Development of a Preoperative Neuroscience Educational Program for Patients with Lumbar Radiculopathy

ABSTRACT


Postoperative rehabilitation for lumbar radiculopathy has shown little effect on reducing pain and disability. Current preoperative education programs with a focus on a biomedical approach feature procedural and anatomical information, and these too have shown little effect on postoperative outcomes. This report describes the development of an evidence-based educational program and booklet for patients undergoing lumbar surgery for radiculopathy using a recently conducted systematic review of neuroscience education for musculoskeletal pain. The previous systematic review produced evidence for neuroscience education as well as best-evidence synthesis of the content and delivery methods for neuroscience education for musculoskeletal pain. These evidence statements were extracted and developed into patient-centered messages and a booklet, which was then evaluated by peer and patient review. The neuroscience educational booklet and preoperative program convey key messages from the previous systematic review aimed at reducing fear and anxiety before surgery and assist in developing realistic expectations regarding pain after surgery. Key topics include the decision to undergo surgery, pain processing, peripheral nerve sensitization, effect of anxiety and stress on pain, surgery and the nervous system, and decreasing nerve sensitization. Feedback from the evaluations of the booklet and preoperative program was favorable from all review groups, suggesting that this proposed evidence-based neuroscience educational program may be ready for clinical application.

Key Words: Preoperative, Neuroscience, Lumbar, Radiculopathy, Education
The primary surgical intervention for lumbar radiculopathy is lumbar laminectomy or lumbar laminotomy with or without discectomy. Studies on lumbar disc surgery for radiculopathy have shown that this surgical intervention has between 60% and 90% success rate, leaving 10%–40% of patients with residual pain, loss of movement, and disability. With persistent pain and disability after surgery, rehabilitation is often prescribed and is proposed to decrease disability, increase movement, and facilitate return to regular activities. However, postoperative rehabilitation has shown little effect on reducing postoperative disability and pain, and surgeons do not readily send patients to rehabilitation after spinal surgery. This may indicate that many patients experience long-term disability after lumbar disc surgery.

A strategy designed to decrease postoperative complications and disability is preoperative education. Preoperative education is commonly used in joint replacement surgery, cardiac surgery, and abdominal surgery. Preoperative education has been shown to help increase knowledge of the surgical procedure, reduce anxiety, reduce postoperative pain, decrease length of hospital stay, and facilitate faster return to preoperative functional levels. To date, only a handful of studies have been conducted on the outcome of preoperative education for lumbar surgery; however, they focused on procedural information and informed consent and showed little added benefit regarding postsurgical outcomes. Three studies surveyed patients who had undergone spinal surgery to determine their preferences regarding preoperative education for spinal surgery. A study by Louw et al. showed that patients wanted more preoperative information not only regarding the surgical procedure, the potential risks, and the limitations and benefits of surgery but also on their pain and how surgery would impact it. A study by McGregor et al. showed that patients wanted preoperative information but provided little information on the exact content of this information. A study by Ronnberg et al. showed that patients undergoing disc surgery were, in general, satisfied with the care given to them preoperatively, but not with the content of the information regarding their impending spinal surgery.

Most education programs used in orthopedic patient populations use anatomical and biomechanical models for addressing pain, which has not only been shown to have limited efficacy but may also lead to an increase in patients' fear, anxiety, and stress, thus negatively impacting their outcomes. Several educational strategies are advocated for patients with low-back pain (LBP), including biomechanical/back school type of education, evidence-based guideline education (i.e., the Back Book), cognitive behavioral therapy, and recently, neuroscience education.

Recent research into educational strategies for patients with chronic LBP finds an increased use of neuroscience education. Neuroscience education is a cognitive-based education intervention that aims to reduce pain and disability by helping patients gain an increased understanding of the biologic process underpinning their pain state. Neuroscience education differs from traditional education strategies such as back school and biomechanical models by not focusing on anatomical or biomechanical models, but rather on neurophysiology, neurobiology, and the processing and representation of pain. Patients have expressed interest in knowing more about how pain works, and it has been demonstrated that patients are quite capable of understanding the neurophysiology of their pain, while professionals will underestimate their ability to understand the "complex" issues related to pain.

