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Self-management techniques and subsequent changes in pain and function in patients with chronic low back pain

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만성 요통 환자의 자가 관리 요법에 따른 통증 및 기능의 변화

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Abstract To investigate the effects of self-management programs for chronic low back pain (LBP), 63 subjects were assigned to three groups; self-exercise group (SEG), hot pack and low-frequency electrical stimulation group (HEG), and thermo-massage group (TMG). Parameters were the pain numeric rating scale (PNRS), Oswestry Disability Index (ODI), Roland Morris Disability Questionnaire (RMDQ) and Relapse frequency (RF). PNRS, ODI and RMDQ of SEG and TMG sustained effectiveness, however, PNRS, which improved after treatment in HEG, worsened in 6 month. Between the groups, all parameters were better in SEG and TMG compare to HEG. Exercise and thermo-massage can be considered as useful self-management performed at home to prevent the relapse of chronic LBP.

Key Words : Low back pain, Exercise, Hot pack, Spinal thermal massage device, Electrical Therapy

요 약 재활치료를 받고 호전된 만성 요통 환자들이 집에서 수행하는 자가 관리 프로그램의 효과를 알아보고자 63명을 자가 운동 (SEG), 핫팩 및 저주파 전기 자극 (HEG) 및 온열 마사지 (TMG) 3개 그룹으로 나누었다. 통증장애 지표로 통증 수치 등급 척도 (PNRS), Oswestry 장애 지수 (ODI) 및 Roland Morris 장애 설문지 (RMDQ)를 병원 내원시, 치료 후 및 가정에서 자가 관리 6 개월 후에 평가하였고 재발 빈도 (RF)를 내원 전 6 개월 전과 자가관리 6 개월 후에 평가하였다. 각 그룹 내의 비교에서 SEG 및 TMG의 PNRS, ODI, RMDQ는 6개월 후에도 효과가 유지되었으나, HEG에서는 치료 후 개선되었던 PNRS가 6개월 후에 악화되었다. 그룹간 비교에서 SEG 및 TMG의 PNRS, ODI, RMDQ 및 RF는 6개월 후에 HEG에 비해 더 좋았다. 운동과 온열 마사지는 요통 자가 관리 방법으로 고려볼 수 있으나, 향후 더 많은 환자들과 다양한 연령, 직업들을 고려하여 추가 연구가 필요하다.

주제어 : 요통, 운동, 온열, 척추온열마사지기, 저주파치료, 자가치료

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1. Introduction

Low back pain (LBP) is induced by a number of factors, such as various activities of daily living, injury, incorrect posture, obesity, stress, and inappropriate exercise. The incidence and prevalence of LBP are high, with approximately 60-80% of adults suffering from LBP[1]. Furthermore, LBP is known as the most common cause of loss of labor ability[2].

While most cases of LBP improve within a few weeks, it becomes chronic in 6-10% patients [3-6], and recurs within a year in 24-87% patients[7-9]. The patient incurs financial burden and time loss from the frequent treatment required for LBP recurrences. Furthermore, patients' quality of life deteriorates as it affects their physical, mental, and social aspects of life[10].

Chronic LBP is defined as lumbosacral pain persisting for 12 weeks or longer that may limit the range of motion (ROM) of the spine and function[11]. While LBP may be provoked by degeneration of the intervertebral disc, spinal muscle or ligament strain, or otherspinal disorders, but some cases have unclear mechanisms and are multifactorial[12]. The treatment goal for chronic LBP is not simply to reduce pain, but also to keep functional activities while maintaining normal daily living[13]. Conservative therapies for LBP include physiotherapies, such as thermotherapy, massage, electrical therapy, therapeutic ultrasound and traction, pharmacological and injection therapies, muscle-strengthening exercises, flexibility exercises, spinal stabilization exercises, as well as proper posture training[14]. Although the effectiveness of these treatments have been confirmed in past studies, it is difficult for doctors and nurses, under the Korean national health insurance system to spend time in providing detailed information to educate patients due to cost and time constraints. Moreover, even if patients were given such information, ensuring continuous compliance is difficult without periodic supervision and management. Many LBP patients have their preferred self-management techniques to practice at home, but studies comparing the effectiveness of each method is in reducing pain and preventing recurrence are lacking.

