

## Original Article

# Study on the mechanism of acupuncture combined with massage therapy in improving waist flexion range and relieving pain in patients with chronic lumbago and leg pain

Xiaochun Lan<sup>1</sup>, Jun Li<sup>1</sup>, Guisheng Zhou<sup>1</sup>, Wei Wei<sup>2</sup>

Departments of <sup>1</sup>Rehabilitation Medicine, <sup>2</sup>Orthopaedics, Wuming Hospital of Guangxi Medical University, Nan-ning 530199, Guangxi, China

Received February 21, 2020; Accepted April 8, 2020; Epub June 15, 2020; Published June 30, 2020

**Abstract:** This study aimed to explore the mechanism of acupuncture combined with massage reduction in improving waist flexion range and relieving pain in patients with chronic lumbago and leg pain. In total, 93 patients with chronic lumbago and leg pain in our hospital were divided into two groups according to the treatment methods. Group A received conventional drug therapy and group B received acupuncture combined with massage reduction in addition to treatment of group A. The efficacy, waist flexion range, modified Japanese Orthopaedic Association (M-JOA) score rating system for low back disorders, modified Oswestry disability index (ODI), visual analog scale (VAS), and inflammatory factors were compared before and after treatment. After treatment, the lumbar curvature, waist flexion range, M-JOA, ODI, VAS scores, tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) and interleukin-6 (IL-6) in group B were superior to group A ( $P < 0.05$ ). Acupuncture combined with massage reduction in patients with chronic lumbago and leg pain is beneficial to further improve the clinical efficacy.

**Keywords:** Chronic lumbago and leg pain, acupuncture, massage reduction, combination therapy, waist flexion, pain

## Introduction

Chronic lumbago and leg pain is quite common in clinical practice, with legs and waist as the main sites of discomfort [1]. The disease is usually caused by sciatica, rheumatoid arthritis, spinal cord lesions, chronic lumbar muscle strain and lumbar disc herniation and other diseases, with clinical manifestations of lower limb, and buttocks, causing lumbosacral pain, and it is difficult to straighten the waist when sitting; the symptoms are further aggravated when tired or cold. If reasonable treatment is not adapted in time, it can lead to disease aggravation or recurrent attacks, seriously affecting the normal work and daily life of patients [2, 3].

At present, western medicine usually uses drugs and surgical therapy to treat these patients, of which drug therapy is mainly based on

oral analgesic drug therapy. Although it can reduce pain in patients to a certain extent, long-term medication will cause a variety of toxic drug side effects, and even lead to gastric perforation in severe cases [4, 5]. Surgical therapy is not only expensive, but also requires certain surgical risks and has a high rate of disease recurrence after surgery [6]. Recent studies have shown that Chinese traditional medicine (TCM) has clear advantages in the treatment of chronic low back and leg pain, with various treatment methods, low treatment cost, high patient comfort during treatment, and low incidence of adverse reactions [7]. Massage and acupuncture belong to two common TCM treatment methods, which improve clinical efficacy by adjusting the biomechanics of the spine, promoting improvement of nerve microcirculation, and promoting the absorption of neuroinflammatory reactions [8, 9]. In view of this, this study combined acupuncture with

# Acupuncture combined with massage therapy for chronic low back and leg pain

massage reduction in the treatment of chronic low back and leg pain in order to obtain the ideal clinical efficacy, as reported below.

## Material and methods

### Material

The clinical data of 93 patients with chronic lumbago and leg pain in our hospital were retrospectively collected and divided into two groups based on the treatment modality; with 46 patients in group A, who underwent conventional drug therapy, and 47 patients in group B, who underwent acupuncture combined with massage reduction therapy in addition to treatment in group A. (1) Inclusion criteria: patients who have signed the informed consent; meet the diagnostic criteria for chronic low back and leg pain in the *Diagnostic Criteria for Clinical Diseases and National Physical Examination Standards* [10]; did not use analgesic drugs, steroids, catecholamines for treatment before being enrolled; and had approval by the medical ethics committee could be included. (2) Exclusion criteria: patients who were combined with mental health diseases; or spinal fractures caused by trauma; or with inflammation, tuberculosis, soft tissue tumors or lumbar and leg bone tumors; or with severe cardiovascular diseases; or severe liver and kidney diseases, were excluded. This study has been approved by the Ethics Committee of Wuming Hospital of Guangxi Medical University. All study participants provided written informed consent before participating in the study.

