

## Original Article

# The effect of three-dimensional nursing management on the respiratory exercise compliance and nursing efficiency in post-thoracotomy patients with acute pulmonary embolisms

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**Abstract:** Objective: To study the effect of the three-dimensional nursing management mode on compliance with respiratory function exercises and on the nursing efficiency in post-thoracotomy, acute pulmonary embolism (PE) patients. Methods: A cohort of 20 post-thoracotomy patients with acute PE were equally and randomly divided into two groups. The patients in the experimental group underwent the three-dimensional nursing management mode, and the patients in the control group underwent ordinary nursing. The compliance with respiratory function exercises during the hospital stay and within 3 months after discharge was observed, and the efficiency of the three-dimensional nursing management mode was determined according to the patient recovery. Results: The overall recovery effect in the experimental group was good, the respiratory function exercise effect was significant, and just one patient still had dyspnea after one week of nursing. There were 5 patients with chest tightness and chest pain and 7 patients with dyspnea in the control group. One patient died after a recurrence of the disease ( $P < 0.05$ ). The total nursing efficiency was 90% in the experimental group and 30% in the control group ( $P < 0.05$ ). Three months after discharge, the patients in the two groups were followed up, and a survey was conducted. In the experimental group, 14 patients and their families were very satisfied with the nursing. In the control group, 2 patients and their families were dissatisfied with the nursing, and the difference was statistically significant ( $P < 0.05$ ). Conclusions: Three-dimensional nursing management with post-thoracotomy, acute pulmonary embolism patients contributes to improving the patients' compliance with respiratory function exercises and to the nursing efficiency. It can greatly improve the nursing efficiency, relieve patients' post-surgical pain, and can promote the formation of a good doctor-patient relationship to a certain extent.

**Keywords:** Thoracotomy, acute pulmonary embolism, three-dimensional nursing management, respiratory function exercises, nursing efficiency

## Introduction

Acute pulmonary embolism (PE) is one of the most serious post-thoracotomy complications, and it has a very high mortality rate. The occurrence of acute PE in patients undergoing thoracotomy requires timely treatment, and scientific nursing and guidance in daily nursing to help the patients form good breathing habits, thereby reducing the possibility of PE recurrence. The three-dimensional nursing management model is used for the clinical nursing of patients from the perspective of logic, time, and knowledge. The three-dimensional nursing

management model is more scientific and effective compared with the conventional nursing model, making the nursing more humanized [1, 2]. The three-dimensional nursing management model is a system engineering methodology proposed by Hall, an American system engineering expert, in 1969. It provides a unified way of thinking for solving the planning, organization and management of large-scale complex systems, and has been widely used in countries all over the world [3, 4]. Based on this, some scholars in China have designed the three-dimensional structure of system safety management, namely professional dimension,

## Three-dimensional nursing management with acute pulmonary embolism patients

process dimension, and logical dimension. This structure covers the management of risk sources, the process of management work, and all other aspects. This model has also been widely used in medical treatment since it was proposed and published. This study investigated a three-dimensional nursing management mode for post-thoracotomy patients with acute PE by exercising their respiratory function and comparing the effects with the effects of conventional nursing. The specific study was as follows.

### Materials and methods

#### *General data*

In this study, 20 patients with acute PE after thoracotomy who were successfully treated in our hospital from January 2001 to January 2018 were recruited as the study cohort and divided into an experimental group and a control group, with 10 cases in each group. The patients in the experimental group ranged in age from 37-69 years old with an average height of 150.0-184.0 cm, an average weight of 58.8-81.5 kg, and an average disease course of 2-31 days. The patients in the control group ranged in age from 36-70 years old, with an average height of 150.2-184.8 cm, and an average weight of 58.3-81.7 kg, and an average disease course of 2-31 days.

#### *Inclusion criteria*

- ① Patients with indications of acute PE after a thoracotomy.
- ② Patients with no history of drug allergies or, drug abuse, or bad habits.
- ③ Patients able to understand the requirements for respiratory function exercises and who have a normal cognitive function.
- ④ This study was approved by the ethics committee of our hospital, and all the patients volunteered to participate in the study and signed an informed consent form [5].