Thus, this study aimed to investigate the effects of various forms of self-management on LBP management, changes in function, and incidence of recurrence in patients with chronic LBP.

2. Subjects and Method

2.1 Subjects

This study was approved as per the applicable laws and regulations, including the Bioethics and Safety Act, Pharmaceutical Affairs Act, Medical Device Clinical Trials Management Standards, and by the institutional review board. Among the patients who presented to the hospital with LBP as the chief complaint, only those who showed improvement after undergoing 2~3 weeks of rehabilitation therapy at the hospital were included. Medical records of patients who received the same nonsteroidal anti-inflammatory drug (NSAID) doses, injection, manual therapy and physiotherapy, including low-frequency electrical stimulation (transcutaneous electrical nerve stimulation; TENS), hot packs and ultrasound therapy, three times a week while being trained for self-exercises were reviewed. The inclusion criteria were ≥ 12 weeks of LBP, age 19-75 years, frequent recurrence of LBP prior to hospital visit, a pain numeric rating scale (PNRS) of ≥ 3, and Oswestry Disability Index (ODI) of ≤ 50%. As per the definition suggested by de Vet HC et al, which has been gaining support in recent studies, LBP recurrence was defined as at least one episode of LBP that persists for more than 24 hours within a

pain-free period of 6 months[15-17].

The exclusion criteria were herniated disc, spinal nerve root compression, history of lumbar surgery, comorbidity of infection, fracture, tumor, and rheumatism, and revisiting to the hospital for rehabilitation therapy following exacerbation of LBP after treatment at the hospital.

2.2 Method

Among patients who underwent 2~3 weeks of rehabilitation therapy, the self-management methods of LBP used for 6 months were surveyed to classify them into the following groups: (1) self-exercise group (SEG), (2) hot pack and low-frequency electrical stimulation group (HEG), and (3) thermo-massage group (TMG). Randomization was done for assignment using a concealed and protected centrally-generated variable-sized block design created by the statistic program.

During treatment at the hospital, patients were taught about self-exercises (stretching and strengthening exercise) by a therapist, including stretching of the erector spinae, hamstrings, gastrocnemius-soleus, quadriceps, and piriformis, as well as maneuvers such as thoraco-lumbar rotation in standing posture, press-up back extension, bridge pose, cat and camel, pelvic tilt, partial curl, quadruped arm/leg raise, balance training, and knee roll. A printout containing figures of the exercise methods and a video were also given. The patients were instructed to exercise at least five times a week, for 30 minutes each session.

Some patients preferred the application of hot packs or low-frequency treatment devices that are easily accessible at home instead of engaging in the exercises they have been taught. These patients used these devices twice a day for 20 minutes for more than six times a week.

Other patients purchased a thermo-massage bed (CGM MB-1401, Ceragem, South Korea), or used them at a paid massage center, for 1-2 times a day for 40 minutes, at least 5 days a week over the 6 months.

The subjects' sex, age, body mass index, duration of LBP, and history were obtained from their medical records. The severity of pain was assessed based on PNRS, and daily functioning was assessed based on ODI and RMDQ[18,19].

The ODI comprises of 10 items, with each item rated on a score of 0~5, and the total score was presented as a percentage[20]. RMDQ consists of 24 items, with the total score ranging from 0-24, where a higher score indicates severe disability, and the scale has been reported to sensitively reflect changes over time in patients with LBP[19,21].

The PNRS, ODI, and RMDQ scores before treatment (baseline, BA) and 2-4 weeks post-treatment at the hospital (PT) were obtained from medical records, and patients who consistently complied to self-management were further assessed 6 months after their final hospital visit (6MO). The change in recurrence incidence 6 months prior to study participation and 6 months after self-management were examined.