### Methods

Group A: The patients were given oral Naproxen Tablets (Approval No.: GYZZ H32024077 Manufacturer: Nanjing Baijinyu Pharmaceutical Co., Ltd. Spec.: 0.1 g\*100 tablets), 5 g each time, 3 times a day, for 2 weeks.

Group B: Acupuncture combined with massage reduction therapy was performed in addition to treatment in group A: (1) Acupuncture: Dachangshu, Weizhong, Shenshu, and Yaojiaji 3-5 were taken as the main points, Xuanzhong, Fengshi, Yanglingquan, and Huanqiao were taken from the matching points, and Feiyang, Taryang, Yinmen, and Kunlun were added. The patient was instructed to receive treatment in the supine position using a disposable sterile acupuncture needle (Huatuobrand, size 0.30

mm × 40 mm), and when lumbar acupuncture treatment was performed, a 1-1.5 inch direct puncture was performed in the direction of the spine, preferably in the lower limbs, and a 2-3 inch direct puncture was performed when buttock acupuncture treatment was performed, preferably in the lower limbs, and other acupoints were routinely operated on using the flat supplement and purgation method, with a needle retention time controlled at 30 min. (2) Massage reduction therapy: The patients were instructed to receive treatment in the supine position, and the lower limbs, buttocks, and lumbosacral region were massaged using dialing, projecting, pushing, kneading, and rolling maneuvers, with the gallbladder meridian and bladder meridian following the line as the focus of massage, and the thumb was used to knead the seventeen vertebrae, Weizhong, Jiaji points, and Yaoyangguan at the corresponding sites to ensure that the maneuver was deep, and the intensity of massage was decided based on the patient's tolerance. All patients were treated with massage and acupuncture once a day for 7 days with 2 courses.

### Outcome measures

Efficacy evaluation [11]: After treatment, if the symptoms of low back and leg pain were not relieved or even aggravated, seriously affecting daily life, it was deemed as ineffective. After treatment, if the symptoms of low back and leg pain partially disappeared, the activity was slightly limited, and the straight leg raising test was improved, it was deemed as significantly effective. After treatment, if the symptoms of low back and leg pain completely disappeared, daily life completely returned to normal, and the straight leg raising test results showed negative, it was deemed as cured. The sum of cure and markedly effect is the total effective rate.

Waist flexion: After treatment, the waist flexion range of patients in both groups was measured by distance measurement method, combined with X ray, and the lumbar curvature was measured by Seze.

Modified Japanese Orthopaedic Association (M-JOA) score rating system for low back disorders score [12]: Before and after treatment, M-JOA score was used to evaluate the lumbar function of patients in the two groups, including clinical signs (6 points), subjective symptoms (9 points), limited daily activities (14 points), the total

# Acupuncture combined with massage therapy for chronic low back and leg pain

**Table 1.** General data of patients in both groups [n (%)]/( $\bar{x} \pm s$ )

Item		Group A (n=46)	Group B (n=47)	t/ $\chi^2$	P
Sex (case)	M	30 (65.22)	32 (68.09)	0.086	0.769
	F	16 (34.78)	15 (31.91)		
Age (yr)		51.25±3.28	51.29±3.22	0.059	0.953
Course of disease (yr)		3.28±0.85	3.32±0.81	0.232	0.817
Causes					
	Sciatica	11 (23.91)	10 (21.28)	0.125	0.996
	Rheumatic arthritis	10 (21.74)	9 (19.15)		
	Myeletterosis	9 (19.57)	10 (21.28)		
	Chronic lumbar strain	8 (17.39)	9 (19.15)		
	Lumbar disc herniation	8 (17.39)	9 (19.15)		

**Table 2.** Curative effects reported in the two groups [n (%)]

Group	Case	Cured	Excellent	Ineffective	ORR
A	46	20 (43.48)	15 (32.61)	11 (23.91)	35 (76.09)
B	47	29 (61.70)	16 (34.04)	2 (4.26)	45 (95.74)*
$\chi^2$					7.471
P					0.006

Note: \*indicates  $P < 0.05$  as compared with group A.

score of the scale was between 0 and 29 points, and the degree of dysfunction was inversely proportional to the score.

