The short term effects of preoperative neuroscience education for lumbar radiculopathy: A case series

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Abstract

Background

Recently a preoperative pain neuroscience education (NE) program was developed for lumbar surgery (LS) for radiculopathy as a means to decrease postoperative pain and disability. This study attempts to determine the short term effects, if any, of providing NE before surgery on patient outcomes.

Methods

A case series of 10 patients (female = 7) received preoperative one-on-one educational session by a physical therapist on the neuroscience of pain, accompanied by an evidence-based booklet, prior to LS for radiculopathy. Post-intervention data was gathered immediately after NE, as well as 1, 3 and 6 months following LS. Primary outcome measures were Pain Catastrophization Scale (PCS), forward flexion, straight leg raise (SLR) and beliefs regarding LS.

Results

Immediately following NE for LS for radiculopathy, all patients had lower PCS scores, with 5 patients exceeding the MDC score of 9.1 and 8 of the patients had PCS change scores exceeding the MDC by the 1, 3 and 6 month follow ups. Physical changes showed that fingertip-to-floor test in 6 patients had changes in beyond the MDC of 4.5 cm and 6 patients had changes in SLR beyond the MDC of 5.7°. The main finding, however, indicated a positive and more realistic shift in expectations regarding pain after the impending LS by all patients.

Conclusions

The results of the case series suggest that immediately after NE, patients scheduled for LS for radiculopathy had meaningful detectable changes in pain catastrophizing, fingertip-to-floor test, passive SLR and positive shifts in their beliefs about LS.

KEYWORDS: PAIN, NEUROSCIENCE, EDUCATION, PREOPERATIVE, SURGERY

VOLUME 9 ARTICLE 11 DOI: 10.14444/2011

Introduction

It is estimated that between 10 – 40% of patients experience persistent pain and disability after lumbar discectomy for radiculopathy[1-3] and postoperative rehabilitation has shown little effect on reducing the postoperative pain and disability. It has been proposed that preoperative education may decrease postoperative pain. The current preoperative counselling by orthopedic surgeons, including lumbar surgery (LS), utilize anatomical and biomechanical models for addressing pain and disability,[7-11] which not only has shown limited efficacy, but may even increase patient fears, anxiety and stress, thus negatively impact their outcomes. Despite this, patients, including those with LS, are interested in knowing more about pain, and education strategies teaching patients about their pain have shown efficacy in easing pain and disability.

Recent research into educational strategies for patients with low back pain (LBP) shows an increased use of therapeutic neuroscience education (TNE). TNE aims to reduce pain and disability by helping patients gain an increased understanding of the biological and physiological processes involved in their pain experience. TNE differs from traditional education strategies by not focusing on anatomical or biomechanical explanations for pain, but rather on neurophysiology, neurobiology, processing and represen-

tation, and meaning of pain. It has been demonstrated that patients are capable of understanding the neurophysiology of pain, while professionals tend to underestimate their patient's ability to understand the "complex" issues related to pain.[28] A recent systematic review suggests strong evidence for TNE addressing pain, disability and physical performance in musculoskeletal pain, particularly spinal disorders.[20] Studies which utilized TNE have reported decreased fear and changes in patients' perception of their pain;[22] an immediate effect on improvements in patients' attitudes about pain;[29] improvements in pain, cognition and physical performance;[9] increased pain thresholds during physical tasks;[24] improved outcomes of therapeutic exercises;[19] and significantly reduced widespread brain activity characteristic of a pain experience.[23]

Recently a preoperative neuroscience educational tool (PNET) was developed to explain LBP and lumbar radiculopathy to patients facing LS from a neurophysiological perspective.[30] The PNET was based on previous TNE studies which have shown immediate post-education changes in cognitions regarding pain and threat, as well as physical performance in patients with chronic LBP. To date, no studies have assessed the ability of TNE to provide similar positive changes in patients following surgical management of their LBP. This case series sought to examine whether the PNET would result in immediate post-education changes in pain catastrophization, physical movements and expectations regarding the impending LS.