#### *Three-dimensional nursing management*

- ① Logic: Scientific and effective nursing was administered to the post-thoracotomy, acute pulmonary embolism patients. The three-dimensional nursing management mode required

the hospital nursing staff to improve their own nursing knowledge and skills, break away from the traditional clinical nursing thinking, and form a systematic nursing knowledge system for acute PE on an ongoing basis [6]. The nursing staff learned the three-dimensional nursing model, carried out nursing care for the post-thoracotomy, acute pulmonary embolism patients, comprehensively and strictly observed and recorded the patients' possible risk factors, and provided timely treatment, which helped to reduce the mortality and improve the recovery of patients [7].

- ② Time: Time is life. Severe acute PE takes only a few hours or even less from onset to death, so the first aid efforts are particularly important. In the three-dimensional nursing management model, the blood pressure, heart rate, and ECG are monitored regularly by the nursing staff, and they have the ability to determine the condition so as to facilitate timely emergency treatment when a patient has abnormal problems [8].

- ③ Knowledge: Three-dimensional nursing management requires that nursing staff have professional clinical nursing knowledge and psychological knowledge, and to make appropriate adjustments according to each patient's condition and psychological status [9, 10]. In the three-dimensional nursing of post-thoracotomy, acute pulmonary embolism patients, the nursing staff should understand the possible risk factors and first aid knowledge for patients with acute PE during their hospitalization in order to help the patients live through the dangerous period. In addition, the nursing staff should pay close attention to the psychological status and emotional changes of patients and carry out timely comfort and psychological counseling when negative emotions occur.

#### *Nursing methods*

Patients with acute PE may experience chest tightness, shortness of breath, and dyspnea during their postoperative recovery, and the patients should do respiratory function exercises. The patients in the experimental group underwent nursing using the three-dimensional nursing management model, and the patients in the control group underwent nursing using the conventional nursing model.

## Three-dimensional nursing management with acute pulmonary embolism patients

Thrombolytic anticoagulant therapy should be instituted immediately after a patient develops the signs of acute PE. During thrombolysis, urokinase (10,000 IU; GYZZ H32023290; Nanjing Nanda Pharmaceutical Co., Ltd.) was dissolved in 0.9% sodium chloride solution according to a body weight of 4400 units/kg, with an injection time of 10 min and a flow rate of 90 mL/h [11]. Subsequently, the injections were performed according to the patient's condition, along with anticoagulant therapy. The anticoagulant drug used was the low molecular weight heparin (5000 IU; GYZZ H10980166; Zhaoke Pharmaceutical (Hefei) Co., Ltd.). Heparin was injected subcutaneously around the umbilical cord [12]. Since thrombolytic and anticoagulant therapy may easily lead to a decreased platelet count in the patients and reduce their coagulation function, bleeding may occur. The nursing staff should monitor each patient's coagulation function to keep the clotting time around 400 s [11, 13]. Also, the nursing staff should pay attention to whether the patient has bleeding, and observe whether the wound is bleeding.

The nursing staff in the experimental group developed detailed nursing goals daily for the patients and their families. The nursing staff regularly monitored the blood pressure, heart rate, etc. In order to prevent the recurrence of PE, the nursing staff massaged their lower limbs observed whether there was swelling, tenderness, etc., and determined whether the circumference of their lower limbs was consistent. If there was swelling, tenderness, etc., the patient was prevented from getting out of bed and the condition was reported to the doctor immediately. After confirming that the indicators were within the normal range, the patients were guided and supervised in exercising their respiratory functions. The experimental group adopted the traditional and interesting exercises combined with traditional lip retraction and abdominal breathing in an interesting manner such as blowing up balloons and blowing feathers.

The patients in the control group underwent routine nursing, with regular blood pressure, heart rate, and respiration, etc. monitoring. The patients were taught respiratory function exercises and then trained on their own, and ward rounds were conducted every 2 hours to check whether there were any abnormalities. During

the period, the families notified the nursing staff in the case of any unexpected conditions.

The respiratory function exercises took the form of traditional lip retraction and abdominal breathing.

### *Evaluation indicators*

The patients' compliance with the respiratory function exercises within the same time period was compared between the two groups, and the overall recovery was analyzed. The hemodynamic parameters of the two groups were compared using the monitoring records to observe if there were any significant differences. In addition, telephone interviews and questionnaires were conducted 3 months after the patients were discharged from the hospital to compare the recovery and satisfaction results of the two groups.