Oswestry disability index (ODI) [13]: Before and after treatment, ODI was used to evaluate the dysfunction of the two groups of patients, with a total of 10 evaluation items, all of which were evaluated using the 1-5 score method, with a total score of 50, which was inversely proportional to the dysfunction.

Visual analog scale (VAS) score [14]: Before and after treatment, VAS scale was used to evaluate the pain of patients in the two groups, with a total score between 0 and 10; 0 indicating no pain and 10 indicating severe pain.

Inflammatory factors: Before and after treatment, 10 ml of fasting cubital venous blood was collected from patients in both groups in the morning and centrifuged at a rate of 3000 r/min, and the supernatant was discarded. Tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) and interleukin-6 (IL-6) were detected by enzyme-linked immunosorbent assay and conducted in strict accordance with the instructions of the kit, which was obtained from Hebei Changtian Pharmaceutical Co., Ltd.

## Statistics

SPSS 22.0 was used for data analysis. Measurement data were expressed as mean  $\pm$  standard deviation. Data conforming to normal distribution were analyzed by t-test. If not conforming, Whitney U test was performed. Enumeration data were expressed as [n (%)]. Chi-squared test was used for comparison of enumeration data.  $P < 0.05$  indicated statistical significance.

## Results

### General data of patients in both groups

There were no statistically significant differences in the various general data metrics of gender, age, disease duration, and cause of disease between the two groups ( $P > 0.05$ ) (**Table 1**).

### Comparison of efficacy between the two groups

The overall response rate in group B was 95.74%, higher than 76.09% in group A, and the difference was significant ( $P < 0.05$ ) (**Table 2**).

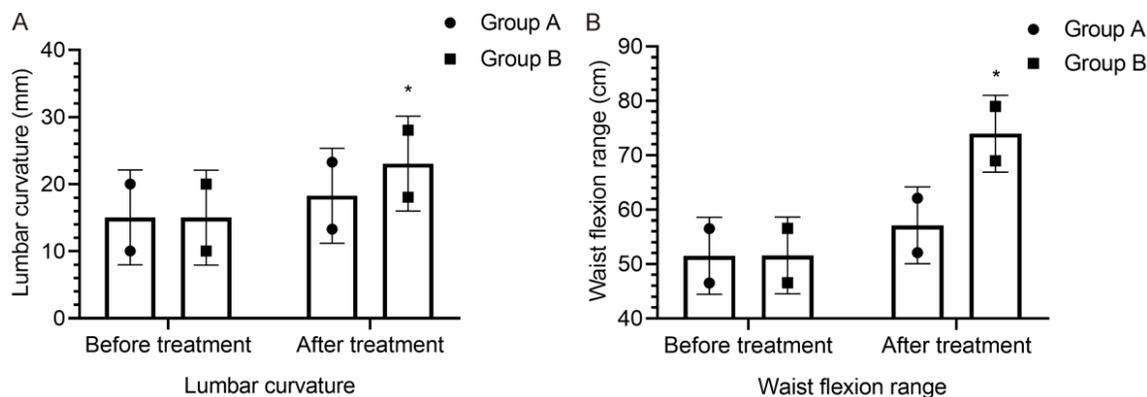
### Comparison of waist flexion range between the two groups

Compared with those before treatment, the lumbar curvature and waist flexion range increased after treatment in both groups, with significant difference within the group ( $P < 0.05$ ). The lumbar curvature and waist flexion range after treatment in group B were greater than those in group A, with significant difference ( $P < 0.05$ ) (**Figure 1**).

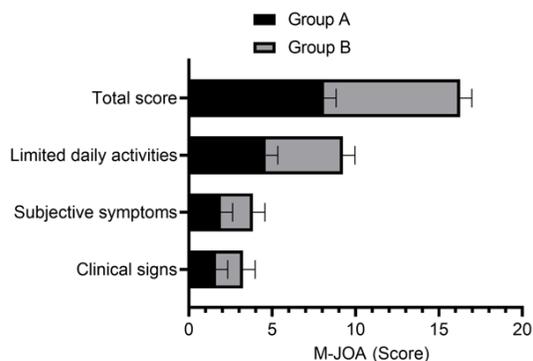
### M-JOA scores in the two groups

Compared with those before treatment, the clinical signs, subjective symptoms, daily activity limits and M-JOA total score after treatment in the two groups were increased, with significant differences within the group ( $P < 0.05$ ). The clinical signs, subjective symptoms, daily activity limits and M-JOA total score after treatment in group B were higher than those in

