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Original Article

Preoperative pain neurophysiology education for lumbar radiculopathy: A randomized-controlled trial

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ABSTRACT

Objectives: This study aims to investigate the postoperative short-term effectiveness of preoperative pain neurophysiology education on pain severity, kinesiophobia, and disability in patients undergoing lumbar surgery for radiculopathy.

Patients and methods: Between April 2019 and August 2019, a total of 41 patients (22 males, 19 females; mean age 52.1±9.5 years; range, 37 to 64 years) scheduled for lumbar radiculopathy surgery were randomized to receive either preoperative routine education only (control group, n=20) or a 70-min pain neurophysiology education in addition to preoperative routine education (intervention group, n=21). The patients were evaluated for the following outcomes prior to surgery (baseline) and at 12 weeks after surgery: low back pain and leg pain using Numeric Pain Rating Scale, disability using Oswestry Disability Index), and kinesiophobia using Tampa Scale for Kinesiophobia.

Results: There were no statistically significant differences in low back pain (p=0.121), leg pain (p=0.142), and the length of stay hospital (p=0.110) between the groups. However, the interaction effects of intervention group were superior to control group regarding disability (p=0.042) and kinesiophobia (p<0.001).

Conclusion: The addition of pain neurophysiology education to routine education following lumbar radiculopathy surgery yields significant improvements for disability and kinesiophobia, although no additional benefits is seen regarding the pain severity and length of stay in hospital in the short-term.

Keywords: Chronic pain, low back pain, neurosurgery, pain neurophysiology education, patient education, radiculopathy.

Conservative treatment of lumbar radiculopathy (LR) is reported to possibly fail and exacerbates symptoms; therefore, lumbar surgery is usually planned after failed conservative treatment.[1,2] The primary surgical intervention for LR is lumbar laminectomy or laminotomy with or without discectomy.[3] The success rate of these surgical interventions has been reported as 60 to 90%.[4-7] Although this rate may be considered successful, 10 to 40% of patients may experience pain, movement loss, and function losses postoperatively.[3]

A rehabilitation program consisting of exercise and physical therapy is recommended to patients due to persistent pain and disability after surgery.[8,9] However, few patients receive postoperative rehabilitation, as surgeons rarely refer them to rehabilitation programs and/or due to their personal preferences.[10,11] In addition, studies on this subject have reported that the long-term effectiveness of postoperative rehabilitation is low.[11,12]

One of the strategies designed to reduce postoperative complications and disability is preoperative patient education.[13] Anatomical and biomechanical explanations are usually used in preoperative education, aiming at increasing patients' knowledge level and reducing their surgical anxiety, postoperative pain, and length of hospital stay.

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However, systematic reviews conducted to examine the effectiveness of these education methods revealed that they had no additional effects on patients undergoing surgery.[14]

Pain Neurophysiology Education (PNE) is frequently used in chronic pain patients and has been shown to be effective in chronic pain disorders and recently been applied in preoperative patient education, as well.[15,16] Instead of anatomical and biomedical explanations, PNE includes explanations of the biological and neurophysiological processes related to the painful situations in which patients find themselves.[15] To date, few studies.[17-19] have been conducted on the effectiveness of preoperative education in patients undergoing lumbar surgery and current reports suggest that PNE may be effective in reducing pain and improving physical function. Besides, the addition of a single PNE session prior to surgery for LR results in significant healthcare savings over three years.[18] However, previous studies are unable to explore the effectiveness a PNE session on the length of stay after surgery. Besides, there is no PNE study in patients undergoing lumbar surgery in Turkey.

In the present study, we aimed to investigate the postoperative short-term effectiveness of preoperative PNE on pain severity, disability, kinesiophobia, and the length of stay in patients undergoing surgery for LR.

PATIENTS AND METHODS

This study was designed as a single-blind, prospective, randomized-controlled study. The study was conducted at Neurosurgery Department of Faculty of Medicine, Kütahya Health Science University between April 2019 and August 2019. A written informed consent was obtained from each patient. The study protocol was approved by the Faculty of Medicine, Kütahya Health Science University Clinical Research Ethics Committee (No. 2019-19/3). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Lumbar radiculopathy surgery was decided by the surgeons for patients who were admitted to neurosurgery department with low back pain. Surgery was planned at the discretion of the surgeons, and the operation date was planned by the assistants and administrative and procedural information was provided to each patient. Meanwhile, all patients were informed and invited to participate in this study exploring the effects of two preoperative education programs.