### *Statistical analyses*

In this paper, the relevant materials and data were processed and analyzed using SPSS 21.0. The measurement data were expressed as ( $\bar{x} \pm s$ ), and t-tests were performed. The enumeration data were expressed as [n (%)], and  $\chi^2$  tests were performed. A  $p$ -value  $< 0.05$  was considered a statistically significant difference.

## **Results**

### *Comparison of the two groups' general data*

No significant differences were observed with regards to age, height, weight, course of the disease, or smoking history in the two groups ( $P > 0.05$ , **Table 1**).

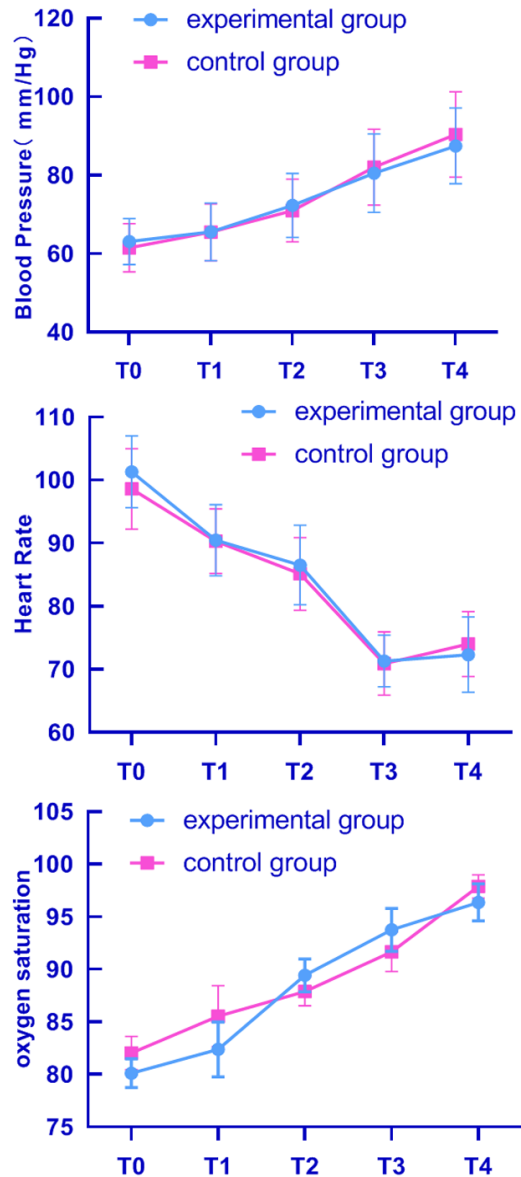
### *Comparison of the hemodynamic parameters*

The hemodynamic parameters were recorded before the thrombolysis (T0), one hour after the thrombolysis (T1), after the thrombolysis (T2), one day after the thrombolysis (T3), and at three days after the thrombolysis (T4) in both groups. The results showed that the heart rates were faster, the blood pressure and oxygen saturation were lower than the normal values at T0, T1, and T2 in both groups, and the heart rate, blood pressure, and oxygen saturation returned to the normal range at T3 and T4 with

# Three-dimensional nursing management with acute pulmonary embolism patients

**Table 1.** Comparison of the general data from the patients in the two groups

Group	Age (year)	Height (cm)	Weight (kg)	Course of disease (d)	Smoking history
Experimental group	53.4±15.9	166.6±17.3	70.1±11.3	11.04±2.13	8
Control group	55.2±16.3	164.7±18.8	71.3±11.1	11.22±2.11	9
t/X <sup>2</sup>	0.25	0.24	0.24	0.31	0.39
P	0.81	0.82	0.81	0.89	0.53



**Figure 1.** Comparison of the hemodynamic parameters. Note: The abscissa from top to bottom indicates time, and the ordinate indicates blood pressure, heart rate, and oxygen saturation in turn.

no statistically significant difference ( $P > 0.05$ ) (Figure 1).