Studies that used neuroscience education have shown that it decreases fear and changes a patient's perception of his/her pain and has an immediate effect on improvements in patients' attitudes about pain. This education intervention has also been shown to result in improvements in pain, cognition, and physical performance; increased pain thresholds during physical tasks; improved outcomes of therapeutic exercises; and significant reduction in widespread brain activity characteristic of a pain experience. The aim of this study was, therefore, to use the current best evidence for neuroscience education for musculoskeletal disorders to develop a preoperative neuroscience educational program for lumbar radiculopathy.

METHODS
Development of the Booklet

The content of the neuroscience education sessions as found in the systematic review on neuroscience education was used to develop appropriate messages for patients considering surgery for lumbar radiculopathy (Table 1). The educational messages were designed to be delivered as one-on-one educational sessions to patients before surgery along with the development of a patient booklet containing the same messages to provide patients with a written version of the content of

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TABLE 1 Content of neuroscience education used in the development of the preoperative neuroscience educational program

<table>
<thead>
<tr>
<th>Neurophysiology of pain&lt;sup&gt;33,38,40,43&lt;/sup&gt;</th>
<th>No reference to anatomical or patho-anatomical models&lt;sup&gt;34,40&lt;/sup&gt;</th>
</tr>
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<tr>
<td>No discussion of emotional or behavioral aspects to pain&lt;sup&gt;40&lt;/sup&gt;</td>
<td>Nociception and nociceptive pathways&lt;sup&gt;33,34,43&lt;/sup&gt;</td>
</tr>
<tr>
<td>Neurones&lt;sup&gt;33,34,43&lt;/sup&gt;</td>
<td>Synapses&lt;sup&gt;33,43&lt;/sup&gt;</td>
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<tr>
<td>Action potential&lt;sup&gt;33,43&lt;/sup&gt;</td>
<td>Spinal inhibition and facilitation&lt;sup&gt;33,34,43&lt;/sup&gt;</td>
</tr>
<tr>
<td>Peripheral sensitization&lt;sup&gt;33,43&lt;/sup&gt;</td>
<td>Central sensitization&lt;sup&gt;33,43&lt;/sup&gt;</td>
</tr>
<tr>
<td>Plasticity of the nervous system&lt;sup&gt;34,43&lt;/sup&gt;</td>
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the educational session. The booklet followed the general philosophy and style of the *Explain Pain* book,<sup>39</sup> which has been used in studies examining neuroscience education for pain and disability.<sup>33,35,36,43</sup> The main aim of the preoperative neuroscience educational program was to help patients reconceptualize their back, hip, and leg pain as an increase in nerve sensitivity and up-regulation of the peripheral and central nervous system and defocus attention from nociceptive input via the tissues from the affected areas. The neuroscience education message aims to reduce anxiety and uncertainty and thus promote positive expectations and beliefs. The structure of the developed neuroscience education program consisted of six sections: (1) the decision to have back surgery; (2) the nervous system anatomy, physiology, and pathways; (3) peripheral nerve sensitization; (4) environmental influences on nerve sensitivity; (5) down-regulation of the nervous system; and (6) recovery after back surgery. Several drafts of the text over a period of several months refined its content, clarity, and readability. The booklet was reviewed to be at sixth grade English, and the word count (4129) was comparable with the length of the *Your Back Operation* booklet used in the UK (4622 words).<sup>25</sup>

Professional evaluation of the booklet included an expert panel consisting of spine surgeons, experts in neuroscience education, pain management physicians, orthopedic nurses, physical therapists, psychologists, and specialists in patient education. The expert panel was given a copy of the booklet along with a questionnaire and were asked to send the completed questionnaire back to the researchers within 30 days. A reminder was sent to the expert panel 1 week before the deadline. The questionnaire had two parts: part 1 contained 11 forced-choice questions on readability, style, information level, believability, length, content, and helpfulness (e.g., “I learned some new, helpful things,” “I knew most of it anyway,” and “I didn’t really find it helpful”). Part 2 contained open-ended questions about the most important messages they took from the booklet, anything they did not like or understand, whether they had any concerns that were not covered, whether they thought the booklet would change what they did after surgery, and their overall rating of the booklet on a scale from 1 to 10. The questionnaire was designed for and borrowed from a previous study.<sup>25</sup>

A second evaluation consisted of a convenience sample of patients who had recently undergone lumbar surgery for radiculopathy. Patients at two orthopedic physical therapy groups (Ortho Spine and Pain clinic in Iowa and RehabAuthority in Idaho) working closely with spine surgeons were approached, and informed consent was obtained. Each patient was given a copy of the draft text to read at their leisure and were asked to complete and return an evaluative questionnaire similar to the one for the expert panel.