Patients diagnosed with LR who were scheduled for surgery were included in this study. Inclusion criteria were as follows: age >18 years or <65 years; being scheduled for LR surgery; and willingness to participate in the study and comply with the prespecified follow-up visits. Exclusion criteria were as follows: being scheduled for surgery other than LR; being scheduled for instrumental lumbar surgery (spinal fusion, arthroplasty, etc.); illiteracy in Turkish language; and presence of chronic pain-related conditions (fibromyalgia, chronic fatigue syndrome, etc.).

A total of 63 patients were screened for eligibility and, after exclusions, 44 agreed to participate and were enrolled in the study. Of the initial group of 44 patients (22 assigned to the intervention group, 22 assigned to the control group), three participants were excluded from the study, as they did not comply with their follow-ups, and the study was completed with 41 patients (22 males, 19 females; mean age 52.1±9.5 years; range, 37 to 64 years) at the end of 12 weeks of follow-up. The study flow chart is shown in Figure 1.

Concealed randomization was performed using computer-generated numbers. All patients were given an envelope, which randomly assigned them to either routine education (control group, n=20) or PNE in addition to routine education (intervention group, n=21). The envelopes contained identical information except that patients in the intervention group were asked to schedule a 70-min PNE session with physician to deliver preoperative PNE session. The patients in the intervention group were told that this was the usual practice of surgeons. The surgeons and their assistants were blinded to the group allocation.

Interventions

The patients in the control group (n=20) received standard preoperative education from their surgeons. This standard education covers information about lumbar anatomy, surgical procedure, risks associated with surgery, general hospital procedures, and length of hospital stay, daily life activities, and physical activity after surgery.

The patients in the intervention group (n=21) received a 70-min PNE session in addition to standard preoperative education. The development and content of PNE has been published elsewhere.[18,19] In PNE, the patient is educated about the neurophysiology

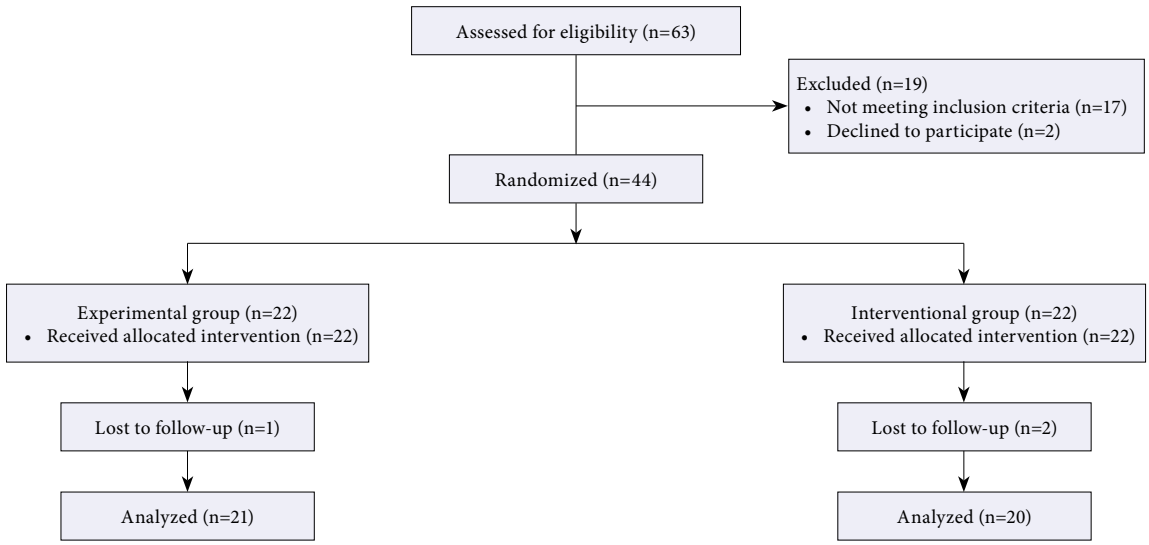

Figure 1. CONSORT flow diagram.

of pain, central sensitization, surgical experiences and environmental issues effects on nerve sensitivity, calming the nervous system, recover after surgery and the role of aerobic exercise to improve disability and pain.[15,18,19] The PNE sessions were conducted by an experienced physician certified in PNE in face-to-face, one-on-one sessions lasting 70 min. Metaphors, anecdotes, and pictures were used in PNE sessions.

