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Effects of Pain Neuroscience Education on Pain, Body Function, Activity Disorders, and Depression in Patients with Chronic low back Pain: Randomized Controlled Trail

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Abstract

Background: Many patients with chronic low back pain have reduced movement due to pain. For that reason, muscle strength weakens, which leads to pain again. The pain caused by such a vicious circle is not only caused by structural problems, but also by physical function, activity disorder, or psychological depression due to biopsychosocial approaches and pain neuroscience education was applied as an intervention to find out its effect. Therefore, this study was experimented with to find out the effects of pain neuroscience education on pain, physical function, activity disorder, and depression in patients with chronic low back pain.

Design: Randomized control trial

Method: The study subjects were 39 patients with chronic low back pain, and the study subjects were randomized through computers to the experimental group applying pain neuroscience education and the control group applying only general physical therapy and myofascial release techniques, and the experiment was conducted for 4 weeks. Pressure Pain Threshold , Schober test, Korean Roland-Morris Disability Questionnaire, Korean Oswestry Disability Index, and Korean Depression Screening Assessment were measured.

Results: As a result of the study, there was no significant difference in pain neuroscience education compared to the group that applied only general physical therapy and myofascial release techniques in both lumbar pressure pain thresholds, Schober test, Korean Roland-Morris disability questionnaire, and Korean Oswestry disability questionnaire. However, the Korean Depression Screening Assessment which is the result of measuring depression, showed significant results($p<0.05$).

Conclusion: Therefore, it is believed that it can be a way to mediate the psychological part through pain neuroscience education for patients with chronic low back pain in the future.

Key words: Chronic Pain; Depression; Education; Low Back Pain; Neuroscience

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Ⅰ. Introduction

In an industrialized modern society, back pain is one of the most common musculoskeletal disorders globally, and it is estimated that the majority of people will experience back pain at least once in their lifetime (Bae et al., 2022; Hwang et al., 2022). The causes of various chronic back pains can be compressed into two main factors. First, there are causes that have been clinically proven and demonstrated by measuring tools, stemming from mechanical degeneration. Second, there are non-mechanical causes, including changes in the neuroplasticity of the central nervous system at the level of the spinal cord. Several pieces of evidence from various literature suggest that the symptoms of chronic back pain can be exacerbated by physical, psychological, and social factors. These factors include the quality of life and personal emotions, which can influence posture and body signal perception, potentially increasing the perception of pain. These factors contribute to the increase in patients experiencing chronic back pain, resulting in rising healthcare costs. This increase in economic burden affects not only patients but also the nation (Jang et al., 2022; Park et al., 2021). To address the increasing number of chronic back pain patients, various approaches have been taken from multiple perspectives. The most commonly used conventional approach targeted patients with orthopedic conditions, explaining structural issues using anatomical or biomechanical models. However, these limited perspectives highlighted the need for a new approach to chronic back pain. Traditional clinical treatments for chronic back pain typically involved general physical therapy, manual therapy, and education on pain management guidelines to reduce chronic back pain (Castro-Sánchez et al., 2012).

As research progressed on the mechanisms of pain and the human body, a new educational model called pain neuroscience education was developed (Louw et al., 2011; Louw et al., 2014; Moseley, 2003; Moseley et al., 2015; Nijs et al., 2011). Explaining pain involves conveying to the patient what pain is, what function it serves, and what biological processes underlie it. The goal of this educational intervention is to change patients' concepts of pain. Pain neuroscience education emerged from educational psychology and aims to reframe pain as a sign of the need to protect the body from harm rather than a sign of tissue damage (Moseley et al., 2015). Unlike traditional anatomical or biomechanical models, pain neuroscience education focuses on neurophysiology, neurobiology, and the expression of pain to explain the mechanisms of pain to patients and reduce nervous system hypersensitivity.