2.3 Statistical analysis

Changes of PNRS, ODI, and RMDQ scores within each group were analyzed with repeated-measures ANOVA, while comparison among the groups was performed using one-way ANOVA. If a significant interaction between group and time was observed, the differences in the pattern of change was examined by contrast analysis with Bonferroni's correction. The difference in the recurrence incidence between 6 months before hospital visit and 6 months after self-management was analyzed with the Wilcoxon signed rank test. Statistical significance was set to $p<0.05$.

3. Result

3.1 Subjects' general characteristics

A total of 120 subjects were recruited, and following the application of the inclusion and exclusion criteria, 63 subjects were enrolled. Twenty-six were men, and 37 were women. The mean age was 60.71 ± 8.17 years, and the mean duration of LBP was 34.03 ± 10.17 months. During the 6 months prior to study participation, the average number of LBP recurrences was 10.79 ± 4.92 times, and the average pain score was 3.99 ± 0.69. Common comorbidities were hypertension (n = 10) and diabetes mellitus (n = 9). The SEG, HEG and TMG consisted of 20, 22, and 21 subjects, respectively. No statistically significant differences were observed in all baseline parameters among the three groups (Table 1).

Table 1. Basic Characteristics

Variables	SEG (N=20)	HEG (N=22)	TMG (N=21)	Total (N=63)
Age (month)	59.98 ±10.24	61.92 ±5.87	60.24 ±8.95	60.71 ±8.17
Sex (Male:Female)	8:12	10:12	8:13	26:37
BMI	24.99 ±3.54	25.98 ±2.90	26.11 ±3.25	25.69 ±3.19
Duration (month)	33.28 ±11.82	35.21 ±15.95	33.59 ±19.52	34.03 ±10.17
Recurrence during last 6 month				
Frequency	10.81 ±4.85	10.72 ±4.67	10.86 ±4.99	10.79 ±4.92
Mean PNRS	4.02 ±0.87	3.67 ±1.24	4.27 ±0.97	3.99 ±0.69
Comorbid Disease				
Hypertension	3	3	4	10
Diabetes Mellitus	4	2	3	9

Values are mean ± standard deviation. SEG: Self exercise Group, HEG: Hot pack and low-frequency Electrical stimulation Group, TMG: Thermo-Massage Group, BMI: Body Mass Index, PNRS: Pain numeric rating scale.

3.2 Comparison before and after treatment and after self-management

The PNRS, ODI, and RMDQ scores of all subjects improved at PT and 6MO as compared to BA, but there was no difference between PT and 6MO ($p<0.05$) (Table 2).

Table 2. Comparison of the Variables between Baseline, Post-treatment, and 6 month.

(N = 63)	Mean(SD)	Contrast ($p<.05$)
PNRS score		
baseline[a]	4.85(0.56)	
PT[b]	1.74(1.25)	a > b & c
6 month[c]	2.17(1.71)	
ODI(%)		
baseline[a]	22.73(5.34)	
PT[b]	7.06(4.88)	a > b & c
6 month[c]	7.08(3.24)	
RMDQ score		
baseline[a]	12.76(3.55)	
PT[b]	3.59(2.88)	a > b & c
6 month[c]	3.38(1.95)	

Values are given as mean(SD). $p<0.05$
PT: Post-Treatment, PNRS: Pain numeric rating scale, ODI: Oswestry disability index, RMDQ: Roland & Morris Disability Questionnaire

Within the SEG and TMG, the PNRS, ODI, and RMDQ scores improved at PT and 6MO compared to BA ($p<0.05$) (Table 3).

However, in the HEG, while ODI and RMDQ scores improved at PT and 6MO compared to BA, the PNRS score improved at PT and worsened at 6MO ($p<0.05$) (Table 3).

