygen and energy consumption [23], and viscoelasticity in the myotendinous junction [24] as well as decreasing the threshold for motor unit recruitment with post-activation potentiation (PAP) and increasing the efficiency in muscle contraction by increasing the rate of cross-bridge formation in the muscles [25]. In contrast, static stretching requires relatively more time than dynamic stretching to obtain therapeutic effects [26]. The significant difference observed between the two types of stretching may stem from the difference in the characteristics of each type of stretch. In addition, recent studies show that dynamic stretching more quickly increase the joint ROM and flexibility compared to static stretching; therefore, dynamic stretching is recommended as a warm-up exercise [27, 28, 29]. Furthermore, an immediate beneficial effect has been reported for short-distance running and jumping after dynamic stretching [27, 29, 30, 31], suggesting that dynamic stretching is more effective than static stretching for muscular performance [28, 30, 32]. The studies mentioned above focused on the immediate effects of dynamic stretching while this study used a 4-week intervention; however, the advantages of dynamic stretching still seemed to have contributed to the higher efficacy observed after the intervention compared to that for static stretching. Comparative physiological neuromuscular studies on the long-term application of static and dynamic stretching are required to clarify this observation.

This study did not observe a significant intergroup difference in ODI. In previous studies, Ahn (2000) applied hamstring stretching 5 times a week for 6 weeks [33], while Bae (2017) applied stretching of the tensor fascia latae 7 times a week for 2 weeks [34]. In this study, stretching was applied 3 times a week for 4 weeks to the iliopsoas muscle, erector spinae, and the rectus femoris; however, this intervention was not sufficient to change the movement pattern [35] and the difficulty in activity of daily living (ADL) [36] due to the difference in research methodology such as the muscles stretched and the intervention duration. Subsequent research is required after modification of the methodology.

The limitation of the study was the small sample size with adults in their 20s, which makes it difficult to generalize the results to the general population with lumbar lordosis and low back pain.

CONCLUSION

This study examined the effects of static and dynamic stretching on lumbar lordosis angle and low back pain in university students. Intragroup comparisons showed significant reductions in lumbar lordosis angle and low back pain in the static stretching group and significant reductions in lumbar lordosis angle, low back pain, and ODI in the dynamic stretching group. The intergroup comparison showed significantly greater differences before and after the intervention in the dynamic stretching group compared to those in the static stretching group, with no significant difference in ODI. Therefore, the results of this study indicate that, while both are useful in the reduction of lumbar lordosis angle and low back pain, dynamic stretching is more effective than static stretching in relieving lumbar lordosis angle and low back pain.