Outcomes

Pain severity

Numeric Pain Rating Scale (NPRS) was used to assess the participants' pain levels. Clinimetric characteristics of the NPRS are adequately established[20] and the test–retest reliability of the scale was found to be high (r=0.82) in patients with chronic pain.[21] In the NPRS, patients are asked to verbally rate the severity of their pain on a scale from 0 to 10.

Disability

The participants' level of disability was evaluated using the Turkish adaptation of the Oswestry Disability Index (ODI), which was developed by Fairbank et al.[22] The scale comprises 10 items, each with six options worth 0 to 5 points. For each item, participants are asked to mark the option that best describes their current condition. A high total score indicates severe disability.[23] Intertester reliability of the ODI was very high (intraclass correlation coefficient = 0.938) and test-retest reliability was also high (intraclass correlation coefficient = 0.918).[23]

Kinesiophobia

The Tampa Scale for Kinesiophobia (TSK) was used for the assessment of kinesiophobia. The TSK is a 17-item questionnaire developed to measure the fear of movement/re-injury. The scale includes injury/re-injury and fear-avoidance parameters in work-related activities. The items are rated on a 4-point Likert-type scale (1=definitely disagree, 4=completely agree) and the total score is between 17 and 68 points. Higher total score indicates higher level of kinesiophobia.[24] Test-retest reliability of the Turkish version of the TSK was found to be excellent (intraclass correlation coefficient = 0.867).[24]

Statistical analysis

The sample size calculation was performed using the G*Power version 3.1.9.2 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany), based on a moderate effect size (0.25) for low back pain intensity values in the study of Louw et al.[19] Given the three measurements in the two groups, correction of sphericity was determined as 0.5. For statistical power of 0.80 and an alpha (α) level of 0.05, a sample size of 38 patients (19 participants in each group) was required. The enrolment goal was set at 44 participants to account for possible dropout (15%).

Statistical analysis was performed using the IBM SPSS version 20.0 software (IBM Corp., Armonk, NY, USA). Continuous variables were expressed in mean ± standard deviation (SD) or median (min-max), while categorical variables were expressed in number

and frequency. All variables were assessed for normal distribution using the Kolmogorov–Smirnov or Shapiro-Wilk test. The continuous data of the intervention and control groups were compared using independent samples t-test. The chi-square test was used to compare the categorical data of two groups. Internal consistency of the ODI and TSK for the first assessment was evaluated using the Cronbach's α. The Cronbach's α values of more than 0.75 indicate good reliability, while those less than 0.75 indicate poor-to-moderate reliability.[25]

The length of stay in hospital was compared between the groups by using the t-test. To detect differences between the groups, 2 (group: intervention and control) ×2 (time: baseline and 12th week) analysis of variances on different outcome measures (leg pain, back pain, ODI and TKS) was conducted. If interactions between the group and time were observed, the main effects using a Bonferroni correction were used. A *p* value of <0.05 was considered statistically significant. If no interaction was observed, then the main effects were analyzed. Partial eta-squared (η2) calculated by the SPSS was used to gauge the effect size. The η2 values less than 0.01 indicate a small effect size, 0.06 indicates a medium effect size, and values over 0.14 indicate a large effect size.[26]

RESULTS

A total of 41 patients underwent lumbar surgery. The mean age was 52.7±9.6 years in the intervention group and 51.4±9.2 years in the control group. No significant differences were observed between the groups in terms of age (p=0.661), height (p=0.802), body weight (p=0.428), body mass index (p=0.522), duration of pain (p=0.571), sex (p=0.867), and education status (p=0.992). Demographic characteristics of the patients are shown in Table 1. In addition, both groups had similar baseline scores for pain intensity, disability, and kinesiophobia (Table 2).