Between the groups, no difference in PNRS, ODI, and RMDQ scores were observed before and after treatment in the clinic, but at 6MO, all three scores were better maintained in the SEG and the TMG as compare to the HEG ($p<0.05$) (Table 3).

Table 3. Comparison of the Variables in Each Groups

	SEG $(N=20)^S$	HEG $(N=22)^H$	TMG $(N=21)^T$	Each Group Contrast
PNRS score				
baseline[a]	4.95 (1.51)	4.85 (1.84)	4.75 (1.31)	
PT[b]	1.68 (1.55)	2.13 (1.46)	1.42 (1.25)	
6 month[c]	1.58 (1.38)	3.55 (2.84)	1.38 (1.18)	H > S & T
Intragroup Contrast	a > b & c	b < a & c	a > b & c	
ODI(%)				
baseline[a]	23.45	22.48	22.25	

	(6.45)	(4.25)	(5.33)	
PT[b]	5.99 (4.01)	9.02 (4.99)	6.16 (4.57)	
6 month[c]	6.04 (2.84)	8.45 (3.84)	6.74 (3.64)	H > S & T
Intragroup Contrast		a > b & c		
RMDQ score				
baseline[a]	13.15 (3.84)	12.89 (3.51)	12.25 (3.54)	
PT[b]	3.18 (2.77)	4.31 (2.99)	3.29 (2.82)	
6 month[c]	1.94 (2.01)	5.25 (1.87)	2.94 (1.67)	H > S & T
Intragroup Contrast		a > b & c		

Values are given as mean(SD), p<0.05, PT: Post-Treatment, PNRS: Pain numeric rating scale, ODI: Oswestry disability index, RMDQ: Roland & Morris Disability Questionnaire.

When comparing the frequency of recurrence between 6 months prior to study participation and 6 months after self-care, the recurrence frequency decreased in the SEG and the TMG, but did not change in the HEG ($p<0.05$) (Table 4).

In comparison between the three groups at 6MO, the recurrence frequencies of the SEG and the TMG were lower compared to that of the HEG ($p<0.05$) (Table 4).

Table 4. Comparison of the Recurrent Frequency during 6 month

Recurrent frequency	SEG[S]	HEG[H]	TMG[T]	Each Group Contrast
Before Treatment	10.81 (4.85)	10.72 (4.67)	10.86 (4.99)	
After Self-Management	3.57 (1.61)*	7.94 (4.89)	3.64 (1.54)*	H > S & T

Values are given as mean(SD), *p<0.05,

4. Discussion

This study comparatively analyzed the self-management techniques for LBP used at home, and examined the PNRS, ODI, RMDQ scores, as well as the recurrence incidence of LBP.

Following professional rehabilitation therapy at the hospital, patients who engaged in self-exercises or used a thermo-massage device for 6 months demonstrated better ADL management and recurrence prevention compared to patients who used hot packs and low-frequency electrical stimulation.

Approximately 70-90% of the population experience at least one episode of LBP, followed by frequent recurrences which diminishes their quality of life and results in time and financial losses[22]. LBP that persists for more than 3 months is considered chronic, and the most common cause has been speculated to be mechanical factors such as lumbar instability and repeated poor posture, which are known to easily fatigue the relevant muscles and thus cause pain[23].

The diagnostic and treatment guidelines for LBP by the Korean Association of Pain Medicine (KAPM) state that LBP should be classified into three categories for treatment: nonspecific LBP, radiculopathy-related LBP, and LBP with specific spinal etiologies[14]. Accordingly, our study was conducted on patients with nonspecific LBP without any serious underlying spinal disorders such as cancer, infection, cauda equina syndrome, spinal stenosis, radiculopathy, ankylosing spondylitis, and compression fracture.

Exercises have been reported to enhance flexibility and endurance, thereby increasing trunk stability and reducing LBP[24].