Third, a convenience sample from the general population was asked to evaluate the booklet and to complete the questionnaire described above. People who had undergone previous spinal surgery, who experienced low back pain at the time, or who were attending any treatment for low back pain were excluded.

RESULTS

Booklet Evaluations

The results from the expert panel and postoperative patient and the general population are found in Figure 1. All of the professional reviewers (n = 12) stated that they strongly supported the themes and messages of the booklet and recognized the need for such material. Although there were few and minor criticisms of the information provided, the overall comments were very positive. These comments and suggestions were discussed among the authors and changes were made to the text as appropriate. Importantly, all the spine surgeons welcomed the booklet and considered it would be useful in their practices. The overall rating of the booklet by the expert panel was 8.2 of 10.

Evaluation of the booklet was returned by five postoperative patients and five people from the general population. Of the responders, all five patients and five people from the general population reported that they found the booklet easy to read...
and interesting, learned new things, and thought the content was easy to follow. All stated that they felt the booklets were not too long, but just right, with an adequate number of images. They thought it would help patients and they would recommend it to a family member. Although all postoperative patients and people from the general population indicated a need for more information about the operation, the booklet was designed to be an adjunct to the usual preoperative education provided by surgeons, who generally discuss the operation at length. The narrative questions showed that postoperative patients and people from the general population understood the main aim of the booklet, that is, the increased sensitization of the nervous system in radiculopathy and how nerves increase and decrease sensitivity. Postoperative patients and people from the general population further explained the greater understanding of movement and an active approach in rehabilitation after lumbar surgery (Table 2). The postoperative patients’ average overall rating of the booklet was 9 of 10. The patients’ responses were again discussed by the authors, and appropriate changes made to the text.

**DISCUSSION**

The use of neuroscience education is increasing. The systematic review used for the development of this study’s preoperative neuroscience education program for lumbar surgery for radiculopathy is the first review of neuroscience education for pain, disability, anxiety, and stress in musculoskeletal conditions. Although this review comprised a rather heterogenous sample of studies using neuroscience education, the results from this review indicate strong evidence for the use of neuroscience education in decreasing pain ratings, increasing physical performance, decreasing perceived disability, and decreasing catastrophization in patients with chronic musculoskeletal pain.

Neuroscience education focuses on a detailed description of the biology and physiology of the

**TABLE 2** Themes captured from descriptions of the important messages from the preoperative neuroscience educational booklet by the five patients and five people from the general population

<table>
<thead>
<tr>
<th>Most important messages from the booklet?</th>
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<tbody>
<tr>
<td>Stress affecting nerve sensitivity</td>
</tr>
<tr>
<td>How much nerve sensitivity is dependent on blood flow</td>
</tr>
<tr>
<td>How to calm nerves down</td>
</tr>
<tr>
<td>Importance of movement after surgery</td>
</tr>
<tr>
<td>Be confident in your surgery decision and don’t second-guess</td>
</tr>
<tr>
<td>Hospital experiences, anxiety and its effect on nerve sensitivity</td>
</tr>
<tr>
<td>Surgery may fix the problem, but the nerves take time to calm down</td>
</tr>
<tr>
<td>Potential changes after surgery?</td>
</tr>
<tr>
<td>Decrease level of stress</td>
</tr>
<tr>
<td>Move more despite sensitivity</td>
</tr>
<tr>
<td>Other comments about the booklet?</td>
</tr>
<tr>
<td>Wish my surgeon told me this before surgery</td>
</tr>
<tr>
<td>Good booklet with easy-to-understand information for all ages</td>
</tr>
<tr>
<td>Good explanation of nerve sensors</td>
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**FIGURE 1** Results from the survey of the expert panel and patients and people from the general population.
nervous system and the brain’s processing of pain and nociceptive input. This approach is in direct contrast to prevailing biomedical models focusing on tissues and tissue injury. A recent survey of United States spine surgeons showed that 97% of spine surgeons use anatomical spine models in their preoperative education, thus using an anatomy- and pathoanatomy-based model explaining pain to patients. Not only have these models shown limited efficacy in decreasing pain and disability, but also, they may, in fact, have increased fear in patients, which in turn may increase their pain.