Although the main effects for time were statistically significant for NPRS leg pain (p<0.001) and low back pain (p<0.001), there were no significant interactions for NPRS leg pain (p=0.142) and low back pain (p=0.121). The ODI for both groups showed good internal consistency with a Cronbach's α value of 0.802. Examination of differences in the mean ODI scores between the treatment and control groups showed that group (p=0.001), time (p<0.001), and interaction effects (p=0.042) were statistically significant. The intervention group showed statistically higher improvements than the control group for disability (inter-group difference=3.75±1.78; 95% CI: 0.10 to 7.36; p=0.042). A large effect size was found (η2=0.407). Similarly, The TSK for both groups showed good internal consistency with Cronbach's α value of 0.768. Besides, the analysis of differences in the mean TSK scores revealed statistically significant group (p<0.001), time (p<0.001), and interaction effects (p<0.001). The intervention group showed statistically higher improvements than the control group in terms of kinesiophobia (inter-group difference=5.6±1.1; 95% CI: 3.37 to 7.89; p<0.001) (Table 3). A large effect size was detected (η2=0.376). Additionally, there

TABLE 1
Demographic characteristics of patients

	Experimental group (n=21)			Interventional group (n=20)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			52.7±9.6			51.4±9.2	0.661*
Height (cm)			169.2±11.4			168.4±8.6	0.802*
Weight (kg)			78.6±11.2			75.8±11.6	0.428*
BMI (kg/m^2)			27.5±5.3			26.6±2.6	0.522*
Duration of pain (month)			37.5±16.6			34.6±15.4	0.571*
Sex							0.867†
Female	10	47.6		9	45.0		
Male	11	52.4		11	55.0		
Education							0.992†
Primary school	13	61.9		12	60		
High school	6	28.6		6	30		
University	2	9.5		2	10		

SD: Standard deviation; n: Numbers of participants; * Significance level for t-test, † Significance level for chi-square test.

TABLE 2
Outcome measures at baseline

	Experimental group (n=21)	Interventional group (n=20)	
	Mean±SD	Mean±SD	*p*
Leg pain (NPRS 0-10)	7.2±1.4	7.4±1.5	0.605
Back pain (NPRS 0-10)	7.9±1.8	8.2±1.3	0.471
ODI (0-100)	43.5±8.2	43.0±4.0	0.806
TKS (17-68)	41.5±3.9	42.8±3.0	0.238

SD: Standard deviation; n: Numbers of participants; NPRS: Numeric pain rating scale; BPS: Back performance scale; ODI: Oswestry disabiliy index; TKS: Tampa kinesiophobia scale; p: Significance level for t-test.

TABLE 3
Changes over time within and between groups

	Baseline	At 12th weeks	Group effect		Time effect		Interaction effect	
	Mean±SD	Mean±SD	F	*p*	F	*p*	F	*p*
Leg pain (NPRS 0-10)			1.37	0.216	145.93	0.001*	2.15	0.142
Experimental group	5.2±1.4	2.1±1.6						
Interventional group	5.4±1.5	2.3±1.8						
Back pain (NPRS 0-10)			0.97	0.376	276.87	0.001*	2.44	0.121
Experimental group	7.9±1.8	1.6±1.7						
Interventional group	8.2±1.3	2.6±2.1						
ODI (0-100)			26.11	0.001*	234.84	0.001*	4.42	0.042*
Experimental group	43.5±8.2	21.3±6.6						
Interventional group	43.0±4.0	31.5±5.8						
TKS (17-68)			22.88	0.001*	90.30	0.001*	25.43	0.001*
Experimental group	41.5±3.4	31.2±5.1						
Interventional group	42.8±3.0	37.5±3.9						

SD: Standard deviation; n: Numbers of participants; NPRS: Numeric pain rating scale; ODI: Oswestry disabiliy index; TKS: Tampa kinesiophobia scale; F: ANOVA statistics; p: Significance level for ANOVA; * p<0.05.

were no significant differences between two groups according to the length of stay in hospital (inter-group difference=0.25; 95% CI: 0.05 to 0.55; p=0.110).