Materials and Methods

Subject Descriptions and Examinations

All patients provided written informed consent to participate in the study. This case series comprises data from 10 patients (7 female; average age 47.4 years) scheduled for non-instrumented lumbar decompressive surgery for lumbar radiculopathy with an average duration of leg pain of 7.3 months (range 2-23), average leg pain of 4.1 out of 10 on a numeric pain rating scale (NPRS) and average time to surgery of 9.5 days (range 2 – 28). Patient demographics can be found in Table 1.

All patients presented with pain in the lower extremity (with radicular pain) with or without neurological symptoms such as numbness, pins and needles and weakness (Figure 1). Two patients (P1 and P10) had prior LS for radiculopathy (single-level discectomy).

Table 1. Patient demographics prior to lumbar surgery for radiculopathy

Patient	Age (years)	Gender	Duration of leg symptoms (months)	Leg pain rating (0-10 NPRS)	Wait time till surgery (days)
1*	50	F	4	6	6
2	70	M	2	8	7
3	51	F	8	9	2
4	24	F	12	3	9
5	47	F	23	4	2
6	70	F	8	6	28
7	27	M	3.5	2	8
8	55	F	3	2	8
9	30	F	3	0	15
10*	50	M	6	1	10
Average	47.4		7.3	4.1	9.5

* Indicates patient had previous lumbar surgery for radiculopathy

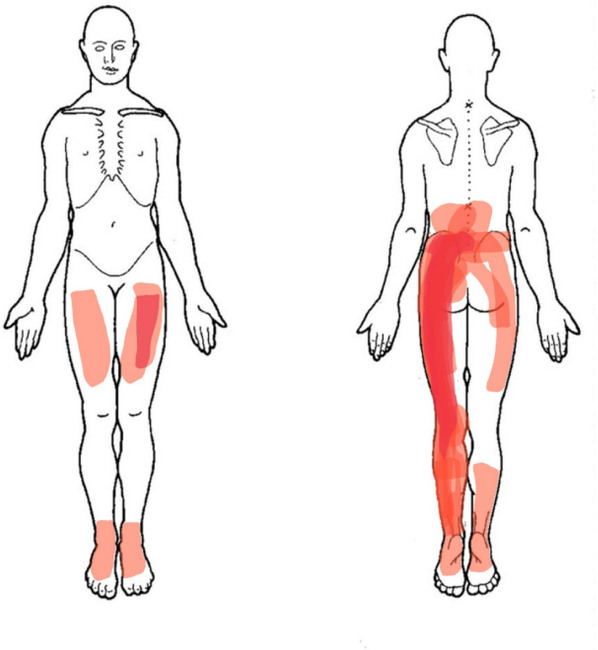

Fig. 1. Cumulative presentation of leg pain in the case series patient population.

Pre-education self-report measures

Prior to TNE and after completion of the consent and demographic intake forms, patients were asked to complete self-report surveys related to pain, function, fear avoidance, pain catastrophization, knowledge of pain and beliefs regarding surgical outcome.

- *Pain (Low Back and Leg) (Numeric Pain Rating Scale – NPRS)*: LBP and leg pain were measured with the use of a NPRS, as has been used in various RCTs for TNE and spinal pain. A change of 2.1 has been proposed as the minimal detectable change (MDC).[33]

- *Oswestry Disability Index (ODI):* The ODI is a 10-item questionnaire that assesses different aspects of physical function. Each item is scored from 0 to 5, with higher values representing greater disability. The total score is multiplied by 2 and expressed as a percentage. The ODI has been shown to be a valid and reliable measure of disability related to LBP.[34-36] A change of 5 points (10%) has been proposed as the minimal clinically important difference.[37]

- *Fear Avoidance Beliefs Questionnaire (FABQ):* The FABQ is a 16-item questionnaire that was designed to quantify fear and avoidance beliefs in individuals with LBP. The FABQ has two subscales: 1) a 7-item scale to measure fear-avoidance beliefs about work and 2) a 4-item scale to measure fear avoidance beliefs about physical activity. Each item is scored from 0 to 6 with possible scores ranging between 0 and 24 and 0 and 42 for the physical activity and work subscales, respectively, with higher scores representing an increase in fear-avoidance beliefs. The FABQ has demonstrated acceptable levels of reliability and validity in previous LBP studies. Presence of avoidance behavior is associated with increased risk of prolonged disability and work loss. It is proposed that FABQ-W scores >34 and FABQ-PA >14 are associated with a higher likelihood of not returning to work.

