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Original Research Article

Clinical effect of suspension training and Mulligan technique in combination with celecoxib in the treatment of chronic non-specific lower back pain

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Abstract

Purpose: *To investigate the clinical efficacy of suspension training and Mulligan technique in combination with celecoxib in the management of chronic lower back ache of unknown causes.*

Methods: *A total of 100 subjects with persistent lower back pain of unknown etiology treated in the Sports Medical Rehabilitation Center, Shijiazhuang, China from June 2019 to December 2020, were assigned at random to control and study cohorts (n = 50/group). Celecoxib (100 to 200 mg/day) was taken orally, once or twice daily by the control cohort, while the other cohort received suspension training, Mulligan technology (once a day, 8 weeks) and celecoxib. The treatment effect, pain and dysfunction scores, inflammatory indicators, quality of life, and complications were compared on Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI).*

Results: *The effect of Macnab standard in study group was significantly better than that in control group ($p < 0.05$). After treatment, VAS and ODI scores in both cohorts were significantly lower than pre-treatment values, but were significantly lesser in the study cohort. Furthermore, TNF-α level, and levels of CRP and IL-6 were significantly reduced when compared with pre-treatment levels, and were significantly lower in study cohort. The GQOL-74 scores in both groups were significantly increased after treatment, but were significantly lower in the control cohort ($p < 0.05$). No significant variations were seen in cases of complications between both cohorts.*

Conclusion: *The use of suspension training and Mulligan technology in combination with celecoxib in treating persistent lower back pain of unknown cause is beneficial in reducing lower back pain, mitigating dysfunction, and improving patients' quality of life. There is however a need for more studies to validate these findings.*

Keywords: *Suspension training, Mulligan technology, Celecoxib, Chronic non-specific low back pain, Clinical efficacy*

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INTRODUCTION

Lower back pain without specific causes lasting for at least 12 weeks is classified as chronic pain. The disease is seen often in orthopedic clinics, and it is not due to any known pathological conditions [1]. The lifetime prevalence of lower back pain is about 84 %, and the prevalence of chronic lower back pain is about 23 % [2]. Due to the non-specificity of chronic lower back pain, a

wide range of treatment strategies such as analgesics, NSAIDs, and muscle relaxants, are proposed for its management, and each treatment is aimed at fundamentally targeting a hypothetical pathological process [3].

Due to long-term continuous use of drugs, there may be some dislocations in human joints. These errors in position lead to pain and reduced range of motion. Mulligan technology helps to correct posture errors through mobilization via movement, so as to effectively relieve pain and movement limitation [4]. Mulligan band links the superior iliac spine of the subject to ball and socket joint of the therapist. Mulligan technology is applied to the symptomatic spinal horizontal transverse process under the thenar, with the path of activity in line with the surface of the apophyseal joint. When a therapist puts in a force, the subject is asked to lean forward at the same time. Following attainment of full flexion, the subject is directed to assume the initial position. The brain directional force is sustained when the subject returns to the initial state. This study investigates the clinical efficacy of applying suspension training and Mulligan technology in combination with celecoxib (a nonsteroidal anti-inflammatory drug (NSAID) used to relieve pain and inflammation [5] in the treatment of chronic non-specific low back pain, in order to provide reference for an alternative choice of clinical treatment.

METHODS

General information on subjects

One hundred (100) subjects with chronic lower back ache of unknown causes treated in Sports Medical Rehabilitation Center, Shijiazhuang City, China from June 2019 to December 2020, were randomly allotted to control and study groups, each with 50 patients. This study was approved by the ethics committee of the same hospital (approval no. Guoyao Zhunzi j20030099), and all subjects voluntarily participated and signed informed consent.

Inclusion criteria

Patients aged 22 - 75 years, those with chronic idiopathic lower back pain confirmed clinically through symptoms, signs and examinations [6]; those who did not receive western medicine and traditional Chinese medicine treatment in the previous 2 weeks before enrollment, and patients with complete clinical medical records, were included in this study.

Exclusion criteria

Subjects who had other lumbar diseases; patients who reacted to medications applied in the study, and those with severe cardiac, hepatic and renal dysfunctions, were excluded.

Treatments [7]

Control group

Control group was treated with 200 mg of Celecoxib (Pfizer Pharmaceutical Co. Ltd.) which was orally administered once or twice a day for 8 weeks.