Stretching leads to reduction of pain, improvement of nutrient supply to the lumbar joint, increase of motor nerve coordination, and enhancement of sensory systems such as the Golgi tendon reflex. It also prevents joint stiffness and improve the ability to control excessive contractions and relaxation of the body[25]. Stretching facilitates blood supply to the pain-causing tissues and induces a reduction of pain-triggering substances, thereby decreasing pain and increasing the ROM of the lower back.

Patients with chronic LBP are known to have a more severe reduction of extensor muscle strength than of flexor muscle strength. Thus, flexor-strengthening exercises can exacerbate

extensor strength reduction, which in turn cause an imbalance in muscle strength[26]. In this study, extensor-strengthening exercises were generally taught to patients.

Superficial heat therapy includes hot pack, heat wrap, and heat blankets; and heat reduces pain by facilitating blood flow, promoting tissue healing, inducing muscle relaxation, and increasing pain threshold[27]. Superficial heat therapy has been reported to be more effective than pharmacological therapy in patients with acute LBP, but it is minimally effective on chronic pain[28,29].

The pain control caused by low-frequency electrical stimulator is based on the gait control theory and the endorphin theory[30]. However, a meta-analysis on chronic LBP could not draw concrete conclusions on the effectiveness of low-frequency therapy[31], and Deyo et al. also reported that it was not more effective than a placebo[32].

Massage relaxes the muscles and the mind, which in turn leads to endorphin secretion that increases pain threshold and blood flow, reducing the excretion of pain-triggering chemical substances as well as stimulating large-diameter nerve fibers, thereby reducing pain[14]. Massage was reported to be effective for subacute or chronic LBP[33,34], and its effects can persist for about a year, which helps cut financial expenditure for healthcare and ultimately reduces the relevant cost[35].

Many studies have reported that exercise therapy is effective in reducing pain and improving function in chronic LBP. In the chronic stage, individual programs such as aerobic, spine-strengthening, and spinal stabilization exercises, or multidimensional rehabilitation therapies have been reported to be effective[36,37].

Reasons for the less improvement observed for pain and ADL, and the increase of LBP recurrence in patients who used hot packs and low-frequency electrical stimulation for self-management compared to the self-exercise and thermo-massage groups may involve the fact that superficial heat cannot relax the deep spinal muscles, and that electrical stimulation only helps pain control at the spinal cord level, and its analgesic effects only persist for several hours after the stimulation ceases. The addition of ultrasound therapy, which delivers heat to 5-8 cm through the skin, may be considered in future studies to compare against the overall physiotherapy management of chronic LBP.

The hot pack and low-frequency electrical stimulation group showed an improvement in PNRS score after hospital treatment, but this worsened after 6 months of self-management. The reason may be that temporary improvement of pain was only achieved when self-managed hot pack and low-frequency electrical stimulation was supplemented by pharmacological, manual, and ultrasound therapies performed at the hospital. Despite worsening of pain, functional deterioration was not exacerbated, presumably because daily living is essential to sustaining life and pain to a certain degree does not have a grave impact on ADL.

SEG and TMG patients showed better pain and functional management. This was in line with the KAPM guidelines that suggested that exercise and massage are more useful for chronic pain, and as previously mentioned, one study reported that the effects of massage can persist for more than one year[38]. In this study, massage therapy using a compressor with the patient lying back down on the massage bed seems to have enabled deep muscle massage. Massage relieves excessive muscle tension and imbalance, and increases muscle extensibility which in turn leads to increased ROM and contributes to spinal and pelvic stability[39]. Furthermore, using instruments for deep muscle massage allows for a minimum pressure of 5-10 kg/cm^2 to the muscles, and thus stimulates the small muscles in

the lumbosacral region, realigns chronic muscle fiber patterns that induce muscle tension, and induces regeneration of injured connective tissues, thereby relieving lumbar instability[40].