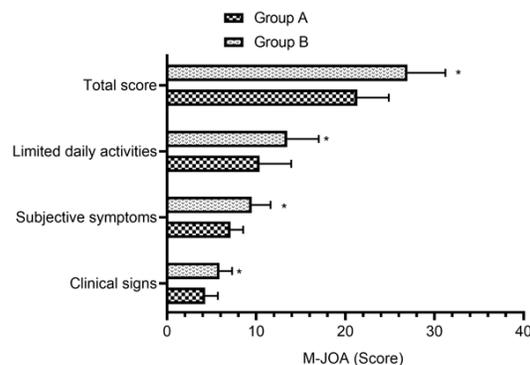
## Acupuncture combined with massage therapy for chronic low back and leg pain



**Figure 1.** Waist flexion range of patients in the two groups. The lumbar curvature and waist flexion range before treatment between the two groups showed  $P > 0.05$ ; the lumbar curvature and waist flexion range after treatment in group B were greater than those in group A,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.



**Figure 2.** M-JOA scores before treatment between the two groups. In comparison of clinical signs, subjective symptoms, limited daily activities, M-JOA total score before treatment between the two groups,  $P > 0.05$ .



**Figure 3.** M-JOA scores after treatment between the two groups. Clinical signs, subjective symptoms, limited daily activities, and M-JOA total scores after treatment in group B were higher than those in group A,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.

group A, with significant differences ( $P < 0.05$ ) (Figures 2 and 3).

### Comparison of ODI between the two groups

Compared with that before treatment, ODI decreased after treatment in both groups, with significant difference in the group ( $P < 0.05$ ). ODI after treatment in group B was lower than that in group A, with significant difference ( $P < 0.05$ ) (Table 3).

### VAS scores in the two groups

Compared with that before treatment, the VAS score decreased after treatment in both groups, with significant difference within the group ( $P < 0.05$ ). The VAS score after treatment in group B was lower than that in group A, with significant difference ( $P < 0.05$ ) (Table 4).

### Inflammatory factors in the two groups of patients

Compared with those before treatment, TNF- $\alpha$  and IL-6 decreased after treatment in both groups, with significant difference within the group ( $P < 0.05$ ). TNF- $\alpha$  and IL-6 in group B were lower than those in group A, with significant difference ( $P < 0.05$ ) (Figure 4).

### Discussion

Chronic low back and leg pain are not independent but a clinical syndrome with complex causes [15]. Studies have shown that about 80% of people will experience different degrees of low back and leg pain symptoms in their lifetime, and although 95% of people can recover within a month, some patients will develop

## Acupuncture combined with massage therapy for chronic low back and leg pain

**Table 3.** ODI of patients in both groups ( $\bar{x} \pm s$ )

Group	Before treatment	After treatment
A (n=46)	42.36±2.18	32.16±1.08 <sup>#</sup>
B (n=47)	42.39±2.15	22.18±1.18 <sup>#,*</sup>
T	0.067	42.521
P	0.947	0.000

Note: <sup>#</sup>indicates  $P < 0.05$  as compared with that before treatment; <sup>\*</sup>indicates  $P < 0.05$  as compared with group A.

**Table 4.** VAS scores of patients in the two groups ( $\bar{x} \pm s$ , score)

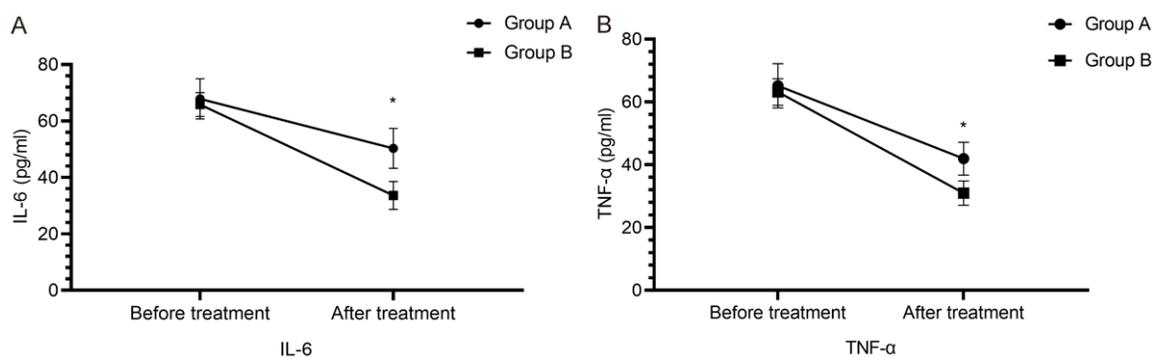
Group	Before treatment	After treatment
A (n=46)	8.15±0.85	3.98±0.56 <sup>#</sup>
B (n=47)	8.19±0.82	1.08±0.28 <sup>#,*</sup>
T	0.187	31.688
P	0.818	0.000