DISCUSSION

The present study showed that the addition of a 70-min preoperative pain-specific neuroscience education program to routine education had statistically and clinically superior outcomes for disability and kinesiophobia for patients undergoing LR surgery at 12 weeks of follow-up. Although leg and back pain improved at any time point, there was no statistically significant difference between the intervention and control groups. Besides, there was no significant difference in the length of stay in hospital between the groups.

In our study, we found that majority of patients were at the middle-age with low education status. We also determined limited lumbar mobility in the majority of patients. We found that severity of low back pain was high and functional status severely limited their daily lives. There was no significant difference in terms of sex in our study, although Skaf et al.[27] reported that postoperative pain was more common in women. Similar to previous studies,[7,28,29] we found a notable postoperative pain ratings following lumbar surgery.

In addition to non-steroidal anti-inflammatory drugs, muscle relaxants, antidepressants, and antiepileptics, perioperative rehabilitation programs are also frequently used for the prevention of postoperative pain.[30,31] Perioperative rehabilitation is usually enhanced with some type of education as a conceivable strategy to improve surgical success[13] and a survey study reported that many surgeons provided some of education form of education to their patients before they underwent surgery for LR.[32] The education mainly covers anatomical and biomedical

topics in the previous preoperative education studies and such educational form seems to be ineffective, when patients are still experiencing pain and disability.[14,33] Besides, Louw et al.[34] reported that patients undergoing surgery desired to improve knowledge about their pain and the impact of surgery in addition to information about the pathology, surgical procedure, and associated risks. Therefore, the education form in the current study, namely PNE, mainly focused on the pain neurophysiology and influence of cognitive-behavioral factors on their recovery following LR surgery.

Several studies have demonstrated that PNE is effective method for pain relief, improving functions, changing pain beliefs and attitudes, decreasing kinesiophobia, and reducing healthcare expenditure in patients with several chronic pain disorders.[35-37] It has been advocated that the action mechanism for PNE is related to function of brain-orchestrated nociceptive inhibition.[38] By understanding of pain well, the threat of pain would decrease, leading to more effective pain coping strategies.[39] The dysfunction of nociceptive inhibition is also one of the cardinal features of postoperative consistent pain.[40] It also explains why patients are still in pain after tissue healing process following surgery. At this stage, PNE can help to restore brain-orchestrated nociceptive inhibition and reduce postoperative pain and dysfunction.[15]

Our results demonstrated that the addition of a 70-min PNE session to routine education resulted in superior outcomes in postoperative disability and kinesiophobia for patients undergoing LR, although there was no significant result regarding the length of stay in hospital and pain severity. In the literature, there are insufficient robust studies to explore the effectiveness preoperative PNE following lumbar surgery. Similar to our results, a case series study showed that the short-term effects of preoperative PNE were promising regarding back performance, pain catastrophizing, and beliefs about pain following lumbar surgery.[15] However, a recent multi-center, randomized-controlled study demonstrated that the addition of a 30-min PNE session to routine education was not superior to routine education alone regarding pain severity and disability for patients undergoing LR surgery.[19] Although they found that PNE group was superior to routine education group at one-month follow-up, the difference was not significant at any time point. The differences in findings can be explained by timing of education. Louw et al.[19] provided a 30-min verbal education form prior to surgery, whereas our study provided the education in a 70-min verbal form. We believe that 30-min session is not enough to re-conceptualize of pain. Moreover, Louw et al.[19] conducted a multi-center study and the differences between the practitioners and methods they used may have influenced the outcomes.

The present study has certain limitations. First, the results cover only 12-week follow-up. Future studies should examine the long-term effectiveness such as one-year or two-year follow up periods. Second, we were unable to examine the difference between two groups regarding healthcare expenditure, as we did not follow patients in the long-term. Future studies should investigate the long-term effectiveness and clarify any potential economic advantage of the addition of PNE to routine education for patients undergoing lumbar surgery in Turkey. Third, we were unable to evaluate whether the participants understood well the information about pain. It would have been reasonable to assess whether PNE increased pain knowledge using a questionnaire such as Neurophysiology of Pain Questionnaire.

In conclusion, the addition of PNE to routine education following LR surgery improved disability and kinesiophobia, although there were no additional benefits regarding pain severity and length of stay in hospital in the short-term. Future studies should investigate the long-term effects and cost-efficacy of this educational method following LR surgery.

Declaration of conflicting interests

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