Recent research suggests that combining pain neuroscience education with cognitive-motor training can reduce pain and disability levels and improve the psychological function and pain perception of individuals with chronic back pain (Malfliet et al., 2018). In non-specific chronic back pain, the persistence of pain may be due to inappropriate pain perception and recognition, among other factors (Sterling et al., 2003). These misconceptions about pain and illness can act as potential barriers to treatment for these patients (Smeets et al., 2008). Inappropriate pain perception and recognition can lead to negative emotions, depression, anxiety, and sleep disorders, all of which are correlated with pain (Alsaadi et al., 2011). Several studies have shown that pain neuroscience education has positive effects on anxiety, stress, catastrophizing, pain, disability, and pain perception in patients with chronic back pain (Louw et al., 2014; Van Oosterwijck et al., 2013).

In this study, we aim to investigate how pain neuroscience education affects the pain and physical function of patients with chronic back pain. Therefore, the purpose of this study is to compare the effects of PNE combined with MFR

on Pain, Body Function, Activity Disorders, and Depression in patients with chronic low back pain.

Ⅱ. Methods

1. Participants

The subjects of this study were patients who had been experiencing chronic back pain for three months or more. Out of the 46 patients who visited the G Neurosurgery Clinic in Yeonsu-gu, Incheon, South Korea, seven were excluded, including four who had a duration of less than three months and three who had a history of back surgery. Therefore, the study was conducted with 39 participants.

The inclusion criteria for selecting research subjects were as follows: Patients in their 50s to 60s who had been experiencing back pain for three months or more, Individuals without a history of surgery, Individuals without visual or auditory impairments, Individuals with an Oswestry Disability Index (Korean version) score of less than 40%, Individuals capable of understanding and performing the instructions provided by the researchers, The exclusion criteria for the study were as follows, Individuals with a history of back surgery, Individuals with an Oswestry Disability Index (Korean version) score of 41% or higher, Individuals with an MMSE-K (Mini-Mental State Examination-Korean version) score of less than 24 points.

The present study was approved by the institutional review board of Sahmyook University (Seoul, Korea, 2-1040781-A-N-012021060HR) and it was registered (KCT0007369) in the Clinical Research Information Service of the Republic of Korea. The objective and procedures of the study were fully understood by the participants, and all participants provided informed consent for inclusion. This study was performed in accordance with the ethical principles of the Declaration of Helsinki.

2. Experimental Procedures

We used G*Power (version 3.1.9.7; Franz Faul, University Kiel, Germany, 2020) for power analysis before recruiting participants. The overall effect size index for all outcome measures and the power of the study were 0.5 and a probability of 0.05 to minimize type II error (80% power), respectively. The estimated target sample size was 34; therefore, we recruited 39 low back pain patients for this experiment. The study included a total of 39 participants who met the inclusion criteria, comprising adults in their 50s to 60s with chronic back pain. Among the 46 initially screened participants, seven were excluded, including four with a pain duration of less than three months and three individuals with a history of back surgery. These 39 selected participants were asked to complete a questionnaire to provide their basic demographic information, such as gender, age, height, weight, and other characteristics.

Before the experiment, the selected participants underwent a medical examination by a physician to record their medical history and X-ray images were taken to document their condition. Pre-tests were conducted at this stage. To minimize bias, the selected participants were randomly assigned to either the pain neuroscience education group, consisting of 19 participants, or the control group, comprising 20 participants. Randomization was performed using a randomization program for researchers (https://www.randomizer.org/). This study conducted a chi-square test to assess homogeneity be-

tween the two groups.

Both groups received standard physical factor therapy and myofascial release techniques, and the treatment duration was the same for both groups. In the control group, standard physical factor therapy was administered twice a week, each session lasting 30 minutes, and myofascial release was administered twice a week, with each session lasting 20 minutes. In addition to these treatments, the pain neuroscience education group received pain neuroscience education twice a week, with each session lasting 15 minutes.After four weeks of intervention, post-tests were conducted, following the same protocol as the pre-tests. It's worth noting that due to participation rates of less than 80%, four participants from the experimental group and five participants from the control group were excluded. As a result, a total of 30 participants completed the study(Figure 1).