- *Pain Catastrophization Scale (PCS):* The PCS is a self-report questionnaire that assesses inappropriate coping strategies and catastrophic thinking about pain and injury. The PCS has been used in previous TNE studies for chronic LBP and demonstrated strong construct validity, reliability and stability.[42] The PCS utilizes a 13-item, 5-point Likert scale with higher scores indicating elevated levels of catastrophizing. Previous studies utilizing the PCS have shown a median score of 18 that of healthy individuals and in patients with pain the PCS is generally higher.[42] The minimal detectable change for the PCS is reported to be 9.1.[43]

- *Neurophysiology of Pain Questionnaire:* Pain knowledge was measured by using a neurophysiology of pain questionnaire (NPQ), since it deals with the content of the TNE for this case series. The NPQ is based on a current pain science text [44] and was used in a previous study measuring the neurophysiology knowledge of patients and healthcare personnel.[28] The NPQ is a 19-point questionnaire requesting 'true' or 'false' answers to statements, with the higher scores indicating more correct answers. The questionnaire used in this study is similar to the one used by Moseley[28] and adapted slightly to make it easier for patients to understand, e.g., "nociception" was replaced with "danger messages."

The results of the pre-education self-report measures are found in Table 2.

Table 2.Table 2: Patient self-report psychometric measures prior to therapeutic neuroscience education (TNE) and prior to lumbar surgery for radiculopathy

Patient	ODI %	FABQ – W	FABQ – PA	PCS	NPQ
1	44	0	23	27	13
2	44	10	10	21	15
3	48	31	17	47	12
4	48	23	22	22	13
5	18	12	18	11	12
6	48	10	15	24	12
7	36	38	23	28	12
8	74	0	24	47	15
9	26	19	22	23	10
10	22	15	13	4	15
Average	40.8	15.8	18.7	25.4	12.9

ODI: Oswestry Disability Index; FABQ-W: Fear Avoidance Beliefs Questionnaire – Work Subscale; FABQ-PA: Fear Avoidance Beliefs Questionnaire – Physical Activity Subscale; PCS: Pain Catastrophization Scale; NPQ: Neurophysiology of Pain Questionnaire.

The pre-education measures revealed the patients in this series to have moderate LBP and leg pain; moderate disability (ODI > 40%);[34-36] potential risk for not returning to work (FABQ-PA > 14); high levels of pain catastrophization (average PCS was 25.4); and limited knowledge of pain (NPQ).[28]

The 10 patients scheduled for LS for radiculopathy were also asked to rate their level of agreement on a 10-point scale (strongly disagree [0] – strongly agree [10]) with 7 statements regarding LS (Table 3). In response to the beliefs regarding LS, patients were ambivalent on 4 of the 7 questions (*I am afraid of the upcoming surgery; I know what to expect after back surgery; back pain after surgery is expected;* and *I can control the amount of postoperative pain*). Patients tended to agree that "*back surgery will 'fix my pain';* and *"I feel prepared and ready for surgery*." They tended to disagree that "*leg pain after surgery is to be expected."*

Pre-education physical performance

Prior to the preoperative TNE, 2 physical tests were performed: fingertip-to-floor test, measured from the longest finger on the dominant hand to the floor and passive straight leg raise (SLR), measured with an inclinometer placed on the tibial plateau 5cm distal to the inferior border of the patella on the most affected leg. Given the high levels of fear and potential provocative nature of forward flexion with herniated discs, active forward flexion was only performed once. The SLR measurements followed a standard protocol described previously. Physical measurement outcomes are shown in Table 4.

Table 3. Patient self-report beliefs regarding lumbar surgery and their radiculopathy

Patient	1	2	3	4	5	6	7	8	9	10	Average Score
I feel prepared and ready for surgery	10	10	1	6	2	8	7	8	3	7	6.2
I am afraid of the upcoming surgery	2	6	4	9	10	1	3	8	5	5	5.3
I know what to expect after back surgery	4	6	0	3	6	9	2	6	9	7	5.2
Back pain after surgery is to be expected	5	2	0	8	8	8	8	6	2	7	5.4
Leg pain after surgery is to be expected	5	2	0	7	7	2	7	0	0	4	3.4
I can control the amount of post-operative pain	5	8	3	8	6	8	3	2	5	7	5.5
Back surgery will 'fix my pain'	10	9	10	9	5	9	7	9	10	7	8.5

Scores are on a 10-point scale (strongly disagree [0] – strongly agree [10]) with each statement.