Note: <sup>#</sup>indicates  $P < 0.05$  as compared with that before treatment; <sup>\*</sup>indicates  $P < 0.05$  as compared with group A.

chronic low back and leg pain [16]. Middle-aged and elderly people are the main affected groups of this disease, which is mainly characterized by pain in the lower limbs, buttocks and lumbosacral region, which is aggravated by exertion or cold, and has a serious impact on the quality of life of patients [17]. According to Western medicine, in daily life and work, after people are injured by wind, cold and dampness, chronic cumulative injury or gradual injury, there will be microscopic pathological changes in the waist, but this pathological change is relatively slow, through the body's self-protection and regulation mechanism, it can decompensate slowly, and then maintain the dynamic balance of the inside and outside of the lumbar spine [18, 19]. After lumbar trauma, it will not only change the intrinsic anatomical position of the lumbar spine and break the original mechanical balance state, but also acutely injure the soft tissues around the lumbar spine and break the original mechanical balance state, resulting in aggravated imbalance state, and then a new extrinsic imbalance of the lumbar spine occurs [20]. All of the above pathological events will have an effect on the body's compensation, and eventually disrupt the state of internal and external balance of the lumbar spine, which in turn triggers symptoms of chronic low back and leg pain [21].

Traditional Chinese medicine (TCM) classifies chronic lumbago and leg pain into the categories of "lumbago and crural pain", "low back pain" and "arthralgia syndrome", and believes that the main causes of the disease are trauma, exertion, and liver and kidney loss [22]. According to TCM, the waist is the organ of the kidney, so there is a close relationship between the kidney and low back pain, and because the kidney and bladder are exterior and interior to each other, with the meridians, Du meridians, Ren meridians and Chong meridians all distributed during this period; kidney deficiency is the internal cause of the appearance of chronic low back and leg pain [23, 24]. TCM advocates that when treating chronic low back and leg pain, it should be treated with syndrome differentiation [25]. In this study, acupuncture and massage therapy were combined in the treatment of this disease, and the results showed that the total effective rate of treatment in group B was higher than that in group A, VAS score and ODI were lower than those in group A, lumbar curvature and waist flexion range were greater than those in group A, and M-JOA score was higher than that in group A ( $P < 0.05$ ). Suggesting that acupuncture combined with massage reduction therapy in patients with chronic low back and leg pain is beneficial to further improve the clinical efficacy, improve waist flexion range and dysfunction, all of which reduce pain. This can be attributed to its specific mechanism of action. Acupuncture is a common traditional Chinese medicine method. First, acupuncture at Jiaji point can promote the improvement of local microcirculation of nerve roots, reduce the degree of nerve stress, and promote the reduction or elimination of inflammatory reactions such as congestion and edema [26]. Second, acupuncture at Dachangshu and Shenyu can directly stimulate the L4-5 nerve roots and inhibit peripheral nerve excitability, prompting the improvement of nerve root tension. Acupuncture at Weizhong conforms to the principle of "distant acupoint selection along meridians" and has the effects of activating meridians and removing blood stasis. Because the radiating pain sites of the lower limbs for chronic low back and leg pain are the Foot-Shaoyang and Foot-Taiyang meridians, Xuanzhong, Fengshi, Yanglingquan, and Huanqiao were selected on the Foot-Shaoyang meridian in this study, and Feiyang, Taryang, Yinmen, and Kunlun were selected as matching acu-

## Acupuncture combined with massage therapy for chronic low back and leg pain



**Figure 4.** M-JOA scores before and after treatment between the two groups. Little difference was found between the two groups in TNF- $\alpha$  and IL-6 before treatment,  $P > 0.05$ ; TNF- $\alpha$  and IL-6 after treatment in group B were lower than those in group A,  $P < 0.05$ . \* indicates  $P < 0.05$  compared with group A.

points on the Foot-Taiyang meridian; which has the effect of harmonizing the Shaoyang meridian and the Taiyang meridian qi, and acupuncture at various points listed above has the effects of dredging collaterals and invigorating the circulation of blood and qi. Massage reduction therapy can effectively correct the dislocation of posterior spinal synovium incarceration, joint disorder, etc., promoting releasing muscle spasms, promote the local tissue metabolism, reduce the compression stimulation of the protrusion on the formation of nerve roots, and finally play an analgesic and anti-inflammatory role [27].