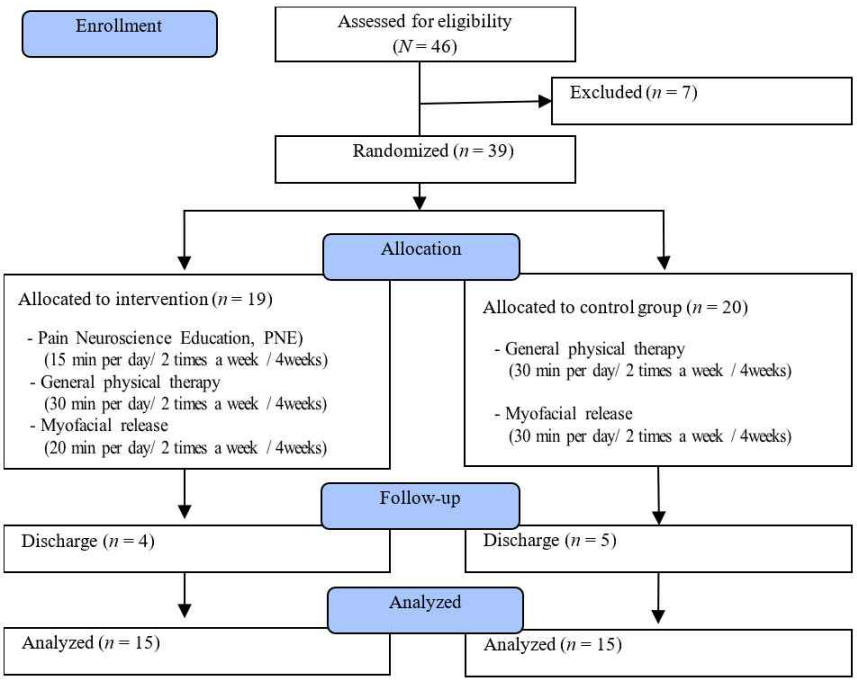

Figure 1. Flow diagram of the experimental procedure.

3. Pain Neuroscience Education (PNE)

In this study, pain neuroscience education, based on Louw's classification, was used to provide patients with information on the mechanisms of pain. The education was divided into four main topics: the definition of pain, the transmission process of pain, the chronicity of pain, and central sensitization. Each of these topics was covered over one week, with two sessions per week (Louw, 2011).

To deliver this education, online resources were utilized, with a particular focus on YouTube, which is currently one of the most popular sources of health-related information (Heathcote et al., 2018). The use of YouTube for learning has been validated with a validity score of 0.886 and demonstrated high reliability with a Cronbach's Alpha of 0.944 (Pratama et al., 2018).

Patients were provided with supplementary materials for the pain neuroscience education content and were instructed to watch YouTube videos from a specified YouTube channel for 15 minutes per session during each week of the education period (https://youtube.com/channel/UCooV-hi0G9RuanLHP9mJH2w). The education sessions were conducted by the responsible researcher, who had received relevant training and was a licensed physical therapist (Table 1).

Table 1. Pain neuroscience education topics.

Weeks		Weekly training topics	Time (Min)
1st	What is Pain?	Definition of pain, Classification of pain, Measurement of pain, Various types of pain	15
	Neurophysiology- 1	Composition of the nervous system, Anatomical structure of nerve cells	15
2nd	Neurophysiology- 2	Types and functions of nerve cells and fibers, Fundamentals of pain mechanisms	15
	Chronic Pain- 1	Definition of chronic pain, Biopsychosocial model	15
3rd	Chronic Pain- 2	Management of chronic pain	15
	Central Sensitization- 1	Definition of central sensitization, Mechanisms of central sensitization, Patterns of pain	15
4th	Central Sensitization- 2	Pain due to neurological disorders, Process of pain recognition in central sensitization, Patients with central sensitization, and physical therapy	15
	Summary of PNE	Q&A	15