Study cohort

These subjects received suspension training, Mulligan technology (once a day, 8 weeks), and celecoxib. The celecoxib regimen was similar to that in control cohort. For suspension training involving bridging, the patient was asked to lie down facing up. Then, the patient lifted the hip off the ground, with the arched body supported on hands and feet. For push-ups, lying on the stomach with hands touching the body and shoulder and elbow inclined, the patient was asked to raise the body off the floor by extending the elbow. For oblique sit-ups, the patient lay on the back, bent the knees, and then tried to bend the trunk to rotate correctly. This action was repeated on the other side of the body. In hanging push-ups, the patient lay on the stomach, with hands close to his body, and the elbows and shoulders raised. Then, he placed his ankles on the handle of the Total Resistance Exercise device, system, and lifted the torso off the floor by extending the elbows. In hanging thigh abduction, the patient hung on a level beam and abducted the left foot, and repeated the action with the right foot. The patients were also instructed to carry out vigorous trunk flexing and extension of the trunk, and determine the exercise that resulted in higher degree of pain. Then, each of the subjects sat on a table with adjustable height and put both feet on the pedal, with slightly bent soles.

Evaluation of parameters/indices

Measurement of lumbar function [8]

The improved Macnab standard [9] was applied for measuring lumbar function. The score was divided into four grades, based on the symptoms, functional status and working conditions of patients *viz*: excellent, good, fair and poor. 'Excellent' implied no pain and limited movement, and that the patient returned to the original

normal work and life. 'Good' implied occasional pain and mild activity limitation, without any impact on work and life. 'Fair' meant that the patient had a certain degree of functional improvement, but normal work and life were still affected. 'Poor' meant persistent lower back pain, no noticeable difference between pre- and post-treatment, or even aggravation of pre-treatment condition.

Scores on pain and dysfunction

The extent of wound-associated pain in patients was determined using the VAS scale [10], with scores ranging from 0 to10 points as a direct function of degree of pain. The degree of dysfunction in the two cohorts of patients was assessed using the Oswestry Disability Index (ODI) questionnaire [11]. The ODI contained 10 questions covering walking, sitting, standing, interference with sleep, sexual life, intensity of pain, social life, tourism, self-care in life, and extraction. The score range of each question was 0-5 points, and the total score ranged from 0 to 100 points as a direct function of the severity of dysfunction in patients [12].

Inflammatory indices

After the treatments, 5 mL of blood was collected from each of the subjects in the fasted state. The serum recovered after centrifugation was subjected to assay of tumor necrosis factor-alpha (TNF-α), IL-6 and C-reactive protein (CRP) using ELISA reagent provided by Brahms, Germany.

Quality of life [13]

When the treatment was completed, quality of life was assessed in each of the subjects in both cohorts using quality of life scale 74 (GQOL-74) [14]. The indices evaluated were psychological function, social function, physical function, and material life. Each dimension was scored 0 to100 points as direct function of QOL.

Incidence of complications

The occurrence of complications such as decreased strength of peroneal long and short muscles, delayed incision, and dural tear complicated with cerebrospinal fluid leakage, were monitored, calculated and recorded.

Statistical analysis

Data are expressed as mean + standard deviation (SD). Differences between the two groups were statistically analyzed using t-test. Differences in the distribution of rates between the two groups were statistically analyzed using chi-squared test. Statistical analysis was performed using SPSS16.0 software (IBM, USA).

RESULTS

General data

The control subjects comprised 23 men and 27 women aged 22 to 75 years (mean age = 42.62 ± 10.56 years), and disease duration spanned 3 to 60 months (mean duration = 16.62 ± 4.52 months). The 22 males and 28 females in the study cohort had age range of 22 to 74 years (mean age = 42.23 ± 9.24 years), with disease duration of 3 to 61 months (average course of disease was 17.48 ± 5.57 months). General data were comparable in the two groups.

Lumbar function

The Macnab standard curative effect in study group was significantly better than that in control group ($p < 0.05$; Table 1).

Table 1: Comparison of lumbar function between the two groups (n=50)

Group	Excellent	Good	Fair	Poor
Study	25	20	4	1
Control	20	13	7	10
Z		2.062		
P-value		0.039		

VAS score and ODI

Table 2 shows that before treatment, VAS and ODI scores were comparable in both cohorts. However, after treatment, VAS scores and ODI in the two cohorts were significantly reduced, relative to pre-treatment, with significantly lower values in study group.

Pre- and post-treatment serum levels of inflammatory mediators

Before treatment, levels of CRP, TNF-α and IL-6 were comparable in both groups. However, post-treatment levels of CRP, TNF-α and IL-6 were significantly reduced, and study group had significantly lower levels than control group ($p < 0.05$; Table 3).