## Comparison of the pulmonary embolism manifestations

In the nursing process, 1 patient in the control group had a recurrence of the disease and died despite treatment. Our comparison of the manifestations and changes of PE between the two groups showed that the PE manifestations, such as chest distress, dyspnea, chest pain, and hemoptysis, gradually decreased. When the nursing time was shorter than 3 days, there was no significant difference in the PE manifestations between the two groups ( $P > 0.05$ ). However, with an increase in the nursing time, the recovery in the experimental group was significantly better than it was in the control group ( $P < 0.05$ ). A specific comparison of the PE manifestations between the two groups is presented in Table 2.

## Comparison of the compliance with the respiratory function exercises

We examined the compliance with the respiratory function exercises and found that, with the extension of the nursing time, the patient compliance in the control group gradually decreased, and all the patients in the control group failed to keep doing the exercises during the 3 months after discharge. However, the patients in the experimental group were able to adhere to the daily exercise task during their hospital stays, and 4 patients still did the daily exercise tasks after their discharge. A comparison of the exercise compliance is shown in Table 3.

## Comparison of the nursing efficiency

We found that the overall efficiency was 90% in the experimental group and 30% in the control group. The difference between the two groups was statistically significant ( $P < 0.05$ ) in Table 4.

## Three-dimensional nursing management with acute pulmonary embolism patients

**Table 2.** Comparison of the PE manifestations in the two groups

Group	1 day of nursing				3 day of nursing			1 week of nursing	
	Chest pain	Dyspnea	Hemoptysis	Death	Chest pain	Dyspnea	Hemoptysis	Chest pain	Dyspnea
Experimental group	8	10	5	0	4	3	0	0	1
Control group	9	9	6	1	7	7	3	5	7
X <sup>2</sup>	0.39	1.05	0.20	1.05	1.02	3.20	3.53	6.67	7.50
P	0.53	0.30	0.65	0.31	0.18	0.07	0.06	0.01	0.006

**Table 3.** Comparison of the respiratory function exercise compliance in the two groups

Time	Experimental group (n=10)	Control group (n=10)	X <sup>2</sup>	P
1 day of nursing	10	10	-	-
3 days of nursing	10	6	5.00	0.025
1 week of nursing	10	2	13.33	0.00
3 months of discharge from the hospital	4	0	5.00	0.025

**Table 4.** Comparison of the nursing efficiency in the two groups

Group	Effective	Significant	Ineffective	Overall efficiency (%)
Experimental group	6	3	1	9 (90%)
Control group	1	2	7	3 (30%)
X <sup>2</sup>				7.50
P				0.006

**Table 5.** Comparison of the patients' and their families' satisfaction

Score	Experimental group and their families	Control group and their families	X <sup>2</sup>	P
0-4	0	2	1.90	0.170
5-6	1	10	10.16	0.001
7-8	5	4	0.14	0.710
9-10	14	2	15.00	0.000

### Comparison of the patients' and their families' satisfaction

The patients were followed up for 3 months after discharge, and the patients and their families were invited to score their satisfaction with the nursing during the hospital stay, with 0-4 points indicating dissatisfied, 5-6 points indicating generally satisfied, 7-8 points indicating satisfied, and 9-10 points indicating markedly satisfied. The results showed that only one patient and one family member in the control group scored less than 4 points, 14 patients scored more than 8 points, 5 patients scored

6-8 points, and 1 patient scored 4-6 points. In the experimental group 2 patients scored 0-4 points, 10 patients scored 4-6 points, 4 patients scored 6-8 points, and 2 patients scored over 8 points in the control group (Table 5).

### Discussion

Acute PE is a common postoperative complication in patients undergoing thoracotomy. Acute PE is characterized by palpitations, chest tightness, chest pain, hemoptysis, and dyspnea. It is often accompanied by an accelerated heart rate and decreased blood pressure and oxygen saturation [14, 15]. As a very important link, the nursing of patients with acute PE after thoracotomy involves close monitoring of the possible symptoms, and the implementation of first aid measures, so as to promote patient recovery and reduce the mortality rate of acute PE [16].