4. Fascia relaxation technique

In this study, myofascial release (MFR) techniques were applied to patients with chronic back pain to reduce pain levels and facilitate functional recovery in the lumbar and pelvic regions. The MFR was administered twice a week for four weeks, with each session lasting 20 minutes. The selected areas for application included the multifidus muscle, erector spinae muscle of the back, iliopsoas muscle, and gluteal muscles around the lumbar region. Specific myofascial release techniques were used for the lumbar region, including vertical sliding on the lumbar area, myofascial release of the erector spinae muscle, iliopsoas myofascial release, and myofascial release of the gluteal muscles (Kim Y. and Kim T., 2021). A physical therapist with over five years of clinical experience applied MFR to the same patients until the end of the experiment. The choice between prone and supine positions for MFR application depended on the location of the targeted muscle.

5. Common physical factor therapy

In this study, for patients with chronic back pain, interventions were applied to reduce pain levels, promote tissue relaxation, and increase blood flow. The interventions included the use of an interferential current therapy device (GP-Multiplus; Goodpl Corp., Korea, 2017) and a Hot Pack (Illite clean hot pack; Samboo Medical Corp., Korea, 2019), each for 15 minutes, totaling 30 minutes.

The interferential current therapy device was applied using a cross-method between the first and fifth lumbar vertebrae regions. It utilized a carrier frequency of 4000 Hz, an amplitude-modulated frequency of 65 Hz, and a sweep frequency

of 95 Hz with a 1:1 swing pattern. The current intensity was adjusted individually until it reached a point where the patient felt a sensation similar to needle pricks but did not cause muscle contractions (Albornoz canello, 2017). The Hot Pack was placed on the patient's lumbar area, covered with a towel, and the patient received the treatment while lying in a supine position, tailored to the lumbar region. A physical therapist with over three years of clinical experience administered the interventions to the same patients until the end of the experiment.

6. Outcome Measurements.

6.1. Primary Outcome: Pain

In this study, a pressure algometer was used to measure and quantify pain in the lumbar region. The accuracy of the pressure algometer used in the research had an error of ± 0.15 kgf, which is equivalent to ± 0.3% of the full scale (50 kg) with one decimal point (The Wagner Fpx 25; Wagner Instruments, U.S.A., 2020). Pressure algometers are advantageous for quantifying pain thresholds and are useful for assessing conditions like tendonitis, hypersensitive areas, arthritis, trigger points, and visceral pain (Fischer, 1986). The intra-rater reliability of measurements showed high reliability with Cronbach's alpha values ranging from 0.94 to 0.98.

To maintain assessor blinding in this study, a physical therapist who was not involved in the intervention conducted the measurements in a separate location. To minimize measurement errors, measurements were taken at three different locations on both sides, using L1, L3, and L5 levels of the lumbar region as reference points. These measurements were conducted one day before the training and one day after the training, and the average values were used.

6.2. Primary Outcome: Body Function

In this study, the Schober test was used to assess the functional abilities of patients with chronic back pain, specifically evaluating lumbar function. The Schober test is employed to determine a reduction in lumbar range of motion and to assess the progress of other pathological conditions related to lower back pain or the effects of treatment. During the test, the patient stands while the examiner marks the patient's PSIS (posterior superior iliac spine). The examiner then draws a horizontal line at the midpoint between the marked points on both sides. The second line is drawn 5 cm below the first line, and the third line is drawn 10 cm above the first line (for a total of 15 cm). The examiner instructs the patient to bend forward as if reaching for their toes, and the examiner measures the distance between the second and third lines. An increase of less than 5 cm is considered a positive result. The inter-rater reliability of measurements showed a high level of agreement with an r-value of 0.96 (Tousignant et al., 2005).