Quality of life

Before treatment, there was no significant difference in quality of life scores between the two groups. However, post-treatment GQOL-74 scores of the two groups were significantly higher than pre-treatment scores, with significantly

Table 2: VAS scores and ODI in both cohorts (points) (n=50)

Cohort	VAS		ODI	
	Pre-treatment	***Post-treatment***	***Pre-treatment***	***Post-treatment***
Study	6.95±1.82	2.16±0.57*	57.46±7.52	20.46±4.82*
Control	7.06±1.77	2.95±0.83*#	58.50±6.74	26.74±5.19*#
t	-0.336	-6.078	-0.798	-6.868
P-value	0.738	0.000	0.427	0.000

*$P < 0.05$, vs. before treatment. #$P < 0.05$, vs. control. Values are mean ± SD

Table 3: Comparison of serum inflammatory mediator levels between the two groups (n=50)

Group	TNF- α (pg/mL)		CRP (mg/L)		IL-6 (ng/L)	
	Pre treatment	***Post treatment***	***Pre treatment***	***Post treatment***	***Pre treatment***	***Post treatment***
Study	7.24±2.14	3.54±1.07*	30.42±8.56	10.47±2.43*	135.42±18.67	70.44±12.56*
Control	7.65±2.02	4.46±1.58*#	32.37±7.38	15.34±3.70*#	138.65±20.46	84.34±15.92*#
t	-1.033	-3.576	-1.280	-8.159	-0.865	-5.084
P-value	0.304	0.001	0.203	0.000	0.389	0.000

*$P < 0.05$, vs. before treatment; #$P < 0.05$, vs. control. Values are mean ± SD.

Table 4: GQOL-74 scores in both groups before and after treatment (points)

Group	Somatic function		Psychological function		Social function		Material life	
	Before treatment	***After treatment***	***Before treatment***	***After treatment***	***Before treatment***	***After treatment***	***Before treatment***	***After treatment***
Study	64.25±5.42	76.38±4.27*	62.38±6.37	78.25±6.54*	69.26±5.66	82.62±5.24*	65.38±5.46	77.56±5.44*
Control	65.23±6.21	70.33±5.26*#	63.37±6.28	72.39±5.21*#	70.12±6.40	75.62±4.74*#	66.18±4.82	71.34±4.70*#
t	-0.841	6.314	-0.783	4.956	-0.719	7.005	-0.777	6.118
P-value	0.403	<0.001	0.436	<0.001	0.478	<0.001	0.439	<0.001

*$P < 0.05$, vs. before treatment; # $p < 0.05$, vs. control. Values are mean ± SD

Table 5: Incidence of complications in the two groups (n=50)

Group	Lumbar plexus injury	Thigh pain	Lower limb weakness	Total
Study	1 (2.00)	2 (4.00)	1 (2.00)	4 (8.00)
Control	0 (0.00)	1 (2.00)	0 (0.00)	1 (2.00)
χ^2				0.842
P-value				0.359

higher GQOL-74 scores in the study ($p < 0.05$; Table 4).

Treatment-related adverse reactions

The incidence of complications did not differ significantly between the two groups (Table 5).

DISCUSSION

Lower back pain is a common human disease. According to clinical study on epidemiological statistics, 70 – 80 % of the human population experience lower back pain in their lifetime [15]. The prevalence of lower back pain has been increasing. It is an important cause of work-related absenteeism and disability which affect socio-economic status of the individual patients. In 10 – 20 % of the affected subjects, a study showed that pain may become chronic when the associated disability lasts for over 3 months [16]. Specific lower back pain has an identified pathoanatomical cause, e.g. tumors or fractures. In these cases, appropriate therapy such as drugs or surgery, is necessary. However, in 90 % of lower back pain cases, the exact specific source of pain is difficult to ascertain. Thus, the pain is categorized as non-specific. In addition, it may result in unusual spinal movement. Back pain is caused by degenerative lesions in nucleus pulposus, sprain in skeletomuscular system, and unusual spinal position or movement disorder, while lower back pain usually occurs at prominent nucleus pulposus and joints closely related to lower back pain-associated nociceptive, mechanical, and chemical receptors [17].