This study had several limitations. There were no existing studies examining whether the massages performed were deep muscle massages, and our sample size was small. In addition, the subjects' physical traits, lifestyle factors, exercise capacity, and duration of illness were not taken into consideration, and compliance with the self-management program over 6 months was not able to objectively investigate because it was measured solely on the basis of self-reporting. Finally, additional studies are needed to examine the long-term effects with follow-ups beyond 6 months. No side effects were reported during this trial.

5. Conclusion

Through this study, it was found that consistent self-management at home through exercise and the use of thermo-massage beds reduces pain, decreases the recurrence of pain, and improves function in patients with chronic LBP who have received hospital treatment. Therefore, it would be important for physicians to inform and teach patients about effective self-management techniques, and adequately advocate them on the importance of continuous compliance in order to improve chronic LBP and recurrence of pain.

REFERENCES

[1] J. W. Frymoyer, M. H. Pope, J. H. Clements, D. G. Wilder, B. MacPherson, & T. Ashikaga (1983). Risk factors in low-back pain. An epidemiological survey. *JBJS*, *65(2)*, 213-218.
DOI : 10.2106/00004623-198365020-00010

[2] J. L. Kelsey, & A. A. White 3rd (1980). Epidemiology and impact of low-back pain. *Spine*, *5(2)*, 133-142.
DOI : 10.1097/00007632-198003000-00007

[3] G. B. Andersson (1999). Epidemiological features of chronic low-back pain. *The lancet*, *354(9178)*, 581-585.
DOI : 10.1016/S0140-6736(99)01312-4

[4] T. S. Carey, J. M. Garrett, A. Jackman, N. Hadler & The North Carolina Back Pain Project. (1999). Recurrence and care seeking after acute back pain: results of a long-term follow-up study. *Medical care*, 157-164.
DOI : 10.1097/00005650-199902000-00006

[5] L. H. Pengel R. D.Herbert, C. G. Maher & K. M. Refshauge (2003). Acute low back pain: systematic review of its prognosis. *Bmj*, *327(7410)*, 323.
DOI : 10.1136/bmj.327.7410.323

[6] M. Von Korff (1994). Studying the natural history of back pain. *Spine*, *19(18 Suppl)*, 2041S-2046S.
DOI : 10.1097/00007632-199409151-00005

[7] M. Bergquist-Ullman & U. Larsson (1977). Acute low back pain in industry: a controlled prospective study with special reference to therapy and confounding factors. *Acta Orthopaedica Scandinavica*, *48(sup170)*, 1-117.
DOI : 10.3109/ort.1977.48.suppl-170.01

[8] A. Faas, A. W. Chavannes, J. T. M. Van Eijk, & J. W. Gubbels, (1993). A randomized, placebo-controlled trial of exercise therapy in patients with acute low back pain. *Spine (Phila Pa 1976). 18(11), 1388-1395.*

[9] W. S. Marras, S. A. Ferguson, D. Burr, P. Schabo & A. Maronitis (2007). Low back pain recurrence in occupational environments. *Spine*, *32(21)*, 2387-2397.
DOI : 10.1097/BRS.0b013e3181557be9

[10] S. Snelgrove & C. Liossi (2013). Living with chronic low back pain: a metasynthesis of qualitative research. *Chronic illness*, *9(4)*, 283-301.
DOI : 10.1177/1742395313476901

[11] M. W. van Tulder, B. W. Koes, J. F. Metsemakers, & L. M. Bouter (1998). Chronic low back pain in primary care: a prospective study on the management and course. *Family Practice*, *15(2)*, 126-132.
DOI : 10.1093/fampra/15.2.126

[12] J. A. DeLeo, & B. A. Winkelstein, (2002). Physiology of chronic spinal pain syndromes: from animal models to biomechanics. *Spine*, *27(22)*, 2526-2537.
DOI : 10.1097/00007632-200211150-00026

[13] S. H. Sanders, K. S. Rucker, K. O. Anderson, R. N. Harden, K. W. Jackson, P. J. Vicente, & R. M. Gallagher (1995). Clinical practice guidelines for chronic non-malignant pain syndrome patients. *Journal of Back and Musculoskeletal Rehabilitation*, *5(2)*, 115-120.
DOI : 10.3233/BMR-1995-5204