To maintain assessor blinding in this study, a physical therapist not involved in the intervention conducted the measurements in a separate location. To minimize measurement errors, measurements were taken at three different time points: one day before the training, and one day after the training, and the average value of these measurements was used.

6.3. Secondary Outcome: Activity Disorder Index

The activity disorder index was assessed using the RMDQ, which measures the degree of dysfunction caused by low

back pain. It consists of a 0- to 24-point scale and is a commonly used assessment method for low back pain disability parameters, such as the Oswestry Disability Index, in clinical settings. The reliability (ICC) of the RMDQ is very high at 0.932, and the Korean version of the RMDQ, which was proven reliable by Lee et al., was used in this study (Lee and Park, 2007; Jeon et al., 2005).

6.4. Secondary Outcome: Depression

In this study, the Korean Depression Screening Tool (K-DEP) was used to objectively measure the reduction in the level of depression in patients with chronic back pain after the intervention. This self-report questionnaire is composed of a total of 12 items and is designed to screen for major depressive disorders. It can be easily administered online via a personal smartphone, making it convenient for assessing patients' depression levels before and after the experiment. Higher scores on this tool indicate a more severe degree of depression. The accuracy of K-DEP was found to be high, with an accuracy level of 94.6% as determined by ROC curve analysis, and it demonstrated strong reliability with a Cronbach's alpha of 0.99. The sensitivity and specificity of K-DEP were 0.92 and 0.94, respectively (Yoon et al., 2018).

7. Statistical Analysis

SPSS statistical software (version 28.0; IBM, Chicago, IL, USA) was used for all statistical analyses. The chi-square test to assess homogeneity between two groups The level of statistical significance was set at $p > 0.05$. The Kolmogorov-Smirnov test was used to analyze the normal distribution of the variables. The independent-sample t-test was performed to identify differences between the groups. The paired t-test was used to compare the results before and after the intervention. The level of statistical significance was set at $p < 0.05$.

Ⅲ. Results

The homogeneity of this experiment was assessed through a chi-square test, and the general characteristics and homogeneity testing of the study participants are as follows(Table 3).

Table 3. Demographic data of the two groups (N= 30)

Parameters	PNE Group (n= 15)	Control Group (n= 15)	t/x2 (p)
Gender(M/F)	6/9	8/7	0.714(0.481)
Age (years)	61.47(3.04)	61.93(2.46)	-0.462(0.648)
Height (cm)	167.93(6.64)	169.67(7.19)	-0.686(0.498)
Weight (kg)	69.40(9.19)	70.80(10.09)	-0.397(0.694)
Obesity rate (%)	24.51(1.85)	24.46(1.85)	0.072(0.943)
Duration of injury (months)	5.73(1.53)	5.87(1.73)	-0.224(0.825)

Data are mean (standard deviation). PNE, pain neuroscience education

Pain

In the measurement of the pressure pain threshold on the right side of the lower back, the experimental group showed a statistically significant improvement from 4.63 ± 0.66 kgf/cm² before the intervention to 4.89 ± 0.76 kgf/cm² after the intervention ($p < 0.05$). The control group also demonstrated a statistically significant improvement, increasing from 4.70 ± 0.74 kgf/cm² before the intervention to 4.89 ± 0.94 kgf/cm² after the intervention ($p < 0.05$).

For the measurement of pressure pain threshold on the left side of the lower back, the experimental group exhibited a statistically significant improvement, increasing from 4.74 ± 0.60 kgf/cm² before the intervention to 4.98 ± 0.70 kgf/cm² after the intervention. Similarly, the control group showed a statistically significant improvement, with pressure pain threshold increasing from 4.73 ± 0.71 kgf/cm² before the intervention to 4.91 ± 0.88 kgf/cm² after the intervention.

In the comparison of group differences based on the intervention method, there was no statistically significant difference between the experimental and control groups(Table 4).

Table 4. Comparison of pain within groups and between groups (N = 30).