The therapies frequently applied for persistent lower back ache in patients are operation, opioid drugs and spinal injections, although the outcomes are often unsatisfactory. In addition, it is not easy to predict the complications which the painkillers NSAIDs, opioids and paracetamol will

have on the CNS and related tissues [18]. Therefore, study on scientific and effective cure for persistent lower back ache of unknown etiology is crucial in mitigating the symptoms, and for improving the standard of existence of subjects. This study has revealed that the Macnab standard curative effect was significantly better in study group than that in control group. In both groups, post-treatment GQOL-74 scores were significantly higher than pre-treatment values, but the GQOL-74 score was significantly higher in study cohort, although complication incidents were comparable in both cohorts. These data suggest that the application of suspension training and Mulligan technology in combination with celecoxib produced a good clinical effect. The combined treatment was effective in improving lumbar function. Moreover, the treatment was safe. Some studies have reported that impaired muscle function in subjects with persistent low back pain is caused by changes in neuromuscular regulatory mechanism that affects torso stability and exercise efficacy. The affected patients have weak lumbar extensors and high fatigue [19]. In addition, compared with healthy people, persistent lower back ache subjects have a lower percentage of maximum voluntary isometric contraction (MVIC) of trunk muscles during exercise [20].

The stability of the body is crucial for maximal usage of strength, control of neuromuscular activity and muscle tolerance. The muscles of the abdomen perform a major function in regulation of spinal segment stability. Therefore, a firm core enhances the neuromuscular efficacy of the whole exercise activities and enhances postural control [21]. Some dislocations may occur in human joints due to injury or long-term continuous use. This leads to pain and reduced range of motion. Mulligan technology is a manual treatment technology which helps to correct postural errors through movement mobilization, thereby effectively relieving pain and movement limitation [22]. Suspension training makes muscles rendered inactive by chronic non-specific lower back pain and the central nervous system to obtain more appropriate and effective stimulation from deep receptor afferents involving the muscles. A likely route through which suspension training affects motor control is that suspension exercise enhances the regulation of torso position via the simultaneous contractions of antagonist and agonist muscles. Therefore, the exercise used in suspension training may increase proprioception and function of muscles around the spine by increasing tension and the ability to maintain the contraction of excited muscles, as well as increasing peripheral input [23].

With unending advancements in cell culture and molecular biology techniques, more and more evidences have shown that long-term chronic inflammatory response plays an important role in the occurrence and development of chronic non-specific low back pain [24]. Studies have found that proinflammatory factors, especially IL-6, TNF-α and IL-1β, are key mediators that trigger pathophysiological changes in chronic non-specific low back pain. The inflammatory factors cause additional pain in lower back pain patients [25]. Results obtained in the present investigation revealed that, at the last monitoring, VAS and ODI scores of the two groups were significantly lower than pre-treatment values, and study group had significantly lower scores than control group. After treatment, the levels of TNF-α, CRP and IL-6 were significantly reduced, relative to pre-treatment, but study group had significantly lower levels of these parameters than control group. These results suggest that the use of suspension training and Mulligan technology in combination with celecoxib produced a good clinical effect, and it was beneficial in reducing the levels of inflammatory mediators, and hence reduced the intensity of low back pain in patients. A likely mechanism that underlies the observed analgesic impact of suspension training may be that, being a special form of unstable exercise, unlike exercise at a more stable level, suspension training also increases muscle contraction [26]. The unstable nature of suspension training also causes damage to muscles, and strengthens control of the neuromuscular environment, thereby reducing lumbar pain. In addition, the suspension training used in this study was carried out as a suspension posture which reduced the pain caused by the traction force generated by the lower limb weight on the back. The training also enhances neuromuscular synchronization, reduces needless pressure caused by unstable environment, and improves joint mobility by increasing muscle activation.

Limitations of this study

This study involved only 100 patients in a single center.

CONCLUSION

The application of suspension training and Mulligan technology in combination with celecoxib produced good clinical treatment effectiveness on persistent lower back pain of unknown etiology. It was efficacious in reducing

both pain and dysfunction, and in improving patients' quality of life. Moreover, the treatment was safe. Due to the very small number of patients that participated in this study, there will be need for more studies in the future to validate these findings.

DECLARATIONS

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Ethical approval

This study was approved by the ethics committee of the same hospital (approval no. Guoyao Zhunzi j20030099).

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

We declare that this work was performed by the authors named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Cong Wang designed the study, supervised the data collection, and analyzed the data. Cong Wang interpreted the data and prepared the manuscript for publication. Guannan Zhang, Jingru Wang, Wendong Zhang, Yu Zhang and Yatong Gu supervised the data collection, analyzed the data and reviewed the draft of the manuscript.

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