REFERENCES

1. Prentice WE, Voight MI. Techniques in musculoskeletal rehabilitation. New York: McGrawHill, 2005.
2. Lee JY, Yoon HI. The comparison of iliopsoas tightness between low back pain patients and healthy subjects. J Korean Acad Orthop Man Physi Ther. 2006; 12(2): 11–20
3. Dunlop RB, Adams M A, Hutton WC. Disk space narrowing and the lumbar facet joint. J Bone Joint Surg Br. 1984; 66(5): 706–10.
4. King JC, Lehmkuhl DL, French J, et al. Dynamic postural reflexes: Comparison in normal subjects and patients with chronic low back pain. Curr Concepts Rehabil Med. 1988; 4: 7–11.
5. Caillit R. Low back pain syndrome. Philadelphia: F.A Davis, 1995.
6. Jonhagen S, Nemeth G, Eriksson E. Hamstring injuries in sprinters. The role of concentric and eccentric hamstring muscle strength and flexibility. Am J Sports Med. 1994; 22(2): 262–6.
7. Anderson B, Burke ER. Scientific, medical, and practical aspects of stretching. Clin Sports Med. 1991; 10(1): 63–86.
8. Shellock FG, Prentice WE. Warming–up and stretching for improved physical performance and prevention of sports–related injuries. Sports Med. 1985; 2(4): 267–78.
9. Marek SM, Cramer JT, Fincher AL, et al. Acute effects of static and proprioceptive neuromuscular facilitation stretching on muscle strength and power output. J Athl Train. 2005; 40(2): 94–103.
10. Weerapong P, Hume PA. Kolt GS. Stretching: Mechanisms and benefits for sport performance and injury prevention. Phys Ther Rev. 2004; 9(4): 189–206.
11. Frantz TL, Ruiz MD. Effects of dynamic warm–up on lower body explosiveness among collegiate baseball players. J Strength Cond Res. 2011; 25(11): 2985–90.
12. Curry BS,Chengkalath D, Crouch GJ, et al. Acute effects of dynamic stretching, static stretching, and light aerobic activity on muscular performance in women. J Strength Cond Res. 2009; 23(6): 1811–9.
13. Hwang DK. The effects of stretching types on judo player's joint working range. Yongin University, Master degree, 2013.
14. Wiltse LL, Winter RB. Terminology and measurement of spondylolisthesis. J Bone Joint Surg Am. 1983; 65(6): 768–72.
15. Collins SL, Moore RA, McQuay HJ. The visual analogue pain intensity scale: what is moderate pain in millimeters? Pain. 1997; 72(1–2): 95–7.
16. Solberg G. Postural disorders and musculoskeletal dysfunction. London. Churchill Livingstone, 2007.
17. Drerup B, Hierholzer E. Automatic localization of anatomical landmark on the back surface and construction of body–fixed coordinate system. J Biomech. 1987; 20 (10): 961–70.
18. Jensen MP, Smith DG, Ehde DM, et al. Pain site and the effects of amputation pain: further clarification of the meaning of mild, moderate, and severe pain. Pain. 2001; 91(3): 317–22.
19. Jeon CH, Kim DJ1, Kim DJ2, et al. Cross–cultural adaptation of the korean version of the oswestry disability index (ODI). J Korean Soc Spine Surg. 2005; 12(2): 146–52.
20. Taylor DC, Dalton JD Jr, Seaber AV, et al. Viscoelastic properties of muscle–tendon units. The biomechanical effects of stretching. Am J Sports Med. 1990; 18(3): 300–9.
21. Paek HJ. Effects of stretching techniques on the flexibility of soleus muscle. Ewha Womans University, Master degree, 1997.
22. Cailliet R. Neck and arm pain. Philadelphia: FA Davis; 1991.
23. Thacker SB, Gilchrist J, Stroup DF, et al. The impact of stretching on sports injury risk: a systematic review of the literature. Med Sci Sports Exerc. 2004; 36(3): 371–8.
24. McNeal JR, Sands WA, Stone MH. Effect of fatigue on kinetic and kinematic variables during a 60–second repeated jumps test. Int J Sports Physiol Perform. 2010; 5(2): 218–29.
25. Young WB, Behm DG. Effects of running, static stretching and practice jumps on explosive force production and jumping performance. J Sports Med Phys Fitness. 2003; 43(1): 21–7.
26. Yang SH. A study of lower extremities performance according to the methods of stretching. Korea Entertainment Industry Association. 2015; 11: 141–50.
27. Wiemann K, Hahn K. Influences of strength, stretching acid circulatory exercises on flexibility parameters of the human hamstrings Int J Sports Med. 1997; 18(5): 340-6.
28. Perrier ET, Pavol MJ, Hoffman MA. The acute effects of a warm–up including static or dynamic stretching on countermovement jump height, reaction time, and flexibility. J Strength Cond Res. 2011; 25(7): 1925-31.

29. Ryan ED, Everett KL, Smith DB, et al. Acute effects of different volumes of dynamic stretching on vertical jump performance, flexibility and muscular endurance. Clin Physiol Funct Imaging. 2014; 34(6): 485-92.
30. Yamaguchi T, Ishii K. Effects of static stretching for 30 seconds and dynamic stretching on leg extension power. J Strength Cond Res. 2005; 19(3): 677-83.
31. Pappas PT, Paradisis GP, Exell TA, et al. Acute effects of stretching on leg and vertical stiffness during treadmill running. J Strength Cond Res. 2017; 31(12): 3417–24.
32. Amiri–Khorasani M, Calleja–Gonzalez J, Mogharabi–Manzari M. Acute effect of different combined stretching methods on acceleration and speed in soccer players. J Hum Kinet. 2016; 50: 179-86.
33. Ahn CS. The effects of hamstring stretching exercise on the angle of lumbar flexion and function of activation with chronic low back patients. Dankook University, Master degree, 2000.
34. Bae HI. The effect of a loading static stretch on pain, flexibility, pelvic tilt, and oswestry disability index in patients with low back pain and shortened tensor fascia lata. Kyungnam University. Master degress, 2017.
35. Zusman M. Central nervous system contribution to mechanically produced motor and sensory responses. Aust J Physiother. 1992; 38(4), 245–55.
36. Faas A. Exercises: which ones are worth trying, for which patients, and when? Spine. 1996; 21(24): 2874–8.