Parameters		PNE Group (n = 15)	Control Group (n = 15)	$t(p)$
PPT Rt. (kgf/㎠)	Pret-est	4.63(0.66)	4.70(0.74)	-0.261(0.796)
	Post-test	4.89(0.76)	4.89(0.94)	
	pre-post	-0.25(0.28)	-0.19(0.27)	-0.594(0.557)
	$t(p)$	-3.461(0.004)	-2.784(0.015)	
PPT Lt. (kgf/㎠)	Pret-est	4.74(0.60)	4.739(0.71)	0.019(0.985)
	Post-test	4.98(0.70)	4.91(0.88)	
	pre-post	-0.24(0.26)	-0.17(0.26)	-0.754(0.457)
	$t(p)$	-3.588(0.003)	-2.535(0.024)	

Data are mean (standard deviation). PNE= pain neuroscience education; PPT= pressure pain threshold; Rt= right; Lt= left.

Body Function

The Schöber test values for the experimental group increased from 4.45 ± 0.86 cm to 4.48 ± 0.80 cm, showing a change of 0.03 ± 0.12 cm. In the control group, the Schöber test values increased from 4.09 ± 0.80 cm to 4.14 ± 0.83 cm, with a change of 0.05 ± 0.13 cm. However, these changes were not statistically significant(Table 5).

Table 5. Comparison of Body Function within groups and between groups (N = 30).

Parameters	PNE Group (n = 15)	Control Group (n = 15)	$t(p)$
Pret-est	4.45(0.86)	4.09(0.80)	1.212(0.236)
Post-test	4.48(0.80)	4.14(0.83)	
pre-post	-0.03(0.12)	-0.05(0.13)	-0.578(0.568)
$t(p)$	-0.845(0.413)	-1.586(0.135)	

Data are mean (standard deviation). PNE=pain neuroscience education.

Activity Disorder

In the K-RMDQ, the experimental group showed a statistically significant reduction from 9.33 ± 1.88 points before the intervention to 8.87 ± 2.07 points after the intervention (p<0.05). The control group, on the other hand, did not show a statistically significant difference, with scores changing from 8.53 ± 2.64 points before the intervention to 8.07 ± 2.34 points after the intervention. Regarding K-ODI, the experimental group demonstrated a statistically significant improvement, with scores changing from 23.20 ± 4.39% before the intervention to 22.00 ± 4.00% after the intervention (p<0.05). The control group did not show a statistically significant difference, as their scores changed from 19.87 ± 4.56% before the intervention to 19.47 ± 3.81% after the intervention. When comparing the groups based on the intervention method, there was no statistically significant difference between the experimental and control groups(Table 6).

Table 6. Comparison of activity disorder within groups and between groups (N = 30).

Parameters		PNE Group (n = 15)	Control Group (n = 15)	$t(p)$
K-RMDQ (point)	Pret-est	9.33(1.88)	8.53(2.64)	0.956(0.347)
	Post-test	8.87(2.07)	8.07(2.34)	
	pre-post	0.47(0.74)	0.47(0.99)	0.000(1.000)
	$t(p)$	2.432(0.029)	1.825(0.089)	
K-ODI (%)	Pret-est	23.20(4.39)	19.87(4.56)	2.037(0.051)
	Post-test	22.00(4.00)	19.47(3.81)	
	pre-post	1.20(1.26)	0.40(1.35)	1.673(0.105)
	$t(p)$	3.674(0.003)	1.146(0.271)	

Data are mean (standard deviation). PNE= pain neuroscience education; K-RMDQ= korean version roland-morris disability questionnaire; K-ODI= korean version oswestry disability Index.

Depression

In K-DEP, the experimental group showed a statistically significant reduction, with scores changing from 23.04 ± 4.84 points before the intervention to 20.80 ± 3.27 points after the intervention (p<0.05). The control group, however, did not exhibit a statistically significant difference, as their scores changed from 20.90 ± 4.76 points before the intervention to 21.15 ± 4.02 points after the intervention. When comparing the groups based on the intervention method, a statistically significant difference was observed between the experimental and control groups (p<0.05)(Table 7).