Intervention: Preoperative Neuroscience Education

Details of the development of the PNET are described elsewhere;[30] however, a brief description and more specifically, the delivery and content is described for this case series. After an extensive systematic review of the literature for RCTs, non-randomized clinical trials or case series evaluating the effect of TNE on pain, disability, anxiety and stress for musculoskeletal conditions, the evidence for TNE was established, and content and delivery methods were explored.[20] The content of the TNE sessions, as found in the systematic review was used to develop appropriate messages for patients undergoing surgery for lumbar radiculopathy. The educational messages were designed to be delivered in one-on-one sessions to patients prior to LS for radiculopathy, along with the development of a patient booklet containing the same messages to provide patients with a written version of the content of the ed-

Table 4. Physical examination findings prior to preoperative education.

Patient	Fingertip-to-Floor (cm)	SLR (degrees)
1	36.5	43
2	31.5	48
3	53	18
4	30	43
5	2	70
6	10.5	38
7	19.5	33
8	47	31
9	-30*	148*
10	10	78
Average	21	55

* Patient was a high-level professional dancer who could easily put her palms flat on the floor. A step was gradually increased until the patient had her longest finger, dominant hand just touch the floor. Step height (30 cm) was thus subtracted from a zero score (touching the floor).

ucational session.[45] The primary focus of the preoperative TNE program was to help patients re-conceptualize their back, hip and leg pain as an increase in nerve sensitivity and up-regulation of the peripheral and central nervous system, at the same time defocusing attention from nociceptive input via the tissues from the affected areas. The TNE message thus aimed to reduce anxiety and uncertainty, and promote positive expectations and beliefs.

The structure of the developed TNE program consisted of six sections (Table 5). The PNET was designed to include prepared pictures, examples, and metaphors.[46] The sensitivity of the nervous system metaphorically described as an alarm system[46] accompanied with drawings of action potentials was used to describe peripheral sensitization, central sensitization, and plasticity of the nervous system. Face and content validity was established with an expert panel (spine surgeons, experts in TNE, pain management physicians, orthopedic nurses, physical therapists, psychologists and specialists in patient education), a convenience sample of patients who had recently undergone lumbar surgery for radiculopathy, as well as a convenience sample from the general population.[47]

Table 5: Content of the Preoperative Neuroscience Educational Tool (PNET) program and booklet

Statistical Analysis

This was to a large degree a descriptive study. Descriptive statistics such as counts and percentages, frequency distributions, means, standard deviations and confidence intervals were used to describe variables. Some pre-specified comparisons were made between certain variables.

Results

Post-intervention data was gathered immediately after TNE (which lasted 30 minutes), as well as 1, 3 and 6 months following surgery. Two patients (patients P5 and P7) did not undergo surgery following the TNE session (P5 - medical complications; P7 - decided to opt out of surgery) but they were followed along with the other cases out to 6 months. One, 3 and 6 month data was collected via mailed, pre-paid postage envelopes containing surveys.

Low Back Pain

Six out of 10 patients reported higher pain scores for their low back immediately after the TNE; however, only one (patient P6) exceeded the minimally detectable change (MDC) of 2.1.[33] (Figure 2) At the 1-month follow up, 8 patients reported less pain than at baseline and immediately following TNE, with 6

Table 5. Content of the Preoperative Neuroscience Educational Tool (PNET) program and booklet.