[14] Chou, R., Qaseem, A., Snow, V., Casey, D., Cross Jr, J. T., Shekelle, P., & Owens, D. K. (2007). Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Annals of internal medicine*, *147(7)*, 478-491.
DOI : 10.7326/0003-4819-147-7-200710020-00006

[15] T. R. Stanton, J. Latimer, C. G. Maher & M. J. Hancock

(2010). How do we define the condition 'recurrent low back pain'? A systematic review. *European Spine Journal*, *19(4)*, 533-539.
DOI : 10.1007/s00586-009-1214-3

[16] H. C. De Vet, M. W. Heymans, K. M. Dunn, D. P. Pope, A. J. Van der Beek, G. J. Macfarlane & P. R. Croft (2002). Episodes of low back pain: a proposal for uniform definitions to be used in research. *Spine*, *27(21)*, 2409-2416.
DOI : 10.1097/01.BRS.0000030307.34002.BE.

[17] G. A. Koumantakis, P. J. Watso & J. A. Oldham (2005). Supplementation of general endurance exercise with stabilisation training versus general exercise only: physiological and functional outcomes of a randomised controlled trial of patients with recurrent low back pain. *Clinical biomechanics*, *20(5)*, 474-482.
DOI : 10.1016/j.clinbiomech.2004.12.006

[18] J. C. Fairbank, J. Couper, J. B. Davies & J. P. O'brien (1980). The Oswestry low back pain disability questionnaire. *Physiotherapy*, *66(8)*, 271-273.

[19] Roland M, Morris R (1983). A study of the natural history of back pain. Part 1: Development of a reliable and sensitive measure of disability in low-back pain. *spine(Phila Pa 1976). 8(2)*, 141-144.
DOI : 10.1097/00007632-198303000-00004

[20] F. Bonetti, S. Curti, S. Mattioli, R. Mugnai, C. Vanti, F. S. Violante & P. Pillastrini (2010). Effectiveness of a'Global Postural Reeducation'program for persistent low back pain: a non-randomized controlled trial. *BMC Musculoskelet Disord.*, *16(11)*, 285.
DOI : 10.1186/1471-2474-11-285

[21] P. W. Stratford & J. M. Binkley (2000). A comparison study of the back pain functional scale and Roland Morris Questionnaire. North American Orthopaedic Rehabilitation Research Network. *The Journal of rheumatology*, *27(8)*, 1928.

[22] V. M. Taylor, R. A. Deyo, D. C. Cherkin & W/ Kreuter (1994). Low back pain hospitalization. Recent United States trends and regional variations. *Spine*, *19(11)*, 1207-1212.
DOI : 10.1097/00007632-199405310-00002

[23] S. Sahrmann, D. C. Azevedo & L. V. Dillen (2017). Diagnosis and treatment of movement system impairment syndromes. *Brazilian journal of physical therapy*, *21(6)*, 391-399.
DOI : 10.1016/j.bjpt.2017.08.001

[24] H. O. Lee (2010). Activation of trunk muscles during stabilization exercises in four-point kneeling. *The Journal of Korean Physical Therapy*, *22(5)*, 33-38.
DOI : 10.1016/j.bjpt.2017.08.001

[25] J. H. Sun (2005). The effect of yoga on adolescent flexibility. *Kyungnam University* (Doctoral dissertation, Dissertation of Master's Degree).

[26] S. Y. Kim (2010). Changes in cross-sectional area of lumbar muscle in patients with chronic back pain. *The Journal of Korean Physical Therapy*, *22(5)*, 39-47.

[27] J. F. Leheman, B. J. Delateur (1990). *Therapeutic Heat and Cold 4th edition*. Philadelphia : Lippincott Williams & Wilkins, 120-37.