Although neuroscience education features an anatomical component (anatomy of the nervous system), it deemphasizes tissue injury (i.e., disc or joint), rather using the anatomy to describe pathways to process nociceptive input. A key message that neuroscience education tries to impart to the patient is a clear difference between nociception and pain. Patients are taught that the nervous system has the ability to increase or decrease its sensitivity (neuroplasticity via peripheral and/or central sensitivity) to help them cope with the injury, surgery, and recovery.

Considering that other educational models use similar education delivery methods as neuroscience education does, it could be argued that the content of neuroscience education may be the key element as to its efficacy compared with more traditional models of explaining pain to patients.

Although various definitions for pain are provided in the scientific literature, patients often see pain as a measure of the health of their tissues. Pain is complex, and recent authors have highlighted the fact that pain could possibly be a better measure of potential threat, rather than true tissue health. The larger the threat is, the higher the pain is perceived. Patients’ pain perception due to tissue health is yet another example of an anatomy and pathoanatomy model driving pain. Considering that neuroscience education purposefully deemphasizes tissue injury and focuses on the processing of nociception with the aim to increase patient’s awareness that nociception and pain do not correlate, it could be seen as a possible mechanism to decrease the threat, thus dampening the pain perception in the patient. Several studies have shown that patients with higher pain ratings have increased disability. Because patients view pain as an indicator of tissue health and the potential that activity may further damage their tissue and thus increase pain, decreased physical movements may be seen as a logical protective mechanism. The results from the systematic review suggest that with decreased pain perception and a greater understanding of nonmechanical factors that may increase or decrease nerve sensitivity (i.e., failed treatment, fear, emotions, and different explanations of their pain), patients may be inclined to see themselves as less disabled and more inclined to increase their activity. This result is the underlying premise of the preoperative neuroscience education program and accompanying booklet.

The development and use of booklets concur with patient education studies highlighting booklets as valuable tools in aiding information retention compared with verbal communication only. Booklets are cost-effective, simple, and a popular method of imparting healthcare information to patients. Booklets have also shown the ability to positively influence compliance, reduce anxiety, and empower patients. The current booklet was developed according to established principles: an extensive review of the literature searching for best evidence; careful synthesis into patient-centered messages; ensuring that text, messages, and images were appropriately designed; and evaluation by an expert panel (representative of preoperative education, surgery, and pain science), postoperative back surgery patients, and a community sample. This booklet is intended to be an adjunct to a preoperative neuroscience education program developed to be delivered in a one-on-one educational format by physical therapists for patients before undergoing lumbar surgery for radiculopathy to supplement verbal communication. It can, however, be used as a template for the verbal one-on-one educational program, allowing for more consistency in the message delivered to patients.

**CONCLUSIONS**

This study reports on the development of a preoperative neuroscience education program for use in patients with lumbar radiculopathy who are ready to undergo spinal surgery for their condition. It is hoped that use of this program will lead to improved outcomes after surgery in terms of postoperative pain and disability. Further research into the use of this program is required, and two pilot studies are currently being conducted to measure the effect of the preoperative neuroscience education program: a small case series measuring the immediate effects on pressure pain thresholds, physical movement (trunk flexion, straight leg raise), pain ratings, and anxiety before and after education and a single-case design pre-educational and posteducational session functional magnetic resonance imaging. Furthermore, more rigorous
evaluation of the preoperative neuroscience education program is planned as a multicenter randomized controlled trial in a group of patients undergoing lumbar surgery for radiculopathy.

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