Section	Topic	Main Theme
1	The decision to have back surgery	Several studies have shown that uncertainty prior to surgery is associated with poor outcomes. The purpose of the PNET is not to discourage surgery, but rather embrace the surgical decision and make positive choices associated with favorable recovery.
2	The nervous system's anatomy, physiology and pathways	The essence of TNE is explaining the biology and physiology of nerves to patients. The session aimed to make patients understand how nerves can be viewed as an alarm system aimed at providing information to the brain from the tissues.
3	Peripheral nerve sensitization	A key element of the preoperative neuroscience educational tool is for patients to understand that pain may be from faulty tissue but also (likely more so) from increased nerve sensitivity. The section aimed to have patients understand how the nervous system modulates sensitivity to protect when facing LBP, surgery, failed treatments, fear and anxiety.
4	Surgical experiences and environmental issues on nerve sensitivity	Several studies have indicated that the surgical experience is stressful, and this section aimed to make patients aware how surgery, hospital experiences, anxiety and interaction with medical personnel may increase sensitivity around the time of the surgery.
5	Calming the nervous system down	The patient is provided information on how the heightened nerve sensitivity can be decreased with the surgery, knowledge, movement and medication. Emphasis is placed on a knowledgeable brain down-regulating nociception and thus modulating the pain experience.
6	Recovery after back surgery	The last section summarized sections 1-5 with various explanations of what to expect during the recovery phase.
References	Scientific evidence for the booklet content	Patients were provided with a list of references titled as scientific evidence for the material in the preoperative neuroscience educational tool as a means to underscore the fact that the program is based on evidence and research.
Q & A Page	Questions to ask the surgeon prior to surgery	A Q & A page was provided at the end as a means to write down remaining questions to ask the surgeon prior to surgery. The fact that knowledge would help ease pain and uncertainty would likely increase pain was once again emphasized as a means to encourage patients to develop a greater understanding of what to expect before, during and after the surgical experience.

of them exceeding the MDC. At the 3 and 6 month follow ups, most patients (9 out of 10) had minimal to no back pain (≤ 2/10).

Leg Pain

Seven out of 10 patients reported higher pain scores for their leg (radiculopathy) immediately after the TNE; however, none exceeded the MDC (Figure 3). Most of the patients had no leg pain at the 1, 3 and 6 month follow ups.

Fear Avoidance

For fear avoidance of physical activity (FABQ-PA), 7 patients reported an immediate decrease following TNE. Prior to TNE, 8 patients scored > 14 points associated with high likelihood not to return to work. Immediately after TNE 7 patients scored less than 14 points, while at 1, 3 and 6 months post-LS a 50% reduction on the high likelihood to not return to work due to FABQ-PA was reversed. For FABQ Work Subscale, pre-TNE scores were decreased by 25% immediately following TNE.

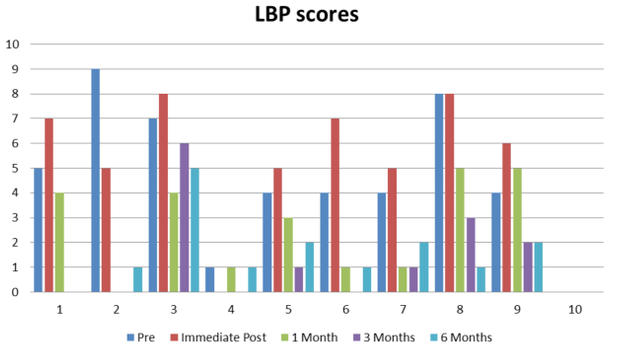

Fig. 2. Low back pain (LBP) scores for all patients prior to therapeutic neuroscience education (TNE), immediately after and the 1, 3 and 6 month follow ups.

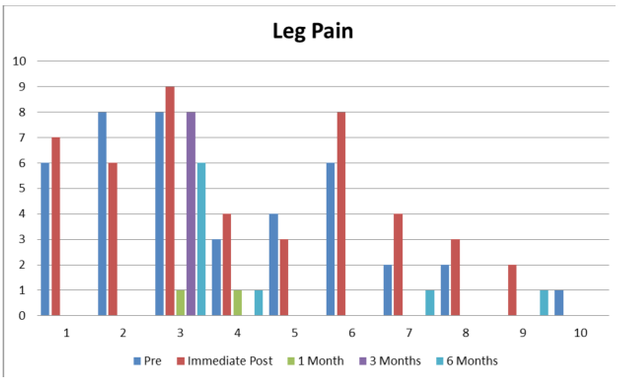

Fig. 3. Leg pain scores for all patients prior to therapeutic neuroscience education (TNE), immediately after and the 1, 3 and 6 month follow ups.