[28] S. F. Nadler, D. J. Steiner, G. N. Erasala, D. A. Hengehold, R. T. Hinkle, M. B. Goodale & K. W. Weingand (2002). Continuous low-level heat wrap therapy provides more efficacy than Ibuprofen and acetaminophen for acute low back pain. *Spine*, *27(10)*, 1012-1017.
DOI : 10.1097/00007632-200205150-00003

[29] M. Nordin & M. Campello (1999). Physical therapy: Exercises and the modalities: When, what and why?. *Neurologic clinics*, *17(1)*, 75-89.
DOI : 10.1016/S0733-8619(05)70115-8

[30] S. M. Fishman, J. C. Ballantyne, J. P. Rathmel. (2010). *Bonica's Management of Pain* 4th edition. Philadelphia : Lippincott Williams & Wilkins, 1365-1374.

[31] S. Milne, V. Welch, L. Brosseau, M. Saginur, B. Shea, P. Tugwell & G. Wells (2001). Transcutaneous electrical nerve stimulation (TENS) for chronic low back pain. *The Cochrane database of systematic reviews*, *(2)*, CD003008.
DOI : 10.1002/14651858.CD003008

[32] R. A. Deyo, N. E. Walsh, D. C. Martin, L. S. Schoenfel & S. Ramamurthy (1990). A controlled trial of transcutaneous electrical nerve stimulation (TENS) and exercise for chronic low back pain. *New England Journal of Medicine*, *322(23)*, 1627-1634.
DOI : 10.1056/NEJM199006073222303

[33] D. C. Cherkin, D. Eisenberg, K. J. Sherman, W. Barlow, T. J. Kaptchuk, J. Street & R. A. Deyo (2001). Randomized trial comparing traditional Chinese medical acupuncture, therapeutic massage, and self-care education for chronic low back pain. *Archives of internal medicine*, *161(8)*, 1081-1088.
DOI : 10.1001/archinte.161.8.1081

[34] M. Preyde (2000). Effectiveness of massage therapy for subacute low-back pain: a randomized controlled trial. *CMAJ*, *162(13)*, 1815-1820.

[35] D. C. Cherkin, K. J. Sherman, R. A. Deyo, & P. G. Shekelle (2003). A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain. *Annals of internal medicine*, *138(11)*, 898-906.
DOI : 10.7326/0003-4819-138-11-200306030-00011

[36] M. van Tulder, A. Malmivaara, R. Esmail & B. Koes (2000). Exercise therapy for low back pain: a systematic review within the framework of the cochrane collaboration back review group. *Spine*, *25(21)*, 2784-2796.
DOI : 10.1097/00007632-200011010-00011

[37] H. Frost S. E. Lamb, J. K. Moffett, J. C. T. Fairbank & J. S. Moser (1998). A fitness programme for patients with chronic low back pain: 2-year follow-up of a randomised controlled trial. *Pain*, *75(2-3)*, 273-279.
DOI : 10.1016/s0304-3959(98)00005-0

[38] R. Chou, A. Qaseem, V. Snow, D. Casey, J. T. Cross Jr,

P. Shekelle & D. K. Owens (2007). Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Annals of internal medicine*, *147(7)*, 478-491.
DOI : 10.7326/0003-4819-147-7-200710020-00006

[39] C. A. Richardson, C. J. Snijders, J. A. Hides, L. Damen, M. S. Pas & J. Storm (2002). The relation between the transversus abdominis muscles, sacroiliac joint mechanics, and low back pain. *Spine*, *27(4)*, 399-405. DOI : 10.1097/00007632-200202150-00015

[40] P. B. O'Sullivan, A. Burnett, A. N. Floyd, K. Gadsdon, J. Logiudice, D. Miller & H. Quirke (2003). Lumbar repositioning deficit in a specific low back pain population. *Spine*, *28(10)*, 1074-1079. DOI : 10.1097/01.BRS.0000061990.56113.6F

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