Chronic lumbago and leg pain are aseptic inflammation produced by exudation, edema, etc. TNF- $\alpha$  and IL-6 are inflammatory factors, which can promote the accumulation of inflammatory cells and the release of inflammatory mediators, promote the aggravation of symptoms and tissue injury, and also increase the degree of lumbago and leg pain [28]. Acupuncture can conduct impulse stimulation of deep acupoint receptors to the spinal cord through Class III and II nerve fibers, and then play a role in pain regulation. Acupuncture can activate the tissue structure related to the mechanism of acupuncture analgesia; inhibit the information of injurious stimuli, and then play a role in analgesia. Acupuncture promotes nerve metabolism, which then inhibits the pathological changes of injury, regulating spinal biomechanics, promote the improvement of local microcirculation, and reduce the degree of pain and inflammation. Coupled with massage reduction therapy, it can promote local tissue metabolism, with anti-inflammatory and analgesic abil-

ity, so the level of inflammatory factors in the body are down-regulated.

In summary, acupuncture combined with massage reduction therapy is conducive to improve the efficacy, waist flexion range and functional disorders, and reduce pain and inflammation in patients with chronic low back and leg pain.

However, the small sample size in this study may be the bias in these results. Further studies with larger sample sizes and far better comprehensive surveys are warranted.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Wei Wei, Department of Orthopaedics, Wuming Hospital of Guangxi Medical University, No. 26, Yongning Road, Wuming District, Nanning 530199, Guangxi, China. Tel: +86-18607893838; E-mail: pjcnkj@163.com

### References

- [1] Mohd Sallehuddin S, Mohamad Nor NS, Ambak R, Abdul Aziz NS, Mohd Zaki NA, Omar MA, Aris T, Nor Hissam NS, Rajadurai SAL and Ayob NH. Changes in body pain among overweight and obese housewives living in Klang Valley, Malaysia: findings from the MyBFF@ home study. *BMC Womens Health* 2018; 18: 101.
- [2] Yu Y, Zheng B, Huang J, Deng D and Jing X. Case report on a 32-year-old female with elevated serum creatinine levels and primary Sjögren's syndrome-chronic interstitial nephritis. *Exp Ther Med* 2019; 18: 4363-4367.
- [3] Morsley K, Berntzen B, Erwood L, Bellerby T and Williamson L. Progressive resistance train-