Table 7. Comparison of depression within groups and between groups (N = 30).

Parameters	PNE Group (n = 15)	Control Group (n = 15)	$t(p)$
Pre-test	23.04(4.84)	20.90(4.76)	1.222(0.232)
Post-test	20.80(3.27)	21.15(4.02)	
pre-post	2.25(1.95)	-0.24(1.40)	4.022(0.000)*
$t(p)$	4.472(0.001)*	-0.673(0.512)	

Data are mean (standard deviation). PNE= pain neuroscience education; K-DEP= Korean depression screening assessment.

Ⅳ. Discussion

Pain is complex, and it is well-known that patient's various perceptions and beliefs about their pain influence their pain experiences. Chronic pain patients often experience memory lapses and have difficulty maintaining focus (Jamison et al., 1988; Parmelee et al., 1993; Schnurr et al., 1995). Pain becomes a strong motivator for patients to seek treatment. The education of patients on managing pain, anxiety, and stress related to back pain has been studied for a long time (Louw et al., 2011). Pain neuroscience education consists of educational sessions that encompass the neurophysiology, neurobiology, and pain transmission processes within the nervous system. Such approaches aim to enhance patients' detailed and fundamental physiological understanding of their chronic pain (Butler and Moseley, 2013).

When examining the results of several previous studies applying pain neuroscience education to chronic low back pain, an experiment combining pain neuroscience education with underwater exercise showed no significant difference in pain between the experimental and control groups (Pires et al., 2015). In an experiment comparing manual therapy for low back pain with pain neuroscience education, no significant difference was observed between the experimental and control groups. Conversely, in an experiment comparing the combination of pain neuroscience education and therapeutic exercise with no such combination for chronic low back pain, significant differences were found between the experimental and control groups (Pardo et al., 2018). In an experiment comparing an intervention that combined pain neuroscience education and Cognition Target Motor Control Training to an intervention that combined pain education and an exercise program for chronic low back pain patients, the pressure pain threshold at the 3-month follow-up was 15% higher in the experimental group (estimated mean difference 0.971; 95% CI, −0.028 to 1.970) (Malfliet et al., 2018).

In this study, both groups received general physical therapy and myofascial release techniques for four weeks, with the experimental group additionally receiving pain neuroscience education. The results of this study showed significant differences within both the experimental and control groups, but no significant differences were observed when comparing the two groups. It is believed that the benefit in the results of the experimental group was more influenced by the motivation to participate in the intervention rather than a direct effect of pain reduction due to pain neuroscience education.

Physical function refers to the ability to maintain the constancy of the body, which includes an individual's strength, mobility, agility, and balance (Reuben and Siu, 1990). When reduced mobility occurs due to chronic low back pain, it initiates a vicious cycle where physical function starts to deteriorate, exacerbating the pain once again (Shin and Cho, 2014). Inactivity resulting from chronic low back pain leads to physical issues and negative emotional states, which can impact health behaviors (Min and Lee, 2006). Previous research indicates that when comparing manual therapy and pain neuroscience education, there was a significant effect in the Straight Leg Raise (SLR) test (p=0.041). According to the simple effects analysis, the SLR improved in the experimental group (p=0.001) but not in the control group (p=0.123) (Louw et al., 2016). In a study comparing pain neuroscience education and lumbar stabilization exercises, the modified Schober test result (F=3.451; p=0.077) was not statistically significant (Kim et al., 2022). In this study, physical function was measured using the Schober test, and the Schober test value in the experimental group increased

from 4.45 ± 0.86 cm to 4.48 ± 0.80 cm, with a change of 0.03 ± 0.12 cm. In the control group, the Schober test value increased from 4.09 ± 0.80 cm to 4.14 ± 0.83 cm, with a change of 0.05 ± 0.13 cm, but there was no statistically significant difference. When compared to previous research, it is suggested that the lack of significance in the results may be due to the influence of various factors such as structural issues, psychological factors, and other variables that concurrently affect movement, leading to movement limitations.