PCS

All patients had lower PCS scores immediately following the TNE, with 5 exceeding the MDC score of 9.1.[43] (Figure 4) Eight of the 10 patients had PCS change scores exceeding the MDC by the 1, 3 and 6 month follow ups. Only patients 5 and 10, who started with low PCS scores (11 and 4 respectively) failed to show decreases in their scores beyond the MDC.

NPQ

Immediately following TNE, patients improved their knowledge of the neurophysiology of pain from 12.9 out of 19 to 14.2, or an increase of 10%. This increase was maintained at 1, 3 and 6 months following LS.

ODI

One month after surgery, 7 out of 8 patients had decreased ODI scores that exceeded the minimal detectable change of 10%. (Figure 5) Six of the patients continued improvement and reported ODI scores lower than 20% at 6 months post-surgery.

Physical Measurements

Physical changes were only measured before and immediately after TNE (30 minutes later). Six of the patients demonstrated changes in fingertip-to-floor test beyond the MDC of 4.5 cm.[48] (Figure 6) Six of the patients demonstrated changes in SLR beyond the MDC of 5.7°(Figure 7).[48]

Beliefs and cognitions about surgery

The immediate changes in beliefs about lumbar

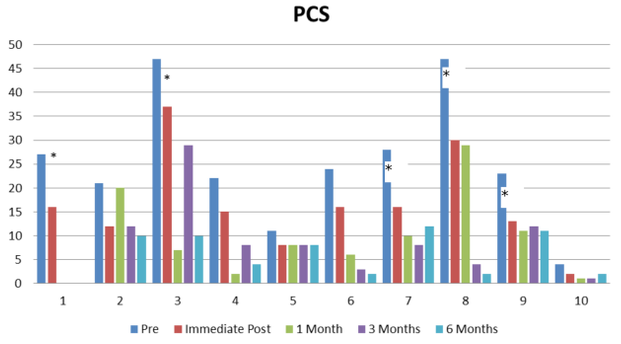

Fig. 4. Pain Catastrophizing Scale (PCS) scores for all patients prior to therapeutic neuroscience education (TNE), immediately after and the 1, 3 and 6 month follow ups. * denotes change exceeded minimal detectable change (MDC) of 9.1 points.

surgery following TNE are presented in Figure 8. The results suggest positive shifts in patient beliefs about LS, and the impact of the surgery on their expected symptoms and recovery.

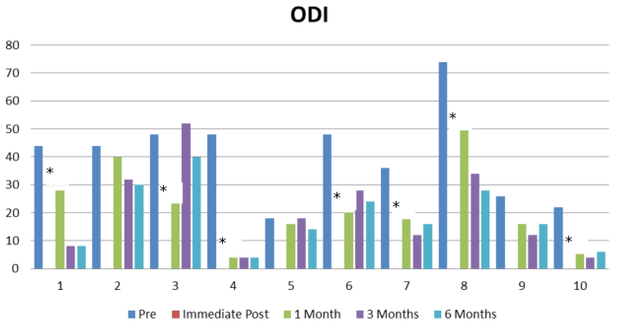

Fig. 5. Oswestry Disability Index (ODI) scores for all patients prior to therapeutic neuroscience education (TNE), and at 1, 3 and 6 month follow ups. * denotes change exceeded minimal detectable change (MDC) of 10%.

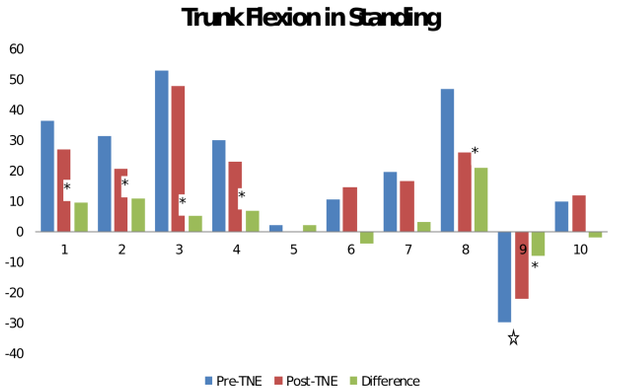

Fig. 6. Fingertip-to-Floor Test measures for all patients prior to therapeutic neuroscience education (TNE), and immediately afterwards. * denotes change exceeded minimal detectable change (MDC) of 4.5 cm. Patient was a high-level professional dancer who could easily put her palms flat on the floor. A step was gradually increased until the patient had her longest finger, dominant hand just touch the floor. Step height (30 cm) was thus subtracted from a zero score (touching the floor).