## Acupuncture combined with massage therapy for chronic low back and leg pain

- ing (PRT) improves rheumatoid arthritis outcomes: a district general hospital (DGH) model. *Musculoskeletal Care* 2018; 16: 13-17.
- [4] Will JS, Bury DC and Miller JA. Mechanical low back pain. *Am Fam Physician* 2018; 98: 421-428.
- [5] Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, Hoy D, Karppinen J, Pransky G and Sieper J. What low back pain is and why we need to pay attention. *Lancet* 2018; 391: 2356-2367.
- [6] Sanzarello I, Merlini L, Rosa MA, Perrone M, Frugiuele J, Borghi R and Faldini C. Central sensitization in chronic low back pain: a narrative review. *J Back Musculoskelet Rehabil* 2016; 29: 625-633.
- [7] Urits I, Burshtein A, Sharma M, Testa L, Gold PA, Orhurhu V, Viswanath O, Jones MR, Sidransky MA, Spektor B and Kaye AD. Low back pain, a comprehensive review: pathophysiology, diagnosis, and treatment. *Curr Pain Headache Rep* 2019; 23: 23.
- [8] Baron R, Binder A, Attal N, Casale R, Dickenson AH and Treede RD. Neuropathic low back pain in clinical practice. *Eur J Pain* 2016; 20: 861-873.
- [9] Alrwaily M, Timko M, Schneider M, Stevans J, Bise C, Hariharan K and Delitto A. Treatment-based classification system for low back pain: revision and update. *Phys Ther* 2016; 96: 1057-1066.
- [10] Nelson NL. Kinesio taping for chronic low back pain: a systematic review. *J Bodyw Mov Ther* 2016; 20: 672-681.
- [11] MacDonald J, Stuart E and Rodenberg R. Musculoskeletal low back pain in school-aged children: a review. *JAMA Pediatr* 2017; 171: 280-287.
- [12] O'Sullivan PB, Caneiro JP, O'Keeffe M, Smith A, Dankaerts W, Fersum K and O'Sullivan K. Cognitive functional therapy: an integrated behavioral approach for the targeted management of disabling low back pain. *Phys Ther* 2018; 98: 408-423.
- [13] Liu L, Huang QM, Liu QG, Thitham N, Li LH, Ma YT and Zhao JM. Evidence for dry needling in the management of myofascial trigger points associated with low back pain: a systematic review and meta-analysis. *Arch Phys Med Rehabil* 2018; 99: 144-152, e142.
- [14] Yamato TP, Maher CG, Saragiotto BT, Hancock MJ, Ostelo RW, Cabral CM, Costa LC and Costa LO. Pilates for low back pain: complete republication of a cochrane review. *Spine (Phila Pa 1976)* 2016; 41: 1013-1021.
- [15] Costa T, Linhares D, Ribeiro da Silva M and Neves N. Ozone therapy for low back pain. A systematic review. *Acta Reumatol Port* 2018; 43: 172-181.
- [16] Puentedura EJ and Flynn T. Combining manual therapy with pain neuroscience education in the treatment of chronic low back pain: a narrative review of the literature. *Physiother Theory Pract* 2016; 32: 408-414.
- [17] Cook CE, George SZ and Reiman MP. Red flag screening for low back pain: nothing to see here, move along: a narrative review. *Br J Sports Med* 2018; 52: 493-496.
- [18] Sehmbi H, D'Souza R and Bhatia A. Low back pain in pregnancy: investigations, management, and role of neuraxial analgesia and anesthesia: a systematic review. *Gynecol Obstet Invest* 2017; 82: 417-436.
- [19] Anheyer D, Haller H, Barth J, Lauche R, Dobos G and Cramer H. Mindfulness-based stress reduction for treating low back pain: a systematic review and meta-analysis. *Ann Intern Med* 2017; 166: 799-807.
- [20] Shi Z, Zhou H, Lu L, Pan B, Wei Z, Yao X, Kang Y, Liu L and Feng S. Aquatic exercises in the treatment of low back pain: a systematic review of the literature and meta-analysis of eight studies. *Am J Phys Med Rehabil* 2018; 97: 116-122.
- [21] da Silva T, Mills K, Brown BT, Herbert RD, Maher CG and Hancock MJ. Risk of recurrence of low back pain: a systematic review. *J Orthop Sports Phys Ther* 2017; 47: 305-313.
- [22] Melcher C, Wegener B, Jansson V, Mutschler W, Kanz KG and Birkenmaier C. Management of acute low back pain without trauma - an algorithm. *Z Orthop Unfall* 2018; 156: 554-560.
- [23] Du S, Hu L, Dong J, Xu G, Chen X, Jin S, Zhang H and Yin H. Self-management program for chronic low back pain: a systematic review and meta-analysis. *Patient Educ Couns* 2017; 100: 37-49.
- [24] van Dieën JH, Flor H and Hodges PW. Low-back pain patients learn to adapt motor behavior with adverse secondary consequences. *Exerc Sport Sci Rev* 2017; 45: 223-229.
- [25] Jonckheer P, Demoulin C, Desomer A and van Wambeke P. Low back and radicular pain: which management in 2018? *Rev Med Liege* 2018; 73: 114-118.
- [26] Pourahmadi MR, Mohsenifar H, Dariush M, Afzabi A and Amiri A. Effectiveness of mobilization with movement (Mulligan concept techniques) on low back pain: a systematic review. *Clin Rehabil* 2018; 32: 1289-1298.
- [27] Alfuth M and Cornely D. Chronic low back pain: comparison of mobilization and core stability exercises. *Der Orthopade* 2016; 45: 579-590.
- [28] Almeida M, Saragiotto B, Richards B and Maher CG. Primary care management of non-specific low back pain: key messages from recent clinical guidelines. *Med J Aust* 2018; 208: 272-275.