*Three-dimensional care management* is a novel nursing model that focuses on the logical, time, and knowledge dimensions of patient care so that caregivers can provide first aid in the event of complications [17]. The three-dimensional nursing management model is the center of the entire emergency patient rescue care model, instructing nurses how to discover, analyze, and solve the problems in time. Through training, the nurses 4 points as dissatisfying, which had a very significant patients

## Three-dimensional nursing management with acute pulmonary embolism patients

has been enhanced. When encountering complex and difficult problems, nurses can make an accurate analysis within a limited time and respond accurately according to the specifications and procedures in a timely manner, thus shortening the rescue time [4]. Patients with acute pulmonary embolism after thoracotomy often exhibit features such as complexity, multiple, sudden, atypical, and other characteristics. These patients usually need to undergo continuous dynamic monitoring to promptly detect changes in their conditions and implement rescues. Therefore, a sound nursing management system is crucial. Three-dimensional nursing management is used with post-thoracotomy, acute pulmonary embolism patients, aiming to explore the existing unsafe factors and seeking ways to reduce adverse nursing events. The goal is to improve the quality of nursing work and reduce the risk of complications.

This study compared the nursing efficiency and post-thoracotomy, acute PE patients' respiratory function exercise compliance after thoracotomy who underwent routine nursing and three-dimensional nursing management. The comparison results showed that there was no significant difference in the hemodynamic parameters before and after the nursing between the two groups ( $P > 0.05$ ). With an extension of the nursing time, the difference in the PE symptoms between the two groups gradually increased. After 1 day of nursing, there was no significant difference in the dyspnea, chest tightness, chest pain, hemoptysis, or other symptoms between the two groups. One patient in the control group died despite emergency rescue efforts due to disease recurrence. After 3 days of nursing, the symptoms in the experimental group were significantly alleviated, with a significant difference between the two groups. After 1 week of nursing, there was only 1 patient with dyspnea in the experimental group, 5 patients with chest tightness and chest pain, and 7 patients with dyspnea in the control group, which is similar to the result reported by Li et al. [4].

Xiao-Ying Zhang et al. [18] concluded that respiratory function exercises can be performed by singing, and in this study, the patients in the experimental group used blowing balloons combined with pursed-lip breathing and abdominal breathing. The results showed good

compliance. Maude Desjardins and Park Sun Ja et al. [19, 20] proposed that respiratory function exercises can improve sound function, and voice dysfunction can be improved through respiratory function exercise. In this study, respiratory function exercise for patients had a significant effect on improving the clinical manifestations of PE. After one week of nursing, the results of the comparison of respiratory function exercise compliance between the two groups showed that all the patients in the experimental group were able to complete their respiratory function exercises every day during the hospital stay. Only 2 patients in the control group kept doing the exercises. The results of follow-up at 3 months after discharge showed that 4 patients in the experimental group still adhered to the daily exercises, but no patients in the control group persisted with the exercises. The overall efficiency was 90% in the experimental group and 30% in the control group ( $P < 0.05$ ). A follow-up survey revealed that 14 patients and their families in the experimental group expressed great satisfaction with the nursing without any unsatisfactory results. In the control group, one patient and one family member were dissatisfied, and two expressed great satisfaction.

In summary, the three-dimensional nursing management model plays a very crucial role in the postoperative nursing of patients with acute PE after thoracotomy. It promotes the recovery of patients, and it helps improve the compliance with the respiratory function exercises. Meanwhile, the effective rate of the three-dimensional nursing management is significantly better than it is with the conventional nursing. This nursing model is worthy of promotion and application in clinical practice. The limitation of this study is that it was a single-center study, and the study cohort was small. In the future, large cohort, multiple-center studies will be conducted, which will make the results of the study more rigorous.

### Disclosure of conflict of interest

None.