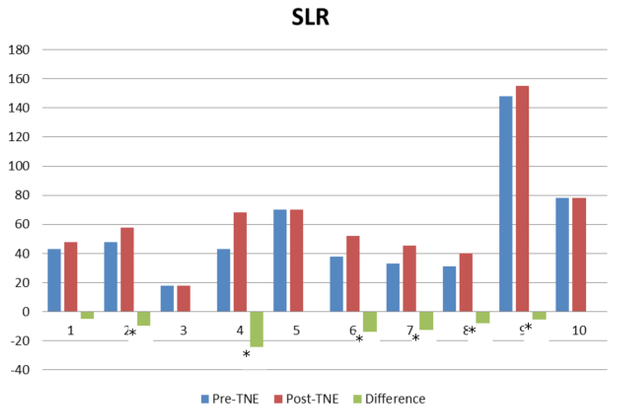

Fig. 7. Straight leg raise (SLR) for all patients prior to therapeutic neuroscience education (TNE), and immediately afterwards. * denotes change exceeded minimal detectable change (MDC) of 5.7 degrees.

Discussion

The aim of this study was to measure the effects of preoperative TNE on symptoms, emotions and cognitions associated with lumbar radiculopathy. The results of this case series suggest that immediately after TNE, patients scheduled for LS for radiculopathy had detectable changes in pain catastrophizing, fingertip-to-floor test, passive SLR and positive shifts in their beliefs about LS. Although the majority of patients reported higher back and leg pain scores immediately after the TNE, most of the changes did not exceed the MDC and may not have represented true change. Previous studies have reported that TNE often produces no significant immediate changes in pain perception, although clinically, others have reported a slight increase in pain after TNE and attributed it to an increased awareness and discussion of pain, pain issues, and the word 'pain', which together may increase pain ratings.[49]

Although care should be taken in the analysis of a case series of patients with no control subjects, results demonstrated immediate positive changes following the application of TNE. The immediate changes in PCS and physical tests concur with previous studies using TNE for CLBP. At the core of TNE for patients with lumbar radiculopathy is a message to help patients realize the pain they experience is more likely due to nerve sensitization and the effect of various perioperative influences rather than

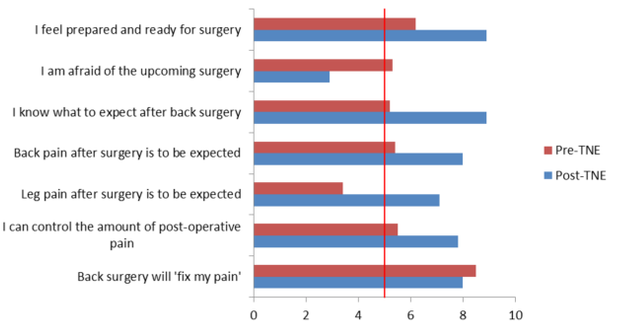

Fig. 8. Patient self-report beliefs about lumbar surgery and their radiculopathy before and immediately after therapeutic neuroscience education (TNE). Scores below 5 indicate disagreement with the statements, whereas scores above 5 indicate agreement with the statements.

a more mechanistic disc injury with resulting nerve irritation.

Disc herniation model descriptions have been associated with increased fear and anxiety,[50-52] which has in turn been linked to limited movement and heightened increased irrational thoughts and coping strategies. Our results show that immediately after the TNE, all patients had lower scores for PCS which might be interpreted as them changing their catastrophic thinking about their pain and injury. This reconceptualization is further demonstrated by the ability of the patients to willfully engage in pushing further the fingertip-to-floor test, which has been shown to be very provocative in discogenic disorders and lumbar radiculopathy and also allow a clinician to move the involved lower extremity further (SLR). Both FABQ-W and FABQ-PA changed for the positive, while the PCS resulted in an immediate lowering of 6.5 points, which is similar to the statistically significant changes produced by Moseley et al. performing TNE in CLBP and measuring immediate post-education findings.[24] Considering the PCS assesses inappropriate coping strategies and catastrophic thinking about pain and injury it could be argued that TNE aiming at re-conceptualizing pain cognitions are likely to have more of an immediate effect, whereas FABQ relates to physical tasks and work, which the newly acquired cognitions have not been able to be applied to. The one and three month data does show significant FABQ changes one and three months after surgery, which concurs with this possible explanation of the FABQ and PCS changes.