Functional impairment is closely related to abnormally high muscle guarding mechanisms occurring in areas with injuries or pain during movement. This response is triggered by an excessive exercise response to pain. These exaggerated responses can lead to limitations in joint mobility and the development of stiffness, which places a significant load on the joints. Such mechanisms can lead to sensitization of peripheral nociceptors and tissue damage. In a study combining pain neuroscience education and lumbar stabilization exercises, the results for the Roland-Morris Disability Questionnaire (RMDQ) showed a significant increase in both the experimental and control groups (p<0.05), with no significant difference between the two groups (p=0.081; p=0.778) (Kim et al., 2022). In this study, functional impairment was measured using the K-RMDQ and K-ODI. The K-RMDQ measurements in the experimental group showed a significant reduction from 9.33 ± 1.88 points before the intervention to 8.87 ± 2.07 points after the intervention (p<0.05), but there was no significant difference between the groups. The K-ODI measurements in the experimental group decreased significantly from 23.20 ± 4.39% to 22.00 ± 4.00%, with a reduction of 5.90 ± 3.40% (p<0.05), and there was no significant difference between the groups.

In this study, both groups received general physical therapy and myofascial release techniques for four weeks, with the experimental group additionally receiving pain neuroscience education. The results of this study showed that there was no statistically significant difference between the groups in both the K-ODI and K-RMDQ assessments. Therefore, it is suggested that whether pain neuroscience education has an impact on improving functional impairment should be confirmed through further research in the future.

Depression is a maladaptive symptom that significantly impairs an individual's function both physically and cognitively, often accompanied by feelings of sadness, emptiness, irritability, and various other emotional states. When pain persists, it can lead to anxiety, depression, somatization, and sleep disturbances, eventually resulting in a reduced quality of life due to daily life disruptions (Schrubbe et al., 2016).

In previous research regarding pain neuroscience education and approaches to depression, patients often fear being labeled as depression patients. Therefore, therapists should explain to chronic pain patients that depression may be a consequence rather than the cause of chronic pain. During the implementation of pain neuroscience education, therapists should discuss the interplay between pain and depression within the framework of the pain neuromatrix mechanism, as mentioned in previous studies (Wijma et al., 2016).

According to previous research on the association between chronic low back pain and depression, the chi-square test results (p<0.01) showed a significant association between chronic low back pain and depression (Sagheer et al., 2013). The values measured for depression, specifically the expected mean score of the Beck Depression Inventory (BDI), were also higher in the experimental group (p=0.001) compared to the control group (Hong et al., 2014).

In this study, depression was measured using K-DEP, and the results showed a significant decrease in the experimental group, with scores decreasing from 23.04 ± 4.84 points before the intervention to 20.80 ± 3.27 points after the intervention (p<0.05). The experimental group exhibited a significantly greater reduction in depression compared to

the control group (p<0.05).

The decrease in depression is believed to be a result of the knowledge transfer regarding pain mechanisms, which enables patients to objectively assess their condition and expands their metacognition, thereby inhibiting catastrophizing. Consequently, anxiety and stress are relatively alleviated, leading to a reduction in depression and an overall beneficial effect.

This study has strengths and limitations as follows. A strength of this study is its alignment with previous research, following a similar approach as observed in prior studies. In addition, we studied psychological factors that have recently been receiving attention in the physical therapy community. This approach provides continuity in research on this topic and offers guidance for future researchers conducting experiments on similar themes. Additionally, unlike many previous PNE studies that often compared exercise groups, this study compared the commonly used Korean clinical method, Myofascial Release (MFR).

However, A limitation of this study is that 30 subjects were included in the final analysis due to the subjects' discharge. The number of statistically significant subjects confirmed through G-power was 34. This is unfortunate and raises doubts about the reliability of the research results.

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