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## References

- [1] Salmerón Jiménez M, Hermoso Alarza F, Martínez Serna I, Marrón Fernández C, Meneses Pardo JC, García Salcedo JA, Torres Serna A, Manama Gama MG, Colmenares Mendoza OE, Diaz-Hellín Gude V and Gamez García AP. Clinical features and outcomes of thoracic surgery patients during the COVID-19 pandemic. *Eur J Cardiothorac Surg* 2020; 58: 738-744.
- [2] Nawazani A, Ghanaim M and Tariq S. Case of COVID-19 infection and polycythaemia presenting with massive acute pulmonary embolism. *BMJ Case Rep* 2020; 13: e237390.
- [3] Wang SY and Wu C. Discussion on the three-dimensional model of integrated safety management. *Mod Manage Sci* 2010; 8: 30-34.
- [4] Li JY, Zhang Y, Huang YD, Zhao ZH and Shen ML. Applied research on three-dimensional nursing management mode in rescuing critical patients in coronary care unit. *J Qiqihar University Med* 2015; 36: 4005-4006.
- [5] Bowers E, Mohapatra AA, Ali AA and Singh MJ. Management of acute pulmonary embolism in a patient with sickle cell anemia using catheter-directed thrombolysis. *Ann Vasc Surg* 2021; 71: 534.e1-534.e5.
- [6] Jha AK. Effect of terlipressin in complex hemodynamic environment of acute pulmonary embolism. *Crit Care Med* 2020; 48: e982.
- [7] Fujii Y, Mori Y, Kambara K, Hirota K, Yanada M, Toda S and Hashiguchi M. Pulmonary vein thrombosis and cerebral infarction after video-assisted thoracic surgery of the left upper lobe: a case series. *JA Clin Rep* 2020; 6: 71.
- [8] Mei LX, Wang YY, Chen Y, Dai L and Chen MW. Subxiphoid versus intercostal video-assisted thoracic surgery for lung resection: a meta-analysis. *Minim Invasive Ther Allied Technol* 2020; 1-11.
- [9] Jack JM, McLellan E, Versyck B, Englesakis MF and Chin KJ. The role of serratus anterior plane and pectoral nerves blocks in cardiac surgery, thoracic surgery and trauma: a qualitative systematic review. *Anaesthesia* 2020; 75: 1372-1385.
- [10] Hakiri S, Kawaguchi K, Tateyama H, Fukui T, Nakamura S, Ozeki N, Mori S and Chen-Yoshikawa TF. Thymic lipofibroadenoma accompanied with largish calcifications. *Gen Thorac Cardiovasc Surg* 2021; 69: 394-397.
- [11] Sobrinho ASF, Scalassara PR and Dajer ME. Low-cost joystick for pediatric respiratory exercises. *J Med Syst* 2020; 44: 186.
- [12] Na KJ, Park S, Lee HJ, Park IK, Kang CH and Kim YT. Comparison between lung perfusion scan and single-photon emission computed tomography/computed tomography for predicting postoperative lung function after pulmonary resection in patients with borderline lung function. *Eur J Cardiothorac Surg* 2020; 58: 1228-1235.
- [13] Weber CF, Wesselly A, Held T, Anheuser P, Schönwälder J and Weischer W. Hyperfibrinolysis after resuscitation due to acute pulmonary artery embolism. *Anesthesiol Intensivmed Notfallmed Schmerzther* 2020; 55: 569-575.
- [14] Elkaryoni A, Merchant KR, Brailovsky Y, Bunte MC, Sperry BW and Darki A. Effect of acute pulmonary embolism on the hospitalization rates in patients with heart failure (from a nationwide cohort sample). *Am J Cardiol* 2020; 135: 185-187.
- [15] Bryk AH, Natorka J, Ząbczyk M, Zettl K, Wiśniewski JR and Undas A. Plasma fibrin clot proteomics in patients with acute pulmonary embolism: association with clot properties. *J Proteomics* 2020; 229: 103946.
- [16] Ou M, Zhang C, Chen J, Zhao S, Cui S and Tu J. Overexpression of MicroRNA-340-5p inhibits pulmonary arterial hypertension induced by APE by downregulating IL-1 $\beta$  and IL-6. *Mol Ther Nucleic Acids* 2020; 21: 542-554.
- [17] Santuzzi CH, Liberato FMG, Morau SAC, de Oliveira NFF and Nascimento LR. Adherence and barriers to general and respiratory exercises in cystic fibrosis. *Pediatr Pulmonol* 2020; 55: 2646-2652.
- [18] Zhang XY, Song YC, Liu CB, Qin C, Liu SH and Li JJ. Effectiveness of oral motor respiratory exercise and vocal intonation therapy on respiratory function and vocal quality in patients with spinal cord injury: a randomized controlled trial. *Neural Regen Res* 2021; 16: 375-381.
- [19] Desjardins M and Bonilha HS. The impact of respiratory exercises on voice outcomes: a systematic review of the literature. *J Voice* 2020; 34: 648.e1-648.e39.
- [20] Park SJ, Kim YM and Yang SR. Effects of lumbar segmental stabilization exercise and respiratory exercise on the vital capacity in patients with chronic back pain. *J Back Musculoskeletal Rehabil* 2020; 33: 841-848.