The largest effect however, occurred in patient beliefs regarding LS. Several studies have shown that beliefs and expected outcomes for surgery are highly correlated with predicting outcome following LS.[55-58] The sample of patients in this case series displayed numerous poor beliefs regarding LS prior to TNE, associated with possible poor outcomes including beliefs of surgery "fixing" pain, expecting little to no pain after surgery, uncertainty about the surgery as well as unknown outcomes. Pain after surgery is to be expected and expectations of no pain after surgery are unrealistic.[58] In a study interviewing patients one month after LS for radiculopathy, Louw et al. showed that patients who experienced pain after surgery expected to have some residual pain, and more than 50% indicated a true concern the pain would not go away, but rather increase.[17] Immediately following the TNE, patients shifted their realistic expectations of back pain (b*ack pain after surgery is to be expected*), leg pain (*leg pain after surgery is to be expected*) and ability to control their own pain (*I can control the amount of post-operative pain*) by > 50%, thus preparing them for potential pain after surgery, which is more realistic. One and three month postoperative data indicated some patients were still experiencing pain, which coincided with persistent decreased psychometric measures of fear avoidance and pain catastrophizing.

The reconceptualization of pain and the pain experience is a key point. To date there have been several preoperative education studies used in orthopedic extremity surgery [12-14,63] and spine surgery,[59-61] mainly preparing patients for their surgery by explaining procedural information. Several RCT's and systematic reviews, however, have shown little to no effect in postoperative outcomes. The studies did show patients felt more prepared for the impending surgery, which concurs with the findings of this case series where patients feel more prepared for surgery (*I feel prepared and ready for surgery; I know what to expect after surgery; and I am afraid of the upcoming surgery*), but no postoperative changes in range of motion, pain, length of hospital stay or function. The one and three month postoperative data from this case series show a dramatic decrease in pain ratings and function. This addition of pain education to preoperative education concurs with the study by McDonald, where total joint arthroplasty patients were provided with pain science education and showed immediate postoperative pain reduction effects.[21]

Another very important potential implication of this case series is the delivery of preemptive TNE. To date TNE has been applied to various orthopedic and musculoskeletal patients, mainly CLBP.[20] One weakness of a case series design is the lack of control patients. This case series, however, showed that patients who received TNE prior to LS had significant changes in LBP, leg pain, pain catastrophization, fear of work, fear of physical activity and function one month after surgery and these positive changes re-

main intact 2 months later (3 months after surgery). Given the fact that between 10 to 40% of patients following LS for radiculopathy experience persistent pain, loss of movement and disability,[64] and postoperative rehabilitation has shown little effect in changing postoperative disability and pain TNE may provide a unique role for physical therapy and spine surgery patients. Furthermore, TNE may provide an additional lessening of pain and disability following LS for radiculopathy, with benefits for all stakeholders in the patient's outcome.

Limitations

Several limitations exist for this case series. Case series by design do not utilize a comparison group and the true effect of TNE compared to other interventions, or no intervention, is not known. The case series was specific to adults undergoing a selective surgical procedure for a specific condition. The possible effect of TNE on other kinds of surgery (i.e., fusions); younger patients; patients with other symptoms and indications for surgery are unknown.

Conclusion

In this case series, 10 patients scheduled for LS for radiculopathy underwent a preoperative TNE program resulting in immediate, 1 and 3 months postoperative clinically meaningful changes in pain, psychometric measures of pain catastrophizing and fear avoidance, function, physical movement and beliefs regarding LS. Although this case series does not suggest superior results to usual or no care, the intervention may be clinically effective in leading to preoperative and possible postoperative changes in lumbar radiculopathy patients undergoing surgery.

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Disclosures

The authors report no financial disclosures.

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Published